



(19) **United States**

(12) **Patent Application Publication**
UNO

(10) **Pub. No.: US 2020/0106022 A1**

(43) **Pub. Date: Apr. 2, 2020**

(54) **ORGANIC ELECTROLUMINESCENCE
DEVICE AND AMINE COMPOUND FOR
ORGANIC ELECTROLUMINESCENCE
DEVICE**

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(21) Appl. No.: **16/455,353**

(22) Filed: **Jun. 27, 2019**

(30) **Foreign Application Priority Data**

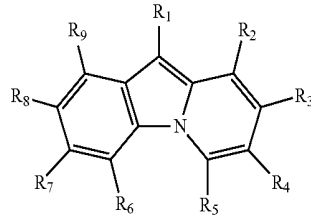
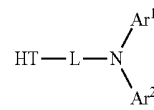
Sep. 28, 2018 (KR) 10-2018-0115457

Publication Classification

(51) **Int. Cl.**
H01L 51/00 (2006.01)
C07D 471/04 (2006.01)
C09K 11/06 (2006.01)
(52) **U.S. Cl.**
CPC *H01L 51/0061* (2013.01); *C07D 471/04*
(2013.01); *H01L 51/5012* (2013.01); *H01L*
51/006 (2013.01); *C09K 11/06* (2013.01)

(57) **ABSTRACT**

An organic electroluminescence device according to embodiments of the present disclosure includes a first electrode, a second electrode opposite the first electrode, and at least one organic layer between the first electrode and the second electrode, wherein the at least one organic layer includes an amine compound represented by Formula 1, and HT in Formula 1 includes a pyridoindole moiety represented by Formula 2. Improved device efficiency and life characteristics may be achieved when the amine compound represented by Formula 1 is included in the organic electroluminescence device.



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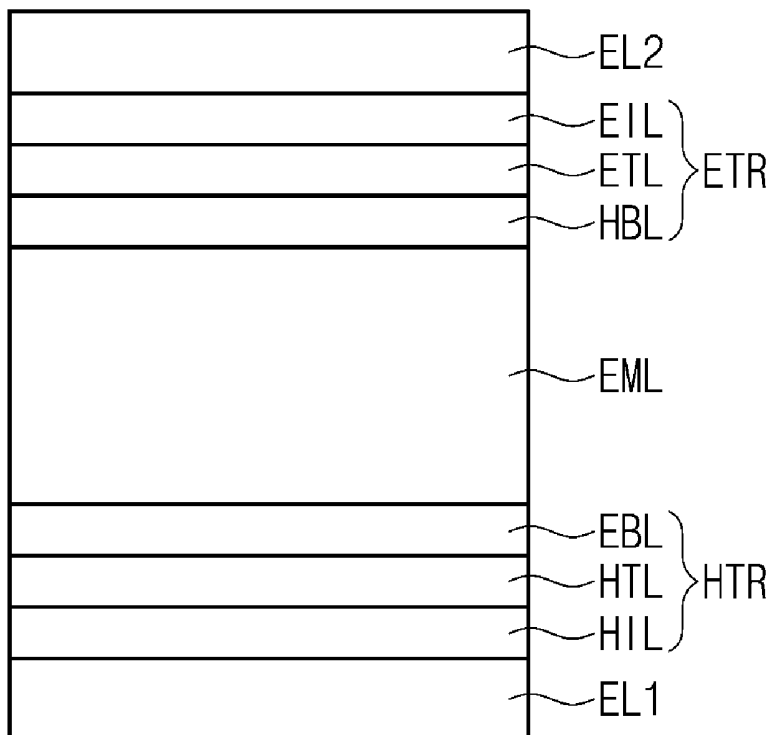


FIG. 1

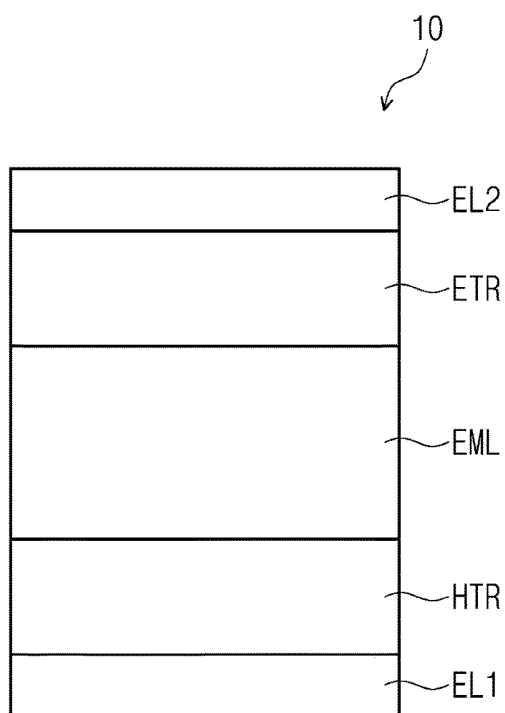


FIG. 2

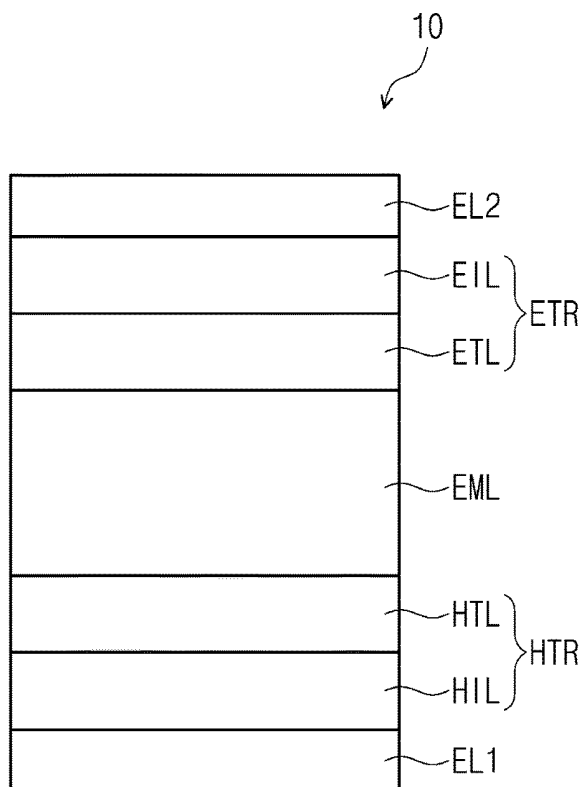
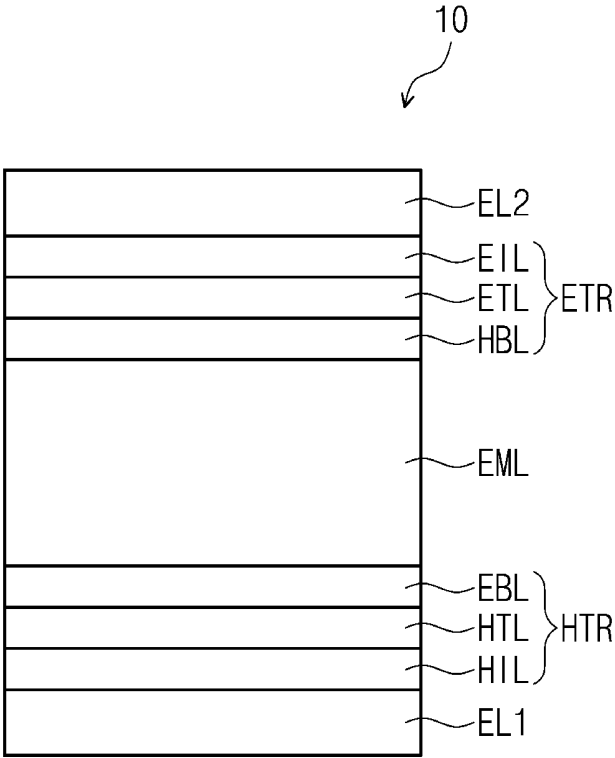


FIG. 3



**ORGANIC ELECTROLUMINESCENCE
DEVICE AND AMINE COMPOUND FOR
ORGANIC ELECTROLUMINESCENCE
DEVICE**

CROSS-REFERENCE TO RELATED
APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2018-0115457, filed on Sep. 28, 2018, the entire content of which is incorporated herein by reference.

BACKGROUND

[0002] One or more aspects of example embodiments of the present disclosure are related to an amine compound and an organic electroluminescence device including the same, and more particularly, to an amine compound used in a hole transport region and an organic electroluminescence device including the same.

[0003] Organic electroluminescence display devices are being actively developed as image display devices. An organic electroluminescence display device differs from a liquid crystal display device in that it is a so-called self-luminescent display device, in which holes and electrons injected from a first electrode and a second electrode, respectively, recombine in an emission layer, and a light emission material including an organic compound in the emission layer emits light to attain display.

[0004] In the application of an organic electroluminescence device to a display device, a decrease in driving voltage, an increase in emission efficiency, and an increased lifetime of the organic electroluminescence device are desired, and materials for organic electroluminescence devices that can stably attain these requirements are being developed.

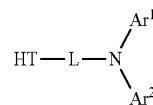
[0005] In order to achieve an organic electroluminescence device with high efficiency, materials for a hole transport layer that can restrain the diffusion, etc. of the exciton energy of an emission layer are being developed.

SUMMARY

[0006] One or more aspects of example embodiments of the present disclosure are directed toward an amine compound as a material for an organic electroluminescence device that is capable of improving emission efficiency and/or device life.

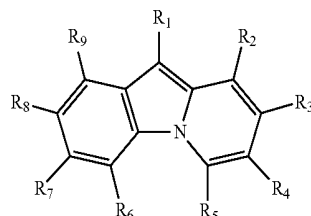
[0007] One or more aspects of example embodiments of the present disclosure are directed toward an organic electroluminescence device having improved thermal charge tolerance by including an amine compound including pyridindole.

[0008] One or more example embodiments of the present disclosure provide an organic electroluminescence device including a first electrode; a second electrode on the first electrode; and a plurality of organic layers between the first electrode and the second electrode, wherein at least one organic layer of the plurality of organic layers includes an amine compound represented by Formula 1:



Formula 1

[0009] In Formula 1, Ar₁ and Ar₂ may each independently be a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; L may be a direct linkage, a substituted or unsubstituted arylene group of 6 to 30 carbon atoms for forming a ring, or a substituted or unsubstituted heteroarylene group of 2 to 30 carbon atoms for forming a ring; and HT may be represented by Formula 2:



Formula 2

[0010] In Formula 2, R₁ to R₉ may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms. At least one pair of R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ may be combined with each other (linked) to form a hexagonal (six-membered) hydrocarbon ring, and when at least one pair of R₂ and R₃, R₃ and R₄, and R₄ and R₅ forms a hexagonal hydrocarbon ring, R₈ may be a hydrogen atom.

[0011] In some embodiments, the plurality of organic layers may include an emission layer; and a hole transport region between the first electrode and the emission layer, wherein the hole transport region may include the amine compound represented by Formula 1.

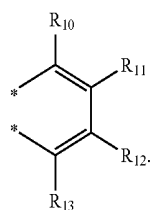
[0012] In some embodiments, the emission layer may be to emit blue light and/or green light.

[0013] In some embodiments, the plurality of organic layers may include an emission layer; a hole injection layer between the first electrode and the emission layer; and a hole transport layer between the hole injection layer and the emission layer, wherein the hole transport layer may include the amine compound represented by Formula 1.

[0014] In some embodiments, one or two pairs selected from R₂ and R₃, R₃ and R₄, and R₄ and R₅ may each form the hexagonal hydrocarbon ring.

[0015] In some embodiments, one or two pairs selected from R₆ and R₇, R₇ and R₈, and R₈ and R₉ may each form the hexagonal hydrocarbon ring.

[0016] In some embodiments, the hexagonal hydrocarbon ring may be represented by Formula 3:

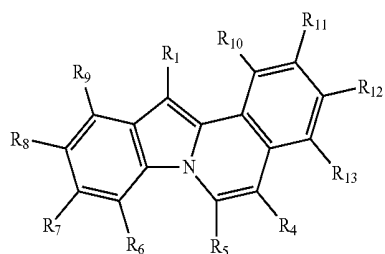


Formula 3

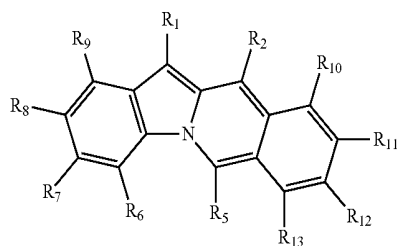
[0017] In Formula 3, R₁₀ to R₁₃ may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms, and * indicates a combining part (points of connection) with Formula 2.

[0018] In some embodiments, any one of R₂ to R₉ and R₁₀ to R₁₃ that is not a part of the hexagonal hydrocarbon ring may be combined with L in Formula 1.

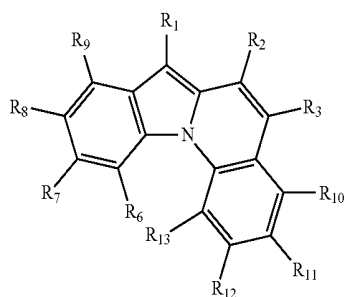
[0019] In some embodiments, HT (Formula 2) may be further represented by one of Formula 2-1a to Formula 2-1d:



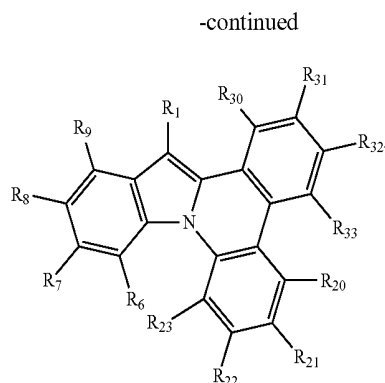
Formula 2-1a



Formula 2-1b



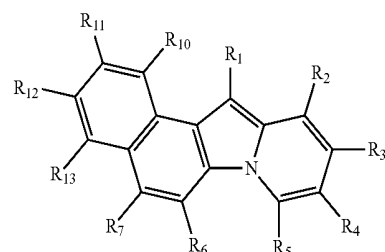
Formula 2-1c



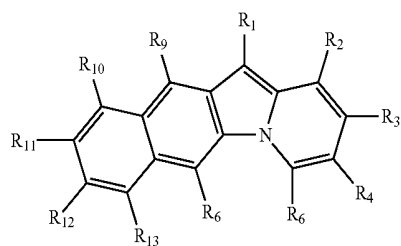
Formula 2-1d

[0020] In Formula 2-1d, R₂₀ to R₂₃ and R₃₀ to R₃₃ may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; and in Formula 2-1a to Formula 2-1d, R₁ to R₉ may be the same as defined in Formula 2, and R₁₀ to R₁₃ may be the same as defined in Formula 3.

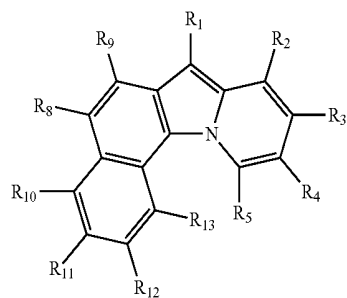
[0021] In some embodiments, HT may be represented by one of Formula 2-2a to Formula 2-2d:



Formula 2-2a



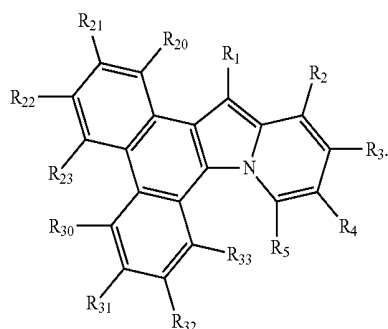
Formula 2-2b



Formula 2-2c

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Formula 2-2d



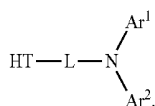
[0022] In Formula 2-2d, R_{20} to R_{23} and R_{30} to R_{33} may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; and in Formula 2-2a to Formula 2-2d, R_1 to R_9 may be the same as defined in Formula 2, and R_{10} to R_{13} may be the same as defined in Formula 3.

[0023] In some embodiments, R_1 may be an unsubstituted phenyl group, an unsubstituted naphthyl group, an unsubstituted biphenyl group, an unsubstituted dibenzofuran group, or an unsubstituted dibenzothiophene group.

[0024] In some embodiments, L may be a direct linkage, a substituted or unsubstituted phenylene group, a substituted or unsubstituted divalent biphenyl group, a substituted or unsubstituted divalent terphenyl group, a substituted or unsubstituted divalent phenanthrene group, a substituted or unsubstituted naphthylene group, or a substituted or unsubstituted divalent dibenzofuran group.

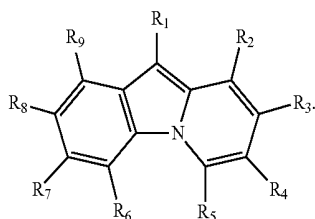
[0025] One or more example embodiments of the present disclosure provide an amine compound represented by Formula 1:

Formula 1

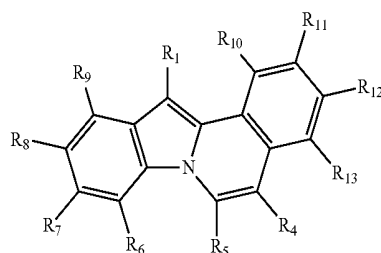


[0026] In Formula 1, Ar_1 and Ar_2 may each independently be a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; L may be a direct linkage, a substituted or unsubstituted arylene group of 6 to 30 carbon atoms for forming a ring, or a substituted or unsubstituted heteroarylene group of 2 to 30 carbon atoms for forming a ring; and HT may be represented by Formula 2:

Formula 2



Formula 2-1a



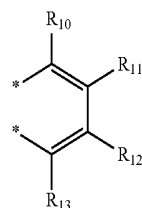
[0027] In Formula 2, R_1 to R_9 may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; at least one pair of R_2 and R_3 , R_3 and R_4 , R_4 and R_5 , R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 may be combined with each other to form a hexagonal (six-membered) hydrocarbon ring; and when at least one pair of R_2 and R_3 , R_3 and R_4 , and R_4 and R_5 forms a hexagonal hydrocarbon ring, R_8 is a hydrogen atom.

[0028] In some embodiments, one or two pairs selected from R_2 and R_3 , R_3 and R_4 , and R_4 and R_5 may each form the hexagonal hydrocarbon ring.

[0029] In some embodiments, one or two pairs selected from R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 may each form the hexagonal hydrocarbon ring.

[0030] In some embodiments, the hexagonal hydrocarbon ring may be represented by Formula 3:

Formula 3

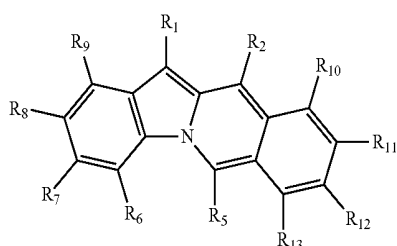


[0031] In Formula 3, R_{10} to R_{13} may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms, and * indicates a combining part (points of connection) with Formula 2.

[0032] In some embodiments, any one of R_2 to R_9 and R_{10} to R_{13} that is not a part of the hexagonal hydrocarbon ring may be combined with L in Formula 1.

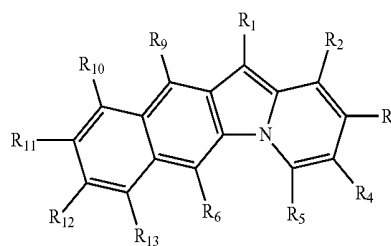
[0033] In some embodiments, HT (Formula 2) may be further represented by one of Formula 2-1a to Formula 2-1d:

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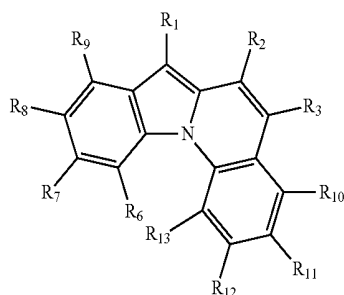


Formula 2-1b

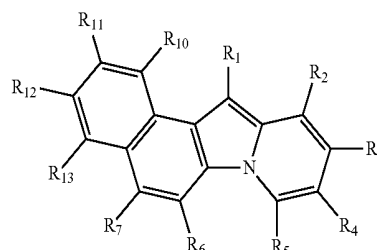
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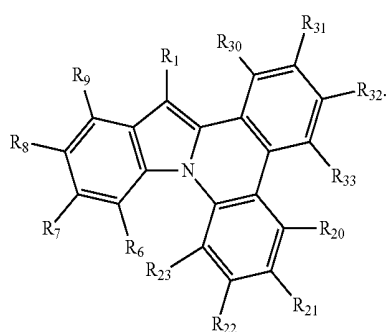
Formula 2-2b



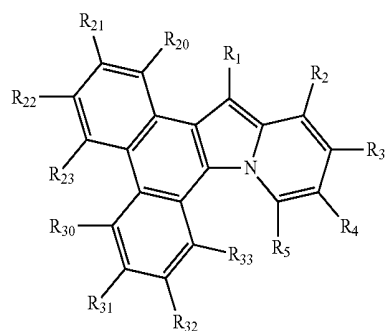
Formula 2-1c



Formula 2-2c



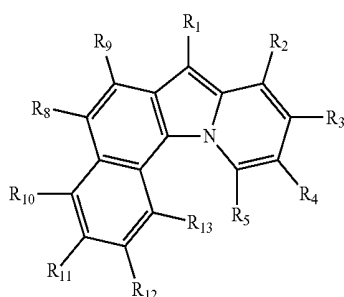
Formula 2-1d



Formula 2-2d

[0034] In Formula 2-1d, R_{20} to R_{23} and R_{30} to R_{33} may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; and in Formula 2-1a to Formula 2-1d, R_1 to R_9 may be the same as defined in Formula 2, and R_{10} to R_{13} may be the same as defined in Formula 3.

[0035] In some embodiments, HT may be represented by one of Formula 2-2a to Formula 2-2d:



Formula 2-2a

[0036] In Formula 2-2d, R_{20} to R_{23} and R_{30} to R_{33} may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; and in Formula 2-2a to Formula 2-2d, R_1 to R_9 may be the same as defined in Formula 2, and R_{10} to R_{13} may be the same as defined in Formula 3.

[0037] In some embodiments, R_1 may be an unsubstituted phenyl group, an unsubstituted naphthyl group, an unsubstituted biphenyl group, an unsubstituted dibenzofuranyl group, or an unsubstituted dibenzothiophene group.

[0038] In some embodiments, L may be a direct linkage, a substituted or unsubstituted phenylene group, a substituted or unsubstituted divalent biphenyl group, a substituted or unsubstituted divalent terphenyl group, a substituted or unsubstituted divalent phenanthrene group, a substituted or unsubstituted naphthylene group, or a substituted or unsubstituted divalent dibenzofuran group.

[0039] In some embodiments, Ar_1 and Ar_2 may each independently be a substituted or unsubstituted phenyl group, a substituted or unsubstituted biphenyl group, a substituted or unsubstituted terphenyl group, a substituted or unsubstituted phenanthrene group, a substituted or unsubstituted triphenylene group, a substituted or unsubstituted naphthyl group, a substituted or unsubstituted fluorenyl group, a substituted or unsubstituted adamantyl group, a substituted

or unsubstituted dibenzofuran group, a substituted or unsubstituted dibenzothiophene group, or a substituted or unsubstituted pyridinyl group.

[0040] In some embodiments, Ar₁ and Ar₂ may each independently be: an aryl group of 6 to 40 carbon atoms for forming a ring, which may be unsubstituted or substituted with at least one substituent selected from a halogen atom, a cyano group, an alkyl group of 1 to 20 carbon atoms, an alkoxy group of 1 to 10 carbon atoms, an aryloxy group of 1 to 20 carbon atoms, an aryl group of 6 to 30 carbon atoms, a triarylsilyl group of 18 to 50 carbon atoms, and an adamantyl group; or a heteroaryl group of 2 to 40 carbon atoms for forming a ring, which may be unsubstituted or substituted with at least one substituent selected from a halogen atom, a cyano group, an alkyl group of 1 to 20 carbon atoms, an alkoxy group of 1 to 10 carbon atoms, an aryloxy group of 1 to 20 carbon atoms, an aryl group of 6 to 30 carbon atoms, a triarylsilyl group of 18 to 50 carbon atoms, and an adamantyl group.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate example embodiments of the present disclosure and, together with the description, serve to explain principles of the present disclosure. In the drawings:

[0042] FIG. 1 is a cross-sectional view schematically illustrating an organic electroluminescence device according to an embodiment of the present disclosure;

[0043] FIG. 2 is a cross-sectional view schematically illustrating an organic electroluminescence device according to an embodiment of the present disclosure; and

[0044] FIG. 3 is a cross-sectional view schematically illustrating an organic electroluminescence device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0045] The present disclosure may include various modifications and may be embodied in different forms, and example embodiments thereof will be explained in more detail with reference to the accompany drawings. The present disclosure may, however, be embodied in various suitable forms, and should not be construed as being limited to the embodiments set forth herein. Rather, all modifications, equivalents, and substituents within the spirit and technical scope of the present disclosure are understood to be included in the present disclosure.

[0046] Like reference numerals refer to like elements throughout, and duplicative descriptions thereof may not be provided. In the drawings, the dimensions of structures may be exaggerated for clarity of illustration. It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, those elements should not be limited by these terms. These terms are only used to distinguish one element from another element. Thus, a first element could be alternatively termed a second element without departing from the teachings of the present disclosure. Similarly, a second element could be alternatively termed a first element. As used herein, the singular forms are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0047] It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, numerals, steps, operations, elements, parts, or combinations thereof, but do not preclude the presence or addition of one or more other features, numerals, steps, operations, elements, parts, or combinations thereof. It will also be understood that when a layer, a film, a region, a plate, etc. is referred to as being “on” another part, it can be “directly on” the other part, or intervening layers may also be present. In contrast, when an element is referred to as being “directly on” another element, no intervening elements are present.

[0048] Expressions such as “at least one of”, “one of”, “selected from”, “at least one selected from”, and “one selected from”, when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list. Further, the use of “may” when describing embodiments of the present disclosure refers to “one or more embodiments of the present disclosure.”

[0049] In the description, “—*” indicates a connecting position or point of connection (e.g., to another formula or moiety).

[0050] In the description, the term “substituted or unsubstituted”, for example, as used to describe a group, indicates that the group may be unsubstituted, or substituted with at least one substituent selected from the group consisting of a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a silyl group, a boron group, a phosphine oxide group, a phosphine sulfide group, an alkyl group, an alkenyl group, an alkoxy group, an aryloxy group, an alkylthio group, an arylthio group, a hydrocarbon ring, an aryl group, and a heterocyclic group. Each of the substituents may be further substituted or unsubstituted. For example, a biphenyl group may be interpreted as an aryl group or a phenyl group substituted with a phenyl group.

[0051] In the description, the term “halogen atom” may include a fluorine atom, a chlorine atom, a bromine atom, and/or an iodine atom.

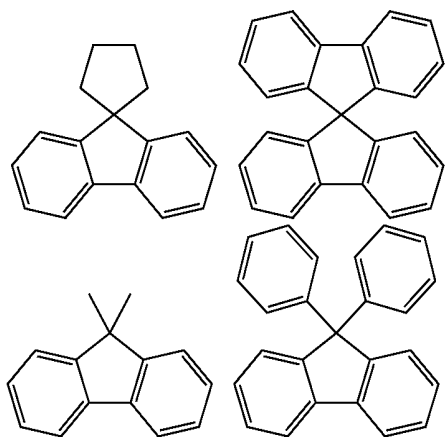
[0052] In the description, the term “alkyl” may indicate a linear, branched, and/or cyclic alkyl. The carbon number of the alkyl may be 1 to 50, 1 to 30, 1 to 20, 1 to 10, or 1 to 6. Non-limiting examples of the alkyl include methyl, ethyl, n-propyl, isopropyl, n-butyl, s-butyl, t-butyl, i-butyl, 2-ethylbutyl, 3,3-dimethylbutyl, n-pentyl, i-pentyl, neopentyl, t-pentyl, cyclopentyl, 1-methylpentyl, 3-methylpentyl, 2-ethylpentyl, 4-methyl-2-pentyl, n-hexyl, 1-methylhexyl, 2-ethylhexyl, 2-butylhexyl, cyclohexyl, 4-methylcyclohexyl, 4-t-butylcyclohexyl, n-heptyl, 1-methylheptyl, 2,2-dimethylheptyl, 2-ethylheptyl, 2-butylheptyl, n-octyl, t-octyl, 2-ethyloctyl, 2-butylloctyl, 2-hexyloctyl, 3,7-dimethyloctyl, cyclooctyl, n-nonyl, n-decyl, adamantyl, 2-ethyldecyl, 2-butyldecyl, 2-hexyldecyl, 2-octyldecyl, n-undecyl, n-dodecyl, 2-ethyldodecyl, 2-butylldodecyl, 2-hexyldodecyl, 2-octyldodecyl, n-tridecyl, n-tetradecyl, n-pentadecyl, n-hexadecyl, 2-ethylhexadecyl, 2-butylhexadecyl, 2-hexylhexadecyl, 2-octylhexadecyl, n-heptadecyl, n-octadecyl, n-nonadecyl, n-eicosyl, 2-ethyleicosyl, 2-butyleicosyl, 2-hexyleicosyl, 2-octyleicosyl, n-henicosyl, n-docosyl, n-tricosyl, n-tetracosyl, n-pentacosyl, n-hexacosyl, n-heptacosyl, n-octacosyl, n-nonacosyl, n-triacontyl, etc.

[0053] In the description, the term “hydrocarbon ring” may refer to a functional group or substituent derived from an aliphatic hydrocarbon ring, or a functional group or

substituent derived from an aromatic hydrocarbon ring. The hydrocarbon ring does not include a heteroatom (e.g., includes only carbon and hydrogen atoms), and may include 5 to 20 carbon atoms for forming a ring. The hydrocarbon ring may be a monocyclic ring, and for example, a hexagonal hydrocarbon ring in the description may be a benzene ring.

[0054] In the description, the term “aryl group” may refer to a functional group or substituent derived from an aromatic hydrocarbon ring. The aryl group may be a monocyclic aryl group or a polycyclic aryl group. The carbon number for forming a ring in the aryl group may be 6 to 30, 6 to 20, or 6 to 15. Non-limiting examples of the aryl group include phenyl, naphthyl, fluorenyl, anthracenyl, phenanthryl, biphenyl, terphenyl, quaterphenyl, quinphenyl, sexiphenyl, triphenylenyl, pyrenyl, benzofluoranthenyl, chrysenyl, etc.

[0055] In the description, the fluorenyl group may be substituted or bisubstituted (e.g. at the 9H position), and two substituents may be combined with each other (e.g., linked) to form a spiro structure. Non-limiting examples of a substituted fluorenyl group are as follows. However, embodiments of the present disclosure are not limited thereto:



[0056] In the description, the term “heteroaryl” may refer to a heteroaryl group including at least one selected from oxygen (O), nitrogen (N), phosphorus (P), silicon (Si), and sulfur (S) as a heteroatom. The carbon number for forming a ring of the heteroaryl may be 2 to 30 or 2 to 20. The heteroaryl may be a monocyclic heteroaryl group or a polycyclic heteroaryl group. The polycyclic heteroaryl may have a dicyclic or tricyclic structure. Non-limiting examples of the heteroaryl include thiophene, furan, pyrrole, imidazole, thiazole, oxazole, oxadiazole, triazole, pyridine, bipyridine, pyrimidine, triazine, triazole, acridyl, pyridazine, pyrazinyl, quinoline, quinazoline, quinoxaline, phenoxazine, phthalazine, pyrido pyrimidine, pyrido pyrazine, pyrazino pyrazine, isoquinoline, indole, carbazole, N-aryl-carbazole, N-heteroarylcarbazole, N-alkylcarbazole, benzoxazole, benzimidazole, benzothiazole, benzocarbazole, benzothiophene, dibenzothiophene, thienothiophene, benzofuran, phenanthroline, thiazole, isooxazole, oxadiazole, thiadiazole, phenothiazine, dibenzosilole, dibenzofuran, etc.

[0057] In the description, the term “silyl group” may refer to an alkyl silyl group or an aryl silyl group. Non-limiting examples of the silyl group include trimethylsilyl, triethyl-

silyl, t-butyldimethylsilyl, vinyltrimethylsilyl, propyldimethylsilyl, triphenylsilyl, diphenylsilyl, phenylsilyl, etc. However, embodiments of the present disclosure are not limited thereto.

[0058] In the description, the term “oxy group” may refer to alkoxy group or an aryloxy group. The alkoxy group may include a linear, branched, or cyclic chain. The carbon number of the alkoxy group is not specifically limited and may be, for example, 1 to 20, or 1 to 10. Non-limiting examples of the oxy group include methoxy, ethoxy, n-propoxy, isopropoxy, butoxy, pentyloxy, hexyloxy, octyloxy, nonyloxy, decyloxy, benzyloxy, etc. However, embodiments of the present disclosure are not limited thereto.

[0059] In the description, the carbon number of the amino group is not specifically limited, but may be 1 to 30. Non-limiting examples of the amino group include an alkyl amino group and an aryl amino group. Non-limiting examples of the amino group include a methylamino group, a dimethylamino group, a phenylamino group, a diphenylamino group, a naphthylamino group, a 9-methyl-anthracenylamino group, a triphenylamino group, etc. However, embodiments of the present disclosure are not limited thereto.

[0060] Hereinafter, an organic electroluminescence device according to an embodiment of the present disclosure and an amine compound included therein according to an embodiment of the present disclosure will be explained.

[0061] FIG. 1-FIG. 3 are cross-sectional views schematically illustrating organic electroluminescence devices according to example embodiments of the present disclosure. Referring to FIG. 1-FIG. 3, an organic electroluminescence device 10 according to an embodiment of the present disclosure may include a first electrode EL1, a hole transport region HTR, an emission layer EML, an electron transport region ETR, and a second electrode EL2, each laminated (stacked) in this listed order.

[0062] The first electrode EL1 and the second electrode EL2 are opposite to each other, and a plurality of organic layers may be between the first electrode EL1 and the second electrode EL2. The plurality of the organic layers may include a hole transport region HTR, an emission layer EML, and/or an electron transport region ETR.

[0063] The organic electroluminescence device 10 according to an embodiment of the present disclosure may include an amine compound according to an embodiment of the present disclosure, which will be described later, in at least one organic layer of the plurality of the organic layers between the first electrode EL1 and the second electrode EL2. For example, an amine compound according to an embodiment of the present disclosure may be included in the hole transport region HTR.

[0064] FIG. 2 differs from FIG. 1 in that FIG. 2 shows a cross-sectional view of an organic electroluminescence device 10 according to an embodiment of the present disclosure, in which a hole transport region HTR includes a hole injection layer HIL and a hole transport layer HTL, and an electron transport region ETR includes an electron injection layer EIL and an electron transport layer ETL. FIG. 3 differs from FIG. 1 in that FIG. 3 shows a cross-sectional view of an organic electroluminescence device 10 according to an embodiment of the present disclosure, wherein a hole transport region HTR includes a hole injection layer HIL, a hole transport layer HTL, and an electron blocking layer EBL, and an electron transport region ETR includes an

electron injection layer EIL, an electron transport layer ETL, and a hole blocking layer HBL. The hole transport layer HTL in the organic electroluminescence device 10 according to an embodiment of the present disclosure may include an amine compound according to an embodiment of the present disclosure.

[0065] Meanwhile, in the organic electroluminescence device 10 according to an embodiment of the present disclosure, the hole transport layer HTL may include a plurality of hole transport sub-layers, among which a hole transport sub-layer adjacent to the emission layer EML may include the amine compound according to an embodiment of the present disclosure.

[0066] The first electrode EL1 may be conductive. The first electrode EL1 may be formed using a metal alloy and/or a conductive compound. The first electrode EL1 may be an anode. In some embodiments, the first electrode EL1 may be a pixel electrode. The first electrode EL1 may be a transmissive electrode, a transfective (semi-transmissive) electrode, or a reflective electrode. When the first electrode EL1 is a transmissive electrode, the first electrode EL1 may be formed using a transparent metal oxide (such as indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), and/or indium tin zinc oxide (ITZO)). When the first electrode EL1 is a transfective electrode or a reflective electrode, the first electrode EL1 may include silver (Ag), magnesium (Mg), copper (Cu), aluminum (Al), platinum (Pt), palladium (Pd), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), lithium (Li), calcium (Ca), LiF/Ca, LiF/Al, molybdenum (Mo), titanium (Ti), a compound thereof, or a mixture thereof (for example, a mixture of Ag and Mg). In some embodiments, the first electrode EL1 may have a structure including a plurality of layers, including a reflective layer or a transfective layer formed using the above materials, and a transmissive conductive layer formed using ITO, IZO, ZnO, or ITZO. For example, the first electrode EL1 may have a three-layer structure of ITO/Ag/ITO. However, embodiments of the present disclosure are not limited thereto. The thickness of the first electrode EL1 may be about 1,000 Å to about 10,000 Å, for example, about 1,000 Å to about 3,000 Å.

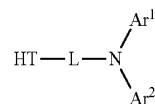
[0067] The hole transport region HTR may be on the first electrode EL1. The hole transport region HTR may include at least one selected from a hole injection layer HIL, a hole transport layer HTL, a hole buffer layer, and an electron blocking layer EBL.

[0068] The hole transport region HTR may have a single layer structure formed using a single material, a single layer structure formed using a plurality of different materials, or a multilayer structure including a plurality of layers formed using a plurality of different materials.

[0069] For example, the hole transport region HTR may have the structure of a single layer of a hole injection layer HIL or a hole transport layer HTL, and may have a structure of a single layer formed using a hole injection material and a hole transport material. Alternatively, the hole transport region HTR may have a structure of a single layer formed using a plurality of different materials, or a structure laminated from the first electrode EL1 of hole injection layer HIL/hole transport layer HTL, hole injection layer HIL/hole transport layer HTL/hole buffer layer, hole injection layer HIL/hole buffer layer, hole transport layer HTL/hole buffer layer, or hole injection layer HIL/hole transport layer HTL/electron blocking layer, without limitation.

[0070] The hole transport region HTR may be formed using any suitable method available in the art (such as a vacuum deposition method, a spin coating method, a cast method, a Langmuir-Blodgett (LB) method, an inkjet printing method, a laser printing method, and/or a laser induced thermal imaging (LITI) method).

[0071] In the organic electroluminescence device 10 according to an embodiment of the present disclosure, at least one of the organic layers between the first electrode EL1 and the second electrode EL2 may include an amine compound represented by Formula 1. In the organic electroluminescence device 10 according to an embodiment of the present disclosure, a hole transport region HTR may include an amine compound represented by Formula 1:

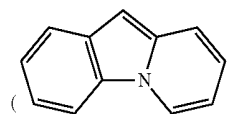


Formula 1

[0072] In Formula 1, Ar₁ and Ar₂ may each independently be a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms; and L may be a direct linkage, a substituted or unsubstituted arylene group of 6 to 30 carbon atoms for forming a ring, or a substituted or unsubstituted heteroarylene group of 2 to 30 carbon atoms for forming a ring.

[0073] In some embodiments, in Formula 1, Ar₁ and Ar₂ may each independently be an aryl group of 6 to 40 carbon atoms for forming a ring, which may be unsubstituted or substituted with at least one substituent selected from a halogen atom, a cyano group, an alkyl group of 1 to 20 carbon atoms, an alkoxy group of 1 to 10 carbon atoms, an aryloxy group of 1 to 20 carbon atoms, an aryl group of 6 to 30 carbon atoms, a triarylsilyl group of 18 to 50 carbon atoms, and an adamantyl group.

[0074] In some embodiments, Ar₁ and Ar₂ may each independently be a heteroaryl group of 2 to 40 carbon atoms for forming a ring, which may be unsubstituted or substituted with at least one substituent selected from a halogen atom, a cyano group, an alkyl group of 1 to 20 carbon atoms, an alkoxy group of 1 to 10 carbon atoms, an aryloxy group of 1 to 20 carbon atoms, an aryl group of 6 to 30 carbon atoms, a triarylsilyl group of 18 to 50 carbon atoms, and an adamantyl group. However, the case in which Ar₁ and Ar₂ include a pyridoindole moiety



is excluded.

[0075] Ar₁ and Ar₂ may each independently be a substituted or unsubstituted phenyl group, a substituted or unsubstituted biphenyl group, a substituted or unsubstituted terphenyl group, a substituted or unsubstituted phenanthrene group, a substituted or unsubstituted triphenylene group, a substituted or unsubstituted naphthyl group, a substituted or

unsubstituted fluorenyl group, a substituted or unsubstituted adamantyl group, a substituted or unsubstituted dibenzofuran group, a substituted or unsubstituted dibenzothiophene group, or a substituted or unsubstituted pyridinyl group.

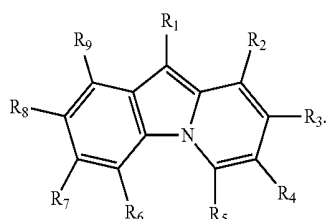
[0076] For example, Ar₁ and Ar₂ may each independently be an unsubstituted phenyl group, a phenyl group substituted with a naphthyl group, a phenyl group substituted with a phenyl group, a phenyl group substituted with deuterium, a phenyl group substituted with a halogen atom, a phenyl group substituted with an aryloxy group, a phenyl group substituted with an adamantyl group, an unsubstituted biphenyl group, a biphenyl group substituted with a phenyl group, an unsubstituted terphenyl group, an unsubstituted phenanthrene group, an unsubstituted triphenylene group, an unsubstituted naphthyl group, a naphthyl group substituted with a phenyl group, an unsubstituted fluorenyl group, a fluorenyl group substituted with a phenyl group, an unsubstituted dibenzofuran group, a dibenzofuran group substituted with a phenyl group, a substituted or unsubstituted dibenzothiophene group, a dibenzothiophene group substituted with a phenyl group, or an unsubstituted pyridinyl group. However, embodiments of the present disclosure are not limited thereto.

[0077] In Formula 1, Ar₁ and Ar₂ may be the same or different.

[0078] In Formula 1, L may be a direct linkage, a substituted or unsubstituted phenylene group, a substituted or unsubstituted divalent biphenyl group, a substituted or unsubstituted divalent terphenyl group, a substituted or unsubstituted divalent phenanthrene group, a substituted or unsubstituted divalent naphthylene group, or a substituted or unsubstituted divalent dibenzofuran group.

[0079] For example, in Formula 1, L may be a direct linkage, an unsubstituted phenylene group, an unsubstituted divalent biphenyl group, an unsubstituted divalent terphenyl group, a substituted or unsubstituted divalent phenanthrene group, an unsubstituted naphthylene group, or an unsubstituted divalent dibenzofuran group. However, embodiments of the present disclosure are not limited thereto.

[0080] In Formula 1, HT may be further represented by Formula 2. For example, the amine compound represented by Formula 1 may include a pyridoindole part (moiety) represented by Formula 2:



Formula 2

[0081] In Formula 2, R₁ to R₉ may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms. R₁ to R₉ may each be the same, or at least one thereof may be different.

[0082] Two neighboring substituents selected from R₂ to R₉ may be combined with each other to form a hexagonal (six-membered) hydrocarbon ring. As used herein, the term “form a hexagonal hydrocarbon ring” refers to a case in

which the two named substituent groups in the pair are replaced with a four-carbon linker so that the two carbons underlying the named substituent groups and the four carbons in the linker thereby form a ring structure. The hexagonal hydrocarbon ring formed by the combination of two substituents may be an aromatic ring not including a heteroatom. In some embodiments, the hexagonal hydrocarbon ring may be a benzene ring.

[0083] In Formula 2, any one of the remaining groups of R₂ to R₉ that are not combined with each other to form a hexagonal hydrocarbon ring, and of R₁₀ to R₁₃ on the hexagonal hydrocarbon ring formed by the combination of two substituents, may be combined with L in Formula 1. In some embodiments, in Formula 2, the remaining groups not combined with L in Formula 1 may all be hydrogen atoms.

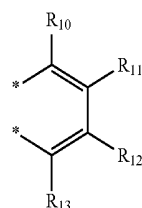
[0084] In Formula 2, at least one pair selected from R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ may be combined with each other to form a hexagonal hydrocarbon ring. For example, one or two pairs selected from R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ may be combined with each other to form one or two hexagonal hydrocarbon rings, respectively.

[0085] Any of the remaining groups of R₂ to R₉ that do not form the hexagonal hydrocarbon ring may be combined with L in Formula 1. In some embodiments, a group on the hexagonal hydrocarbon ring formed by the combination of R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, or R₈ and R₉ may be combined with L in Formula 1. In some embodiments, when at least one pair selected from R₂ and R₃, R₃ and R₄, and R₄ and R₅ forms a hexagonal hydrocarbon ring, R₈ may be a hydrogen atom.

[0086] For example, in an amine compound according to an embodiment of the present disclosure, when at least one pair selected from R₂ and R₃, R₃ and R₄, and R₄ and R₅ is combined with each other to form a hexagonal hydrocarbon ring, R₈ is excluded from being combined with L in Formula 1.

[0087] In Formula 2, R₁ may be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms. For example, R₁ may be an unsubstituted phenyl group, an unsubstituted naphthyl group, an unsubstituted biphenyl group, an unsubstituted dibenzofuran group, or an unsubstituted dibenzothiophene group. However, embodiments of the present disclosure are not limited thereto.

[0088] In Formula 2, at least one pair selected from R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ may be combined with each other to form a hexagonal hydrocarbon ring represented by Formula 3:



Formula 3

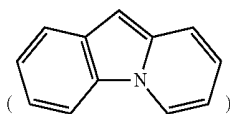
[0089] In Formula 3, R₁₀ to R₁₃ may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or

unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms. In Formula 3, * may be a combining part (point of connection) with Formula 2.

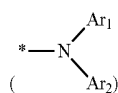
[0090] For example, in Formula 2, at least one pair selected from R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ may be combined with each other and with a moiety represented by Formula 3 to form a benzene ring. In some embodiments, for example, at least one pair selected from R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ in Formula 2 may be combined with each other and with Formula 3 to form a benzene ring that is coupled to a pyridoindole moiety.

[0091] Referring to Formula 1 to Formula 3, an amine compound according to an embodiment of the present disclosure may include, as a substituent, a condensed ring having four or five rings including a pyridoindole moiety. The amine compound according to an embodiment of the present disclosure may be a monoamine compound including, as a substituent, a condensed ring having four or five rings including a pyridoindole moiety.

[0092] The amine compound according to an embodiment of the present disclosure may include both a pyridoindole moiety



and an arylamine moiety



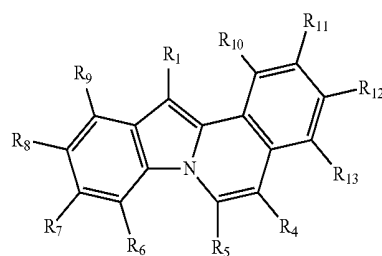
(e.g., simultaneously). When the amine compound according to an embodiment of the present disclosure includes both a pyridoindole moiety and an arylamine moiety (e.g., simultaneously), an organic electroluminescence device including the amine compound may show long life characteristics and/or high emission efficiency.

[0093] The amine compound according to an embodiment of the present disclosure includes a pyridoindole moiety having excellent thermal/charge tolerance, along with an arylamine moiety having long life characteristics, thereby improving tolerance to high temperature and charge. Accordingly, the amine compound may be used as a material for an organic electroluminescence device having an improved device lifetime (e.g., lifespan). In some embodiments, the nitrogen atom included in the pyridoindole moiety may improve the hole transport capacity of the entire amine compound molecule, and the recombination probability of holes and electrons in an emission layer of an organic electroluminescence device may be increased. Thus, the amine compound according to an embodiment of the present disclosure may provide an organic electroluminescence device with improved emission efficiency.

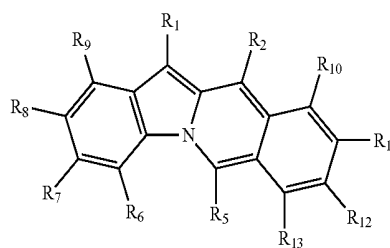
[0094] In Formula 2, one or two pairs selected from R₂ and R₃, R₃ and R₄, and R₄ and R₅ may form a hexagonal hydrocarbon ring represented by Formula 3. For example, in Formula 2, one pair selected from R₂ and R₃, R₃ and R₄, R₄ and R₅ may form a hexagonal hydrocarbon ring, or each of R₂ and R₃, and R₄ and R₅ may form a hexagonal hydrocarbon ring.

[0095] Formula 2 may be represented by one selected from Formula 2-1a to Formula 2-1d:

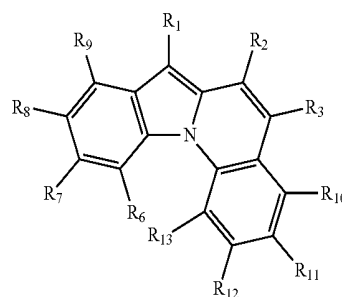
Formula 2-1a



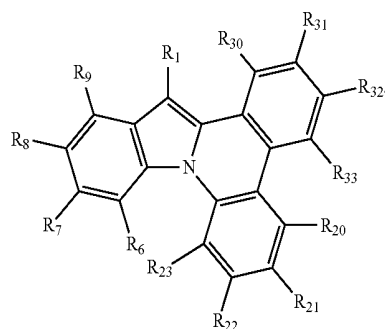
Formula 2-1b



Formula 2-1c



Formula 2-1d



[0096] Each of Formula 2-1a to Formula 2-1c represents a structure in which one pair selected from R₂ and R₃, R₃ and R₄, or R₄ and R₅, respectively, forms a hexagonal hydrocarbon ring, and Formula 2-1d represents a structure in which two pairs, R₂ and R₃ and R₄ and R₅, each form a hexagonal hydrocarbon ring.

[0097] In Formula 2-1d, R₂₀ to R₂₃ and R₃₀ to R₃₃ may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino

group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms. R_{20} to R_{23} and R_{30} to R_{33} may be the same, or at least one thereof may be different.

[0098] In Formula 2-1a to Formula 2-1d, the same explanation referring to Formula 2 may be applied to R_1 to R_9 , and the same explanation referring to Formula 3 may be applied to R_{10} to R_{13} .

[0099] In some embodiments, in Formula 2-1a to Formula 2-1d, R_8 may be a hydrogen atom. In Formula 2-1a to Formula 2-1d, R_8 may not be connected with L in Formula 1.

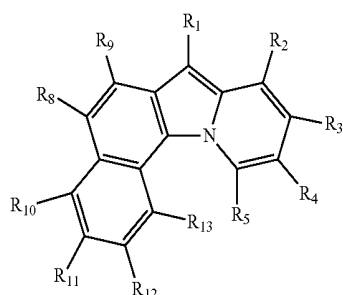
[0100] In Formula 2-1a, the position combined with L in Formula 1 may be one selected from R_4 , R_5 , R_6 , R_7 , R_9 , and R_{10} to R_{13} , and in Formula 2-1b, the position combined with L in Formula 1 may be one selected from R_2 , R_5 , R_6 , R_7 , R_9 , and R_{10} to R_{13} . In Formula 2-1c, the position combined with L in Formula 1 may be one selected from R_2 , R_3 , R_6 , R_7 , R_9 , and R_{10} to R_{13} , and in Formula 2-1d, the position combined with L in Formula 1 may be one selected from R_6 , R_7 , R_9 , R_{20} to R_{23} , and R_{30} to R_{33} . For example, in the amine compound represented by Formula 2-1a to Formula 2-1d, R_1 and R_8 may not be combined with L in Formula 1.

[0101] Formula 2-1a to Formula 2-1c represent structures in which one benzene ring is condensed with a pyridoindole moiety so that "HT" in Formula 1 has four condensed rings. Formula 2-1d represents a structure in which two benzene rings are condensed with a pyridoindole moiety so that "HT" in Formula 1 has five condensed rings.

[0102] Meanwhile, Formula 2-1a to Formula 2-1d may represent structures in which an aromatic hydrocarbon group (e.g., a benzene ring) is condensed with the pyridine ring of a pyridoindole moiety.

[0103] In some embodiments, in Formula 2, one or two pairs selected from R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 may form hexagonal hydrocarbon rings represented by Formula 3. For example, in Formula 2, one pair selected from R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 may form a hexagonal hydrocarbon ring, or each of R_6 and R_7 , and R_8 and R_9 may form a hexagonal hydrocarbon ring.

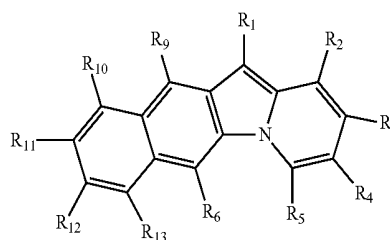
[0104] Formula 2 may be further represented by one selected from Formula 2-2a to Formula 2-2d:



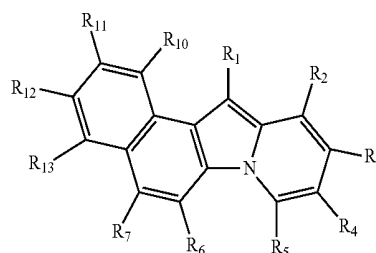
Formula 2-2a

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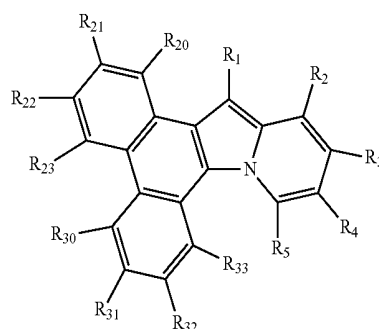
Formula 2-2b



Formula 2-2c



Formula 2-2d



[0105] Each of Formula 2-2a to Formula 2-2c represents a structure in which one pair selected from R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 , respectively, forms a hexagonal hydrocarbon ring, and Formula 2-2d represents a structure in which two pairs, R_6 and R_7 and R_8 and R_9 , each form a hexagonal hydrocarbon ring.

[0106] In Formula 2-2d, R_{20} to R_{23} and R_{30} to R_{33} may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms.

[0107] In Formula 2-2a to Formula 2-2d, the same explanation referring to Formula 2 may be applied to R_1 to R_9 , and the same explanation referring to Formula 3 may be applied to R_{10} to R_{13} .

[0108] In Formula 2-2a, the position combined with L in Formula 1 may be one selected from R_2 to R_5 , R_8 , R_9 , and R_{10} to R_{13} , and in Formula 2-2b, the position combined with L in Formula 1 may be one selected from R_2 to R_5 , R_6 , R_9 , and R_{10} to R_{13} . In Formula 2-2c, the position combined with L in Formula 1 may be one selected from R_2 to R_5 , R_6 , R_7 , and R_{10} to R_{13} , and in Formula 2-2d, the position combined with L in Formula 1 may be one selected from R_2 to R_5 , R_{20} to R_{23} , and R_{30} to R_{33} .

[0109] Formula 2-2a to Formula 2-2c represent structures in which one benzene ring is condensed with a pyridoindole moiety so that "HT" in Formula 1 has four condensed rings.

Formula 2-2d represents a structure in which two benzene rings are condensed with a pyridoindole moiety so that "HT" in Formula 1 has five condensed rings.

[0110] Meanwhile, Formula 2-2a to Formula 2-2d may represent structures in which an aromatic hydrocarbon group is condensed with the indole part of a pyridoindole moiety.

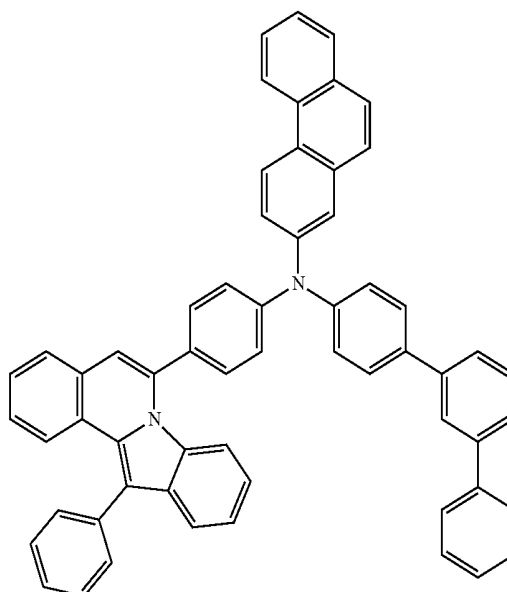
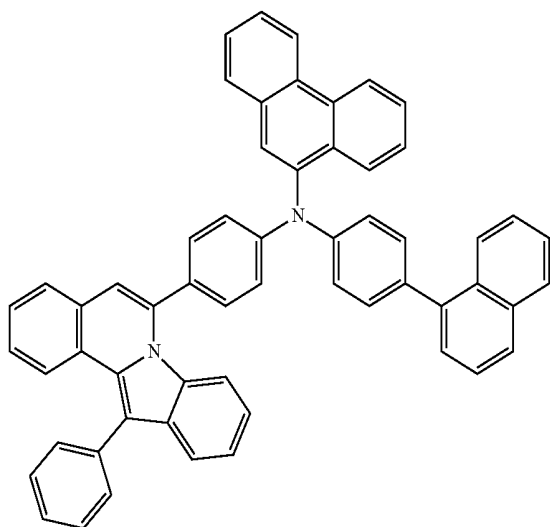
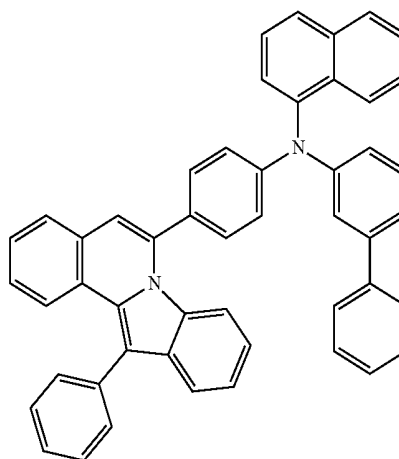
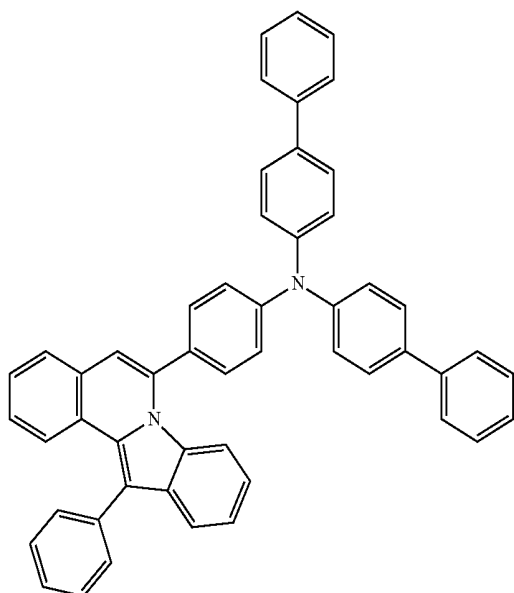
[0111] In Formula 2-1a to Formula 2-1d and Formula 2-2a to Formula 2-2d, R_1 may be an unsubstituted phenyl group, and all substituents R_2 to R_{13} , R_{20} to R_{23} , and R_{30} to R_{33} that are not combined with (linked to) Formula 1 may each be a hydrogen atom.

[0112] The amine compound represented by Formula 1 according to an embodiment of the present disclosure may

be further represented by at least one selected from the compounds represented in Compound Group 1 and Compound Group 2. For example, the organic electroluminescence device according to an embodiment of the present disclosure may include at least one selected from the compounds represented in Compound Group 1 and Compound Group 2 in at least one organic layer.

[0113] Compound Group 1 represents amine compounds in which the HT moiety in Formula 1 is represented by one selected from Formula 2-1a to Formula 2-1d. Compound Group 2 represents amine compounds in which the HT moiety in Formula 1 is represented by one selected from Formula 2-2a to Formula 2-2d:

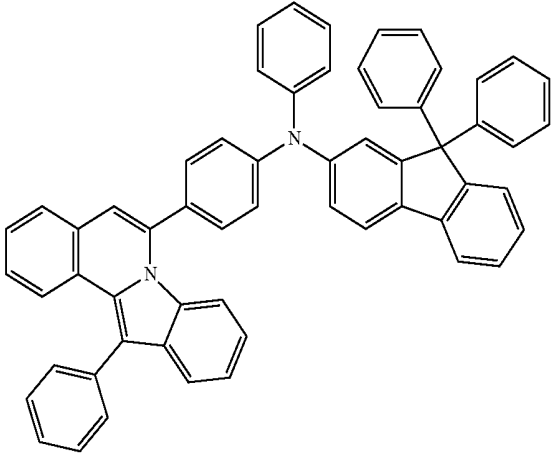
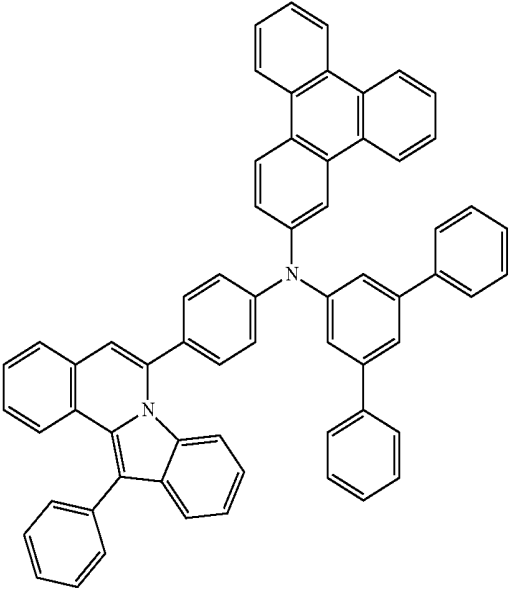
Compound Group 1



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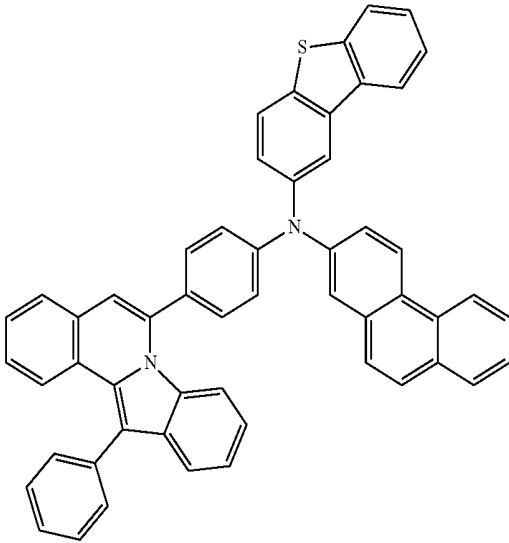
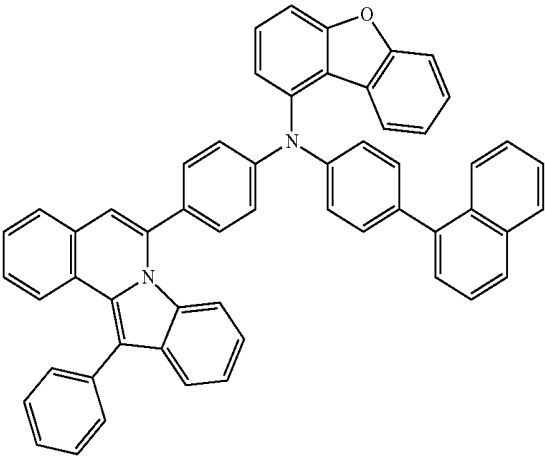
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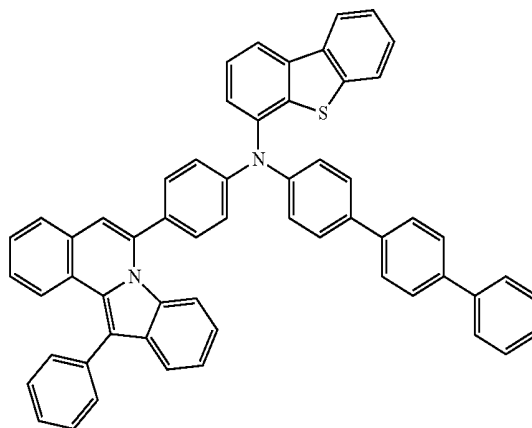
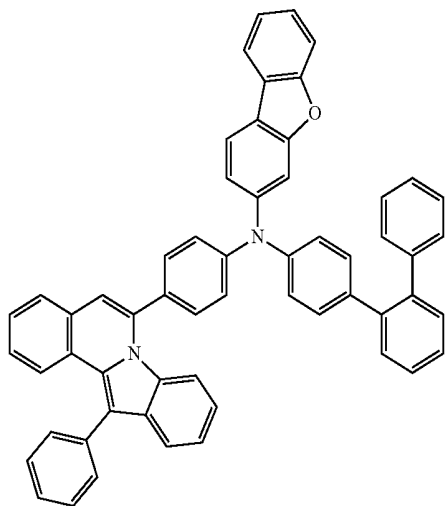
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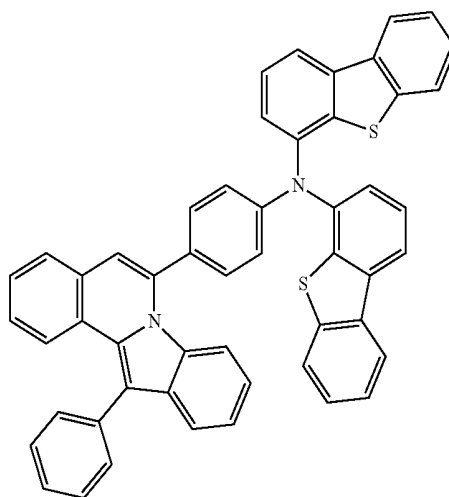
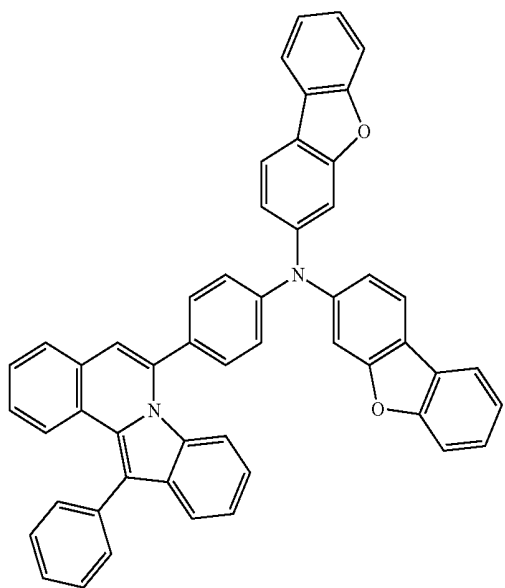
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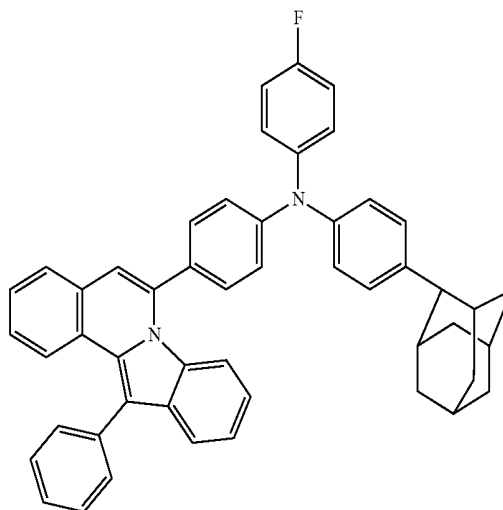
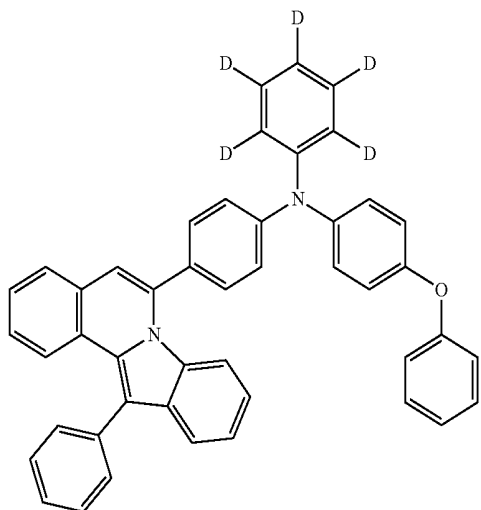
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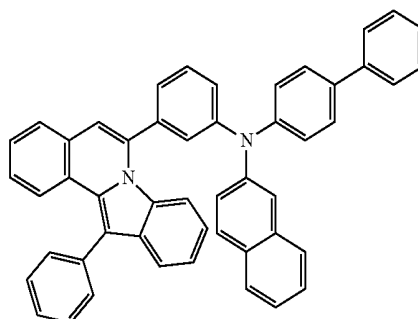
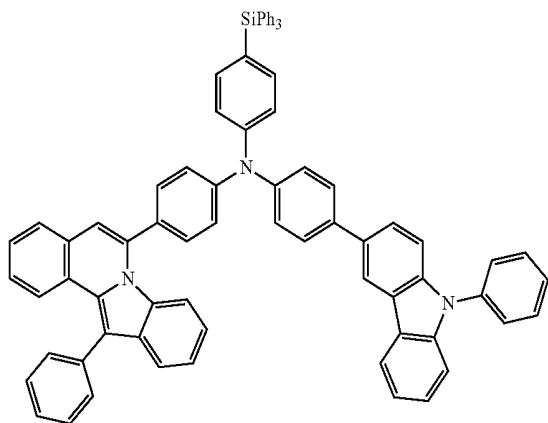
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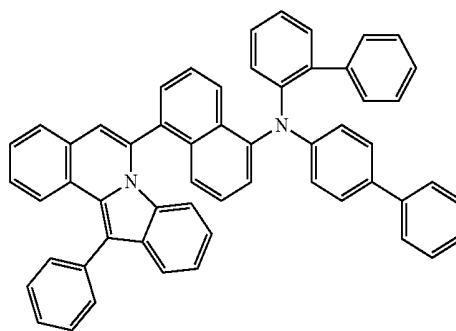
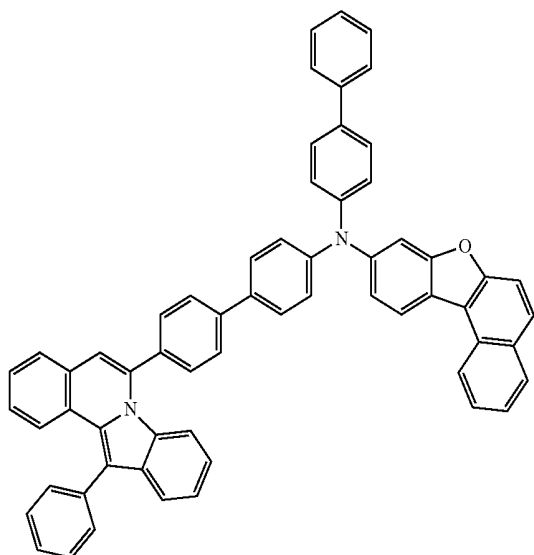
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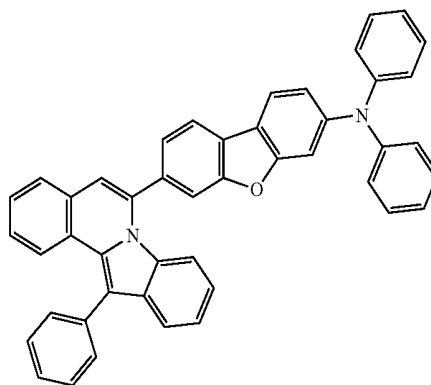
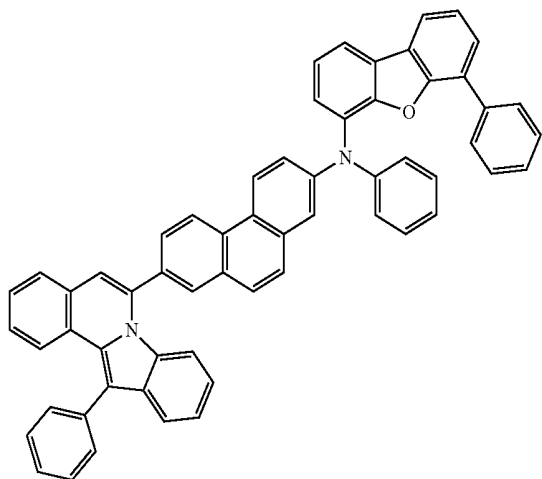
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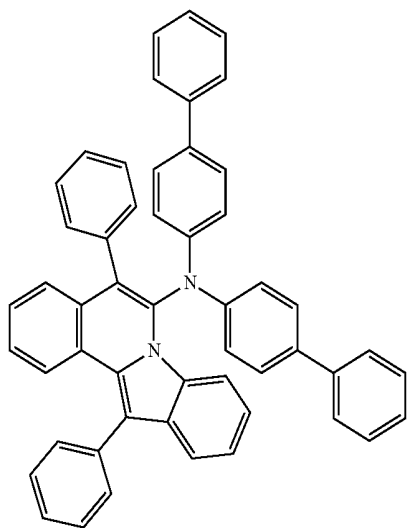


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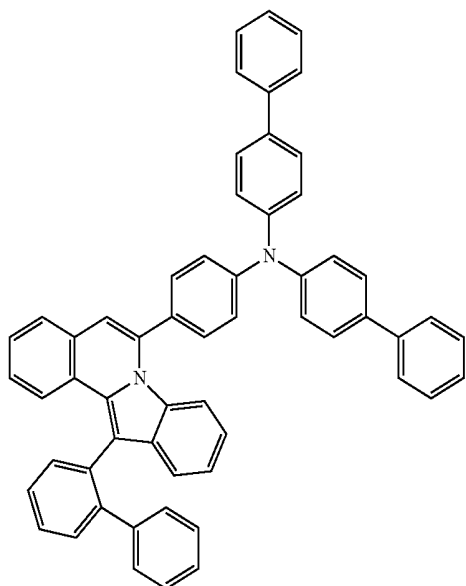
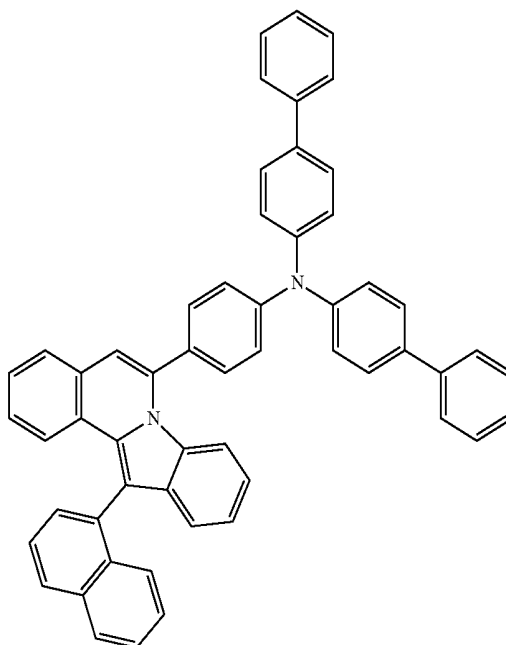


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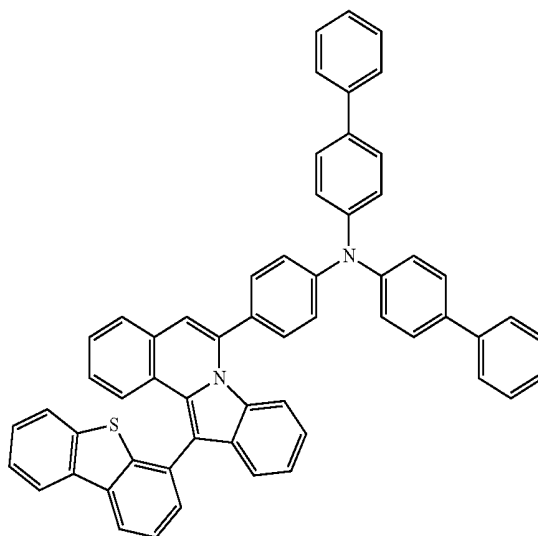
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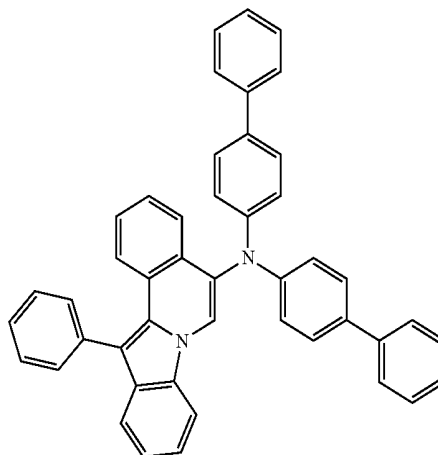
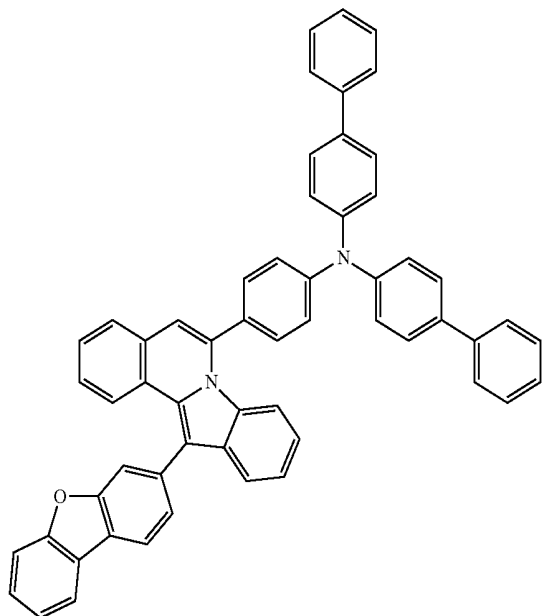
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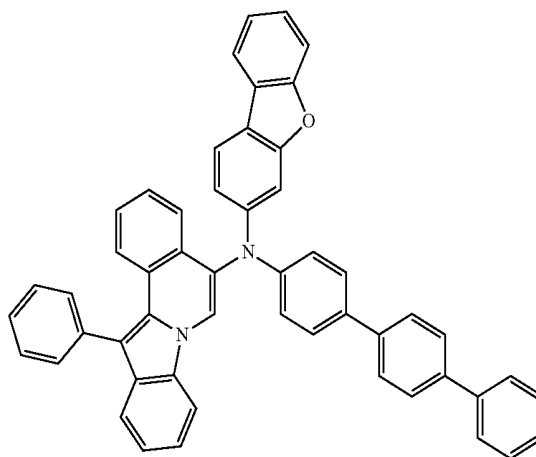
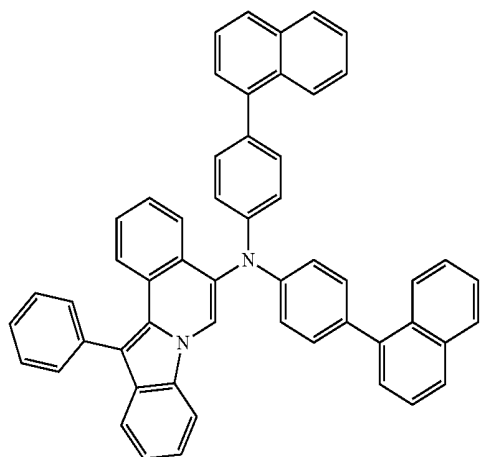
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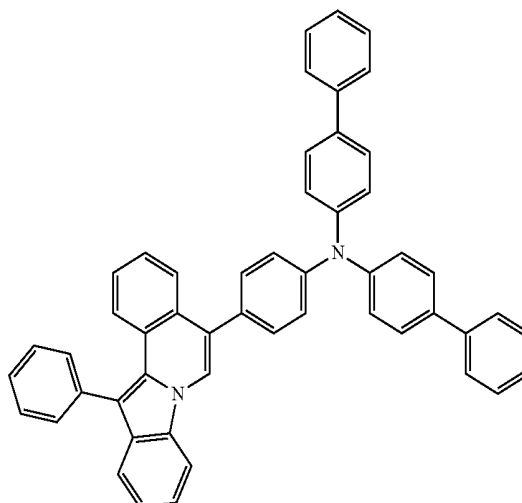
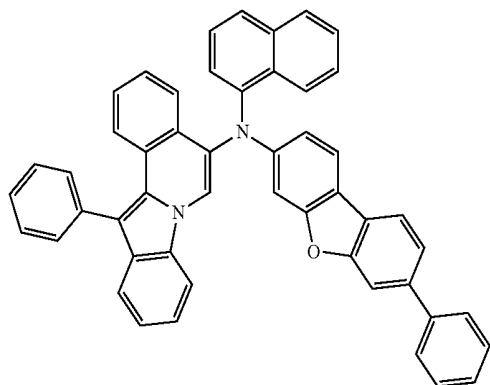
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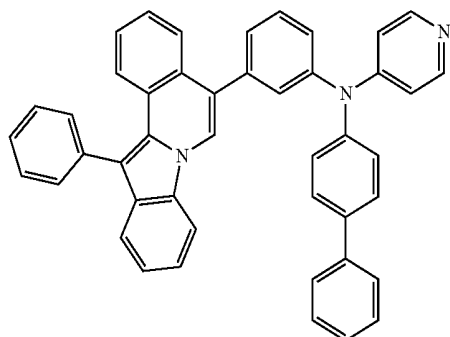
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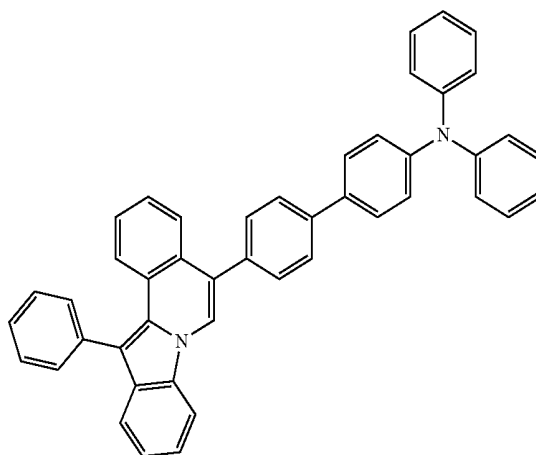


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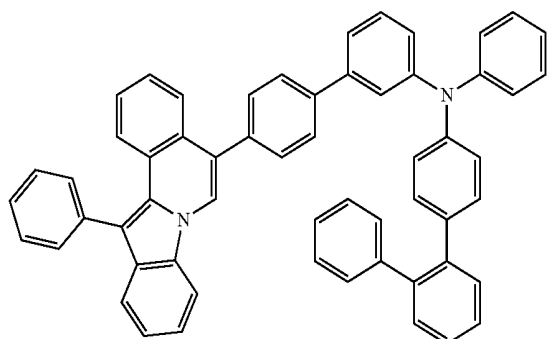
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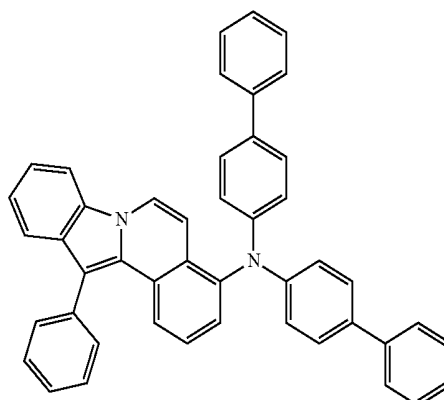
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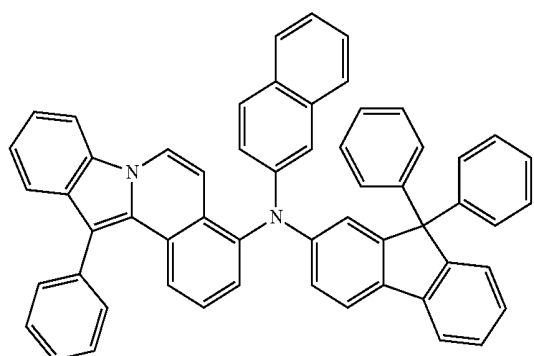
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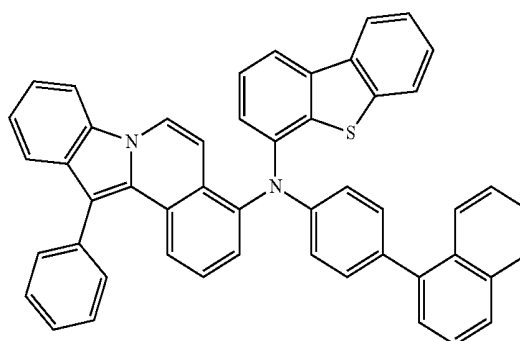
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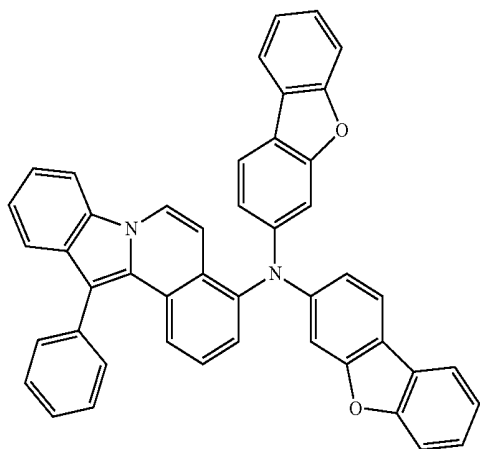


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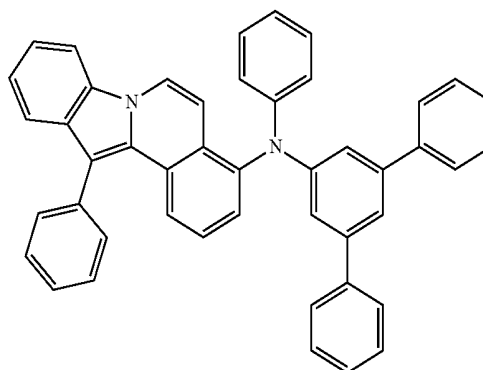


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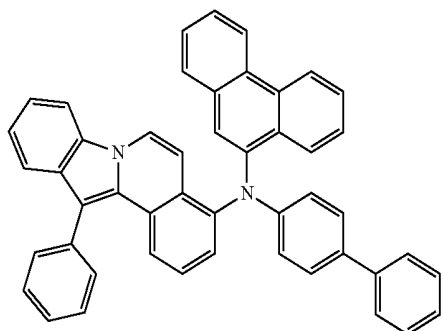
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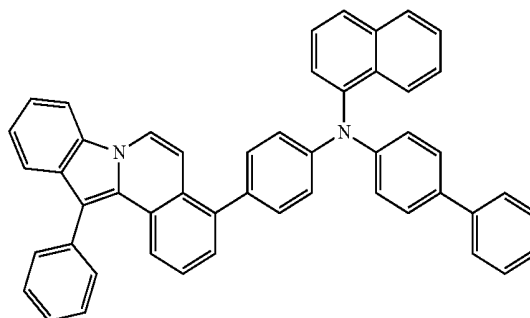
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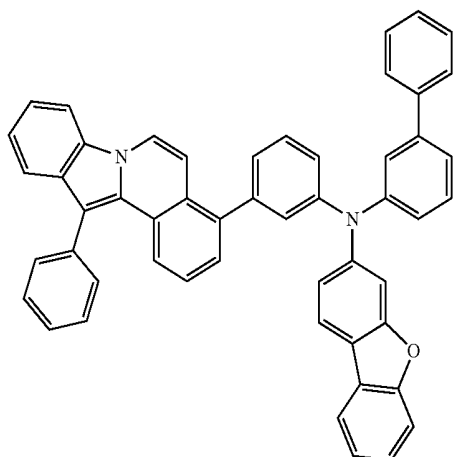
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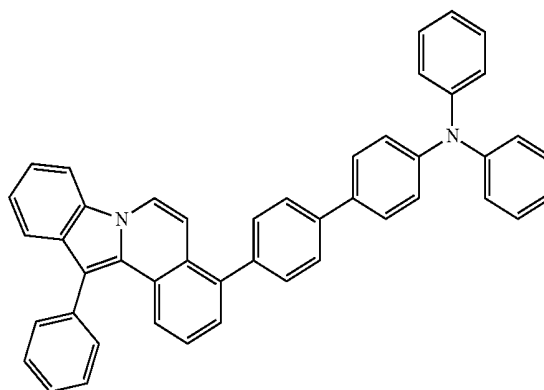
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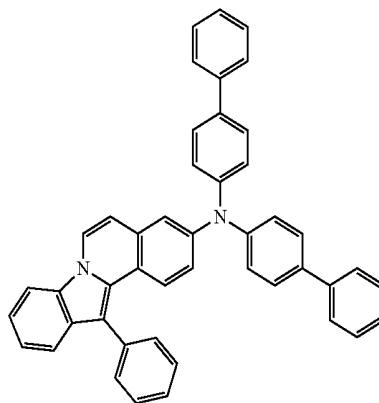
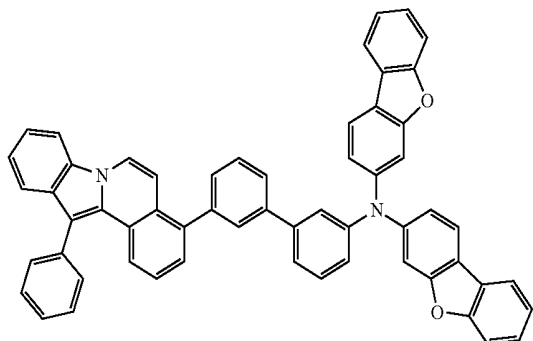
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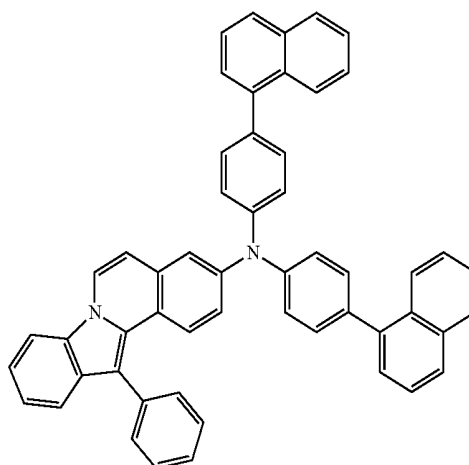
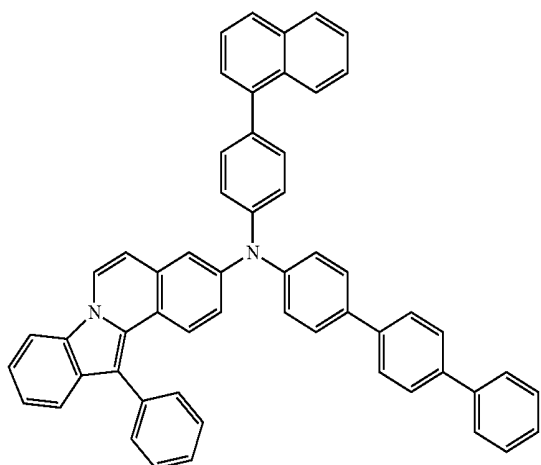
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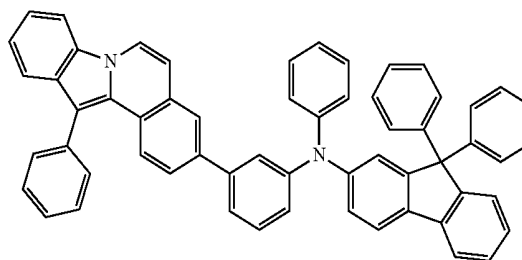
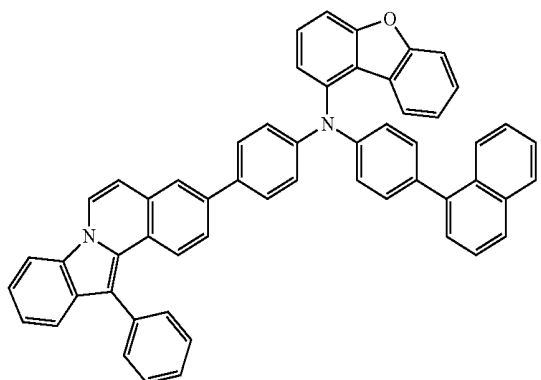
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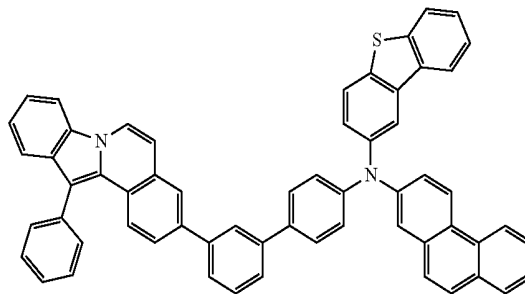
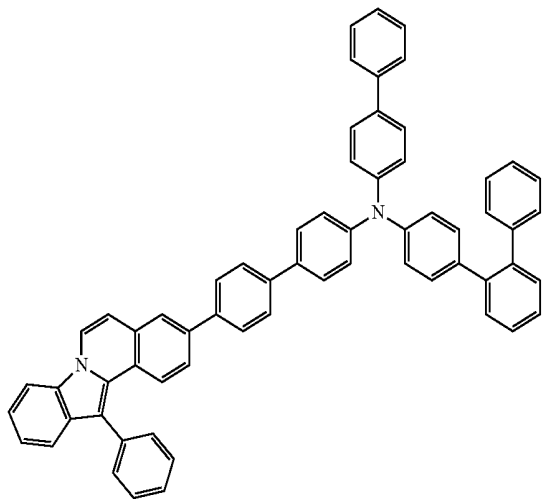
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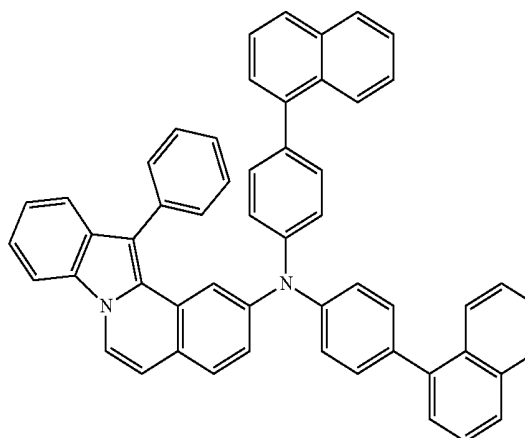
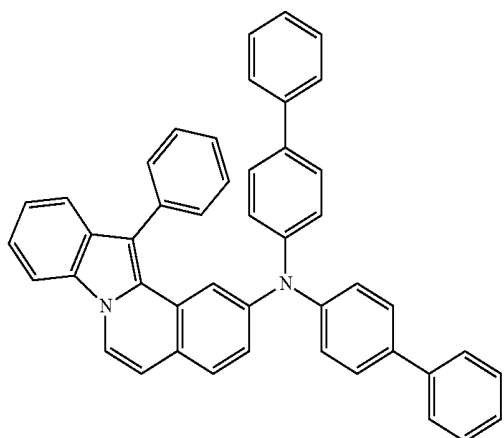
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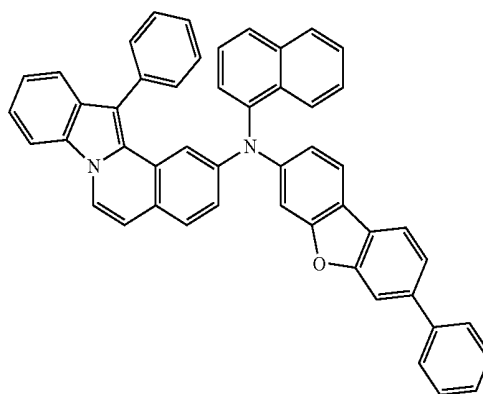
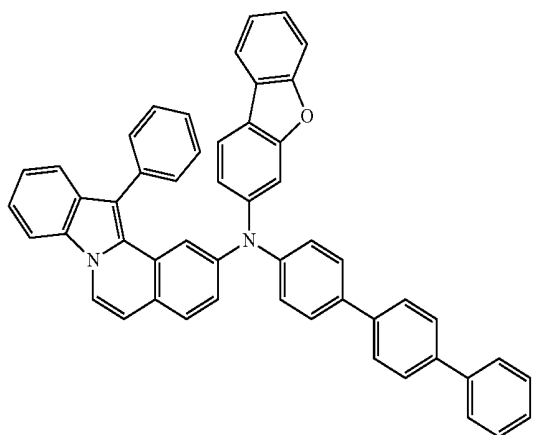
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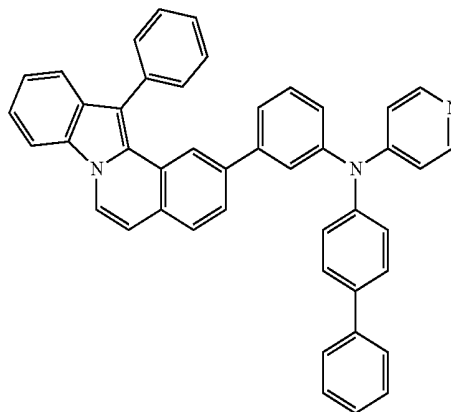
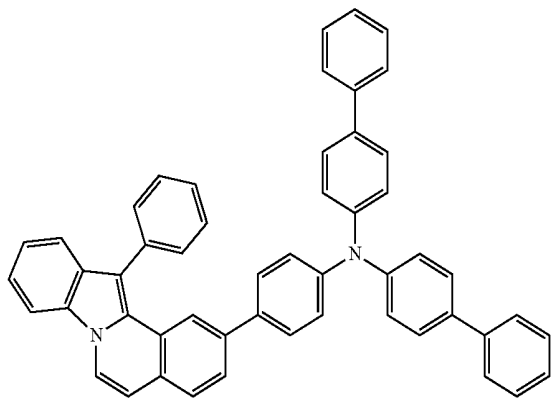
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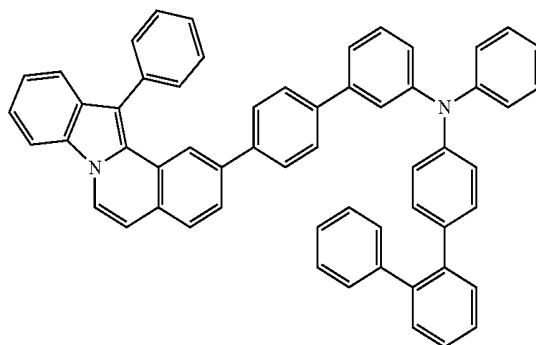
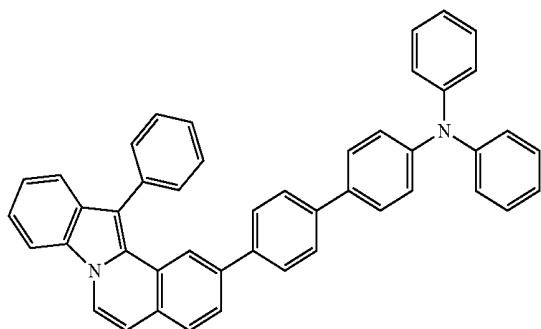
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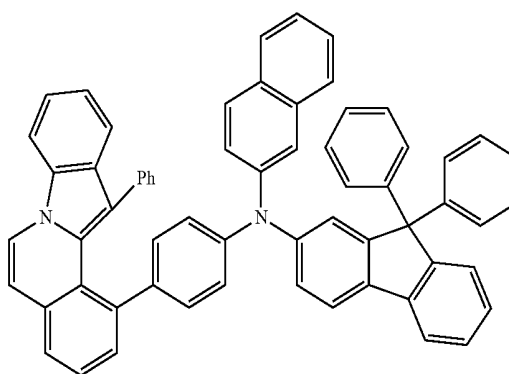
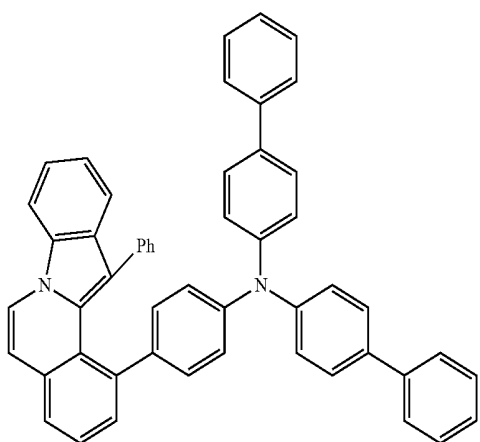
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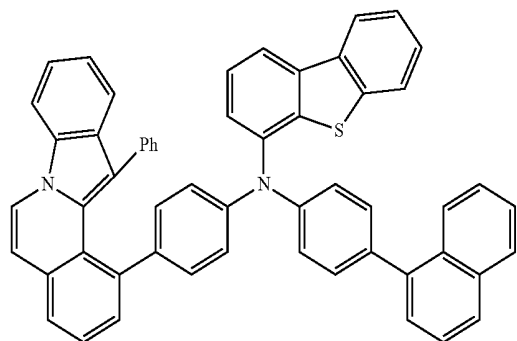
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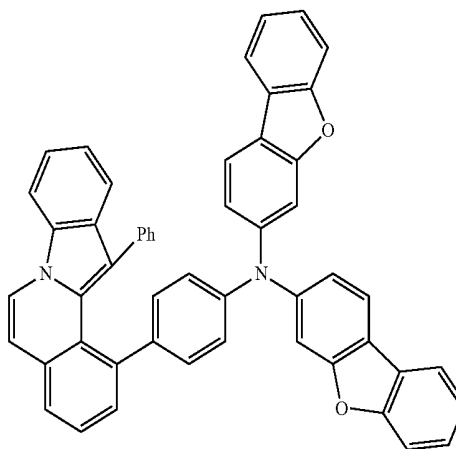


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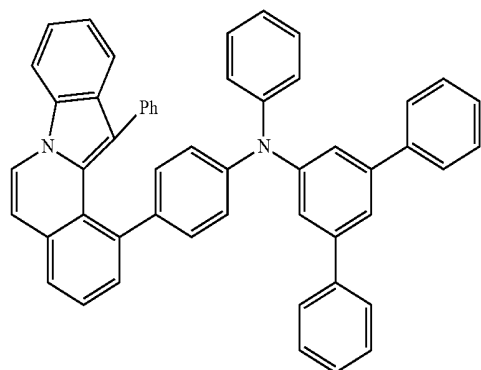
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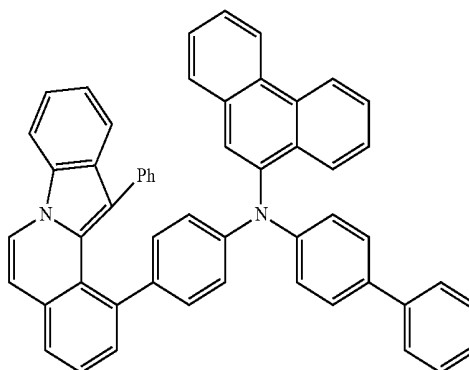
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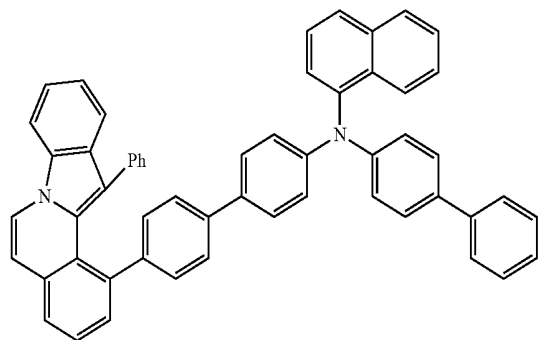
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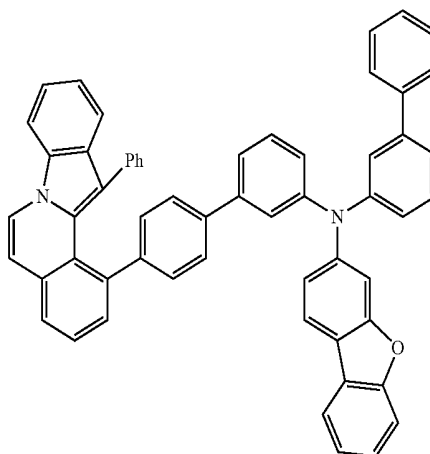
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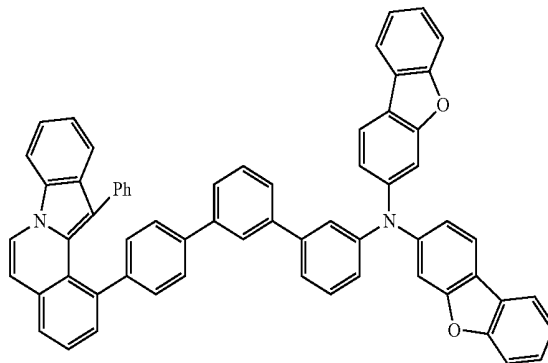
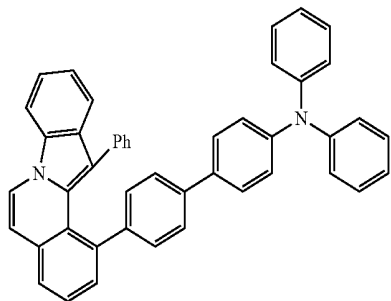
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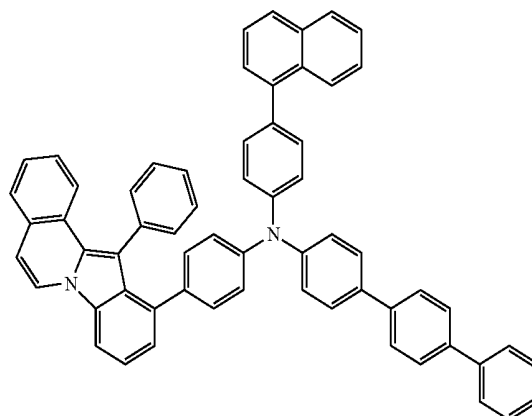
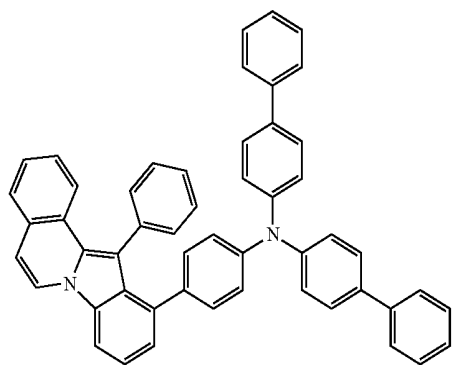
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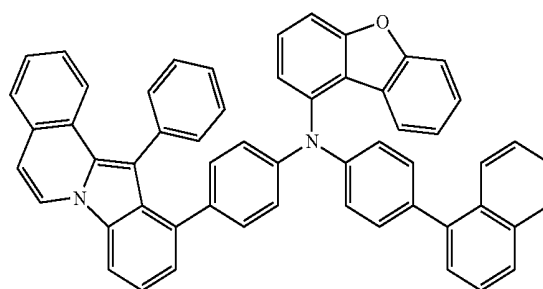
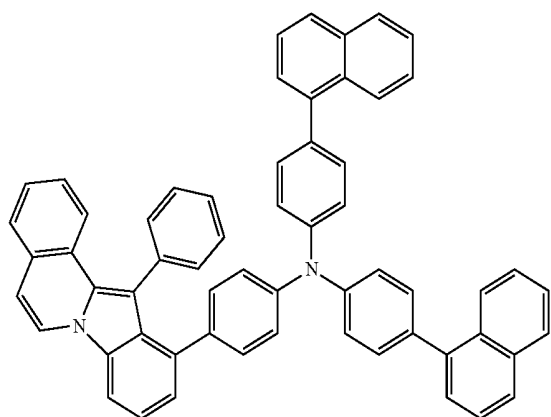
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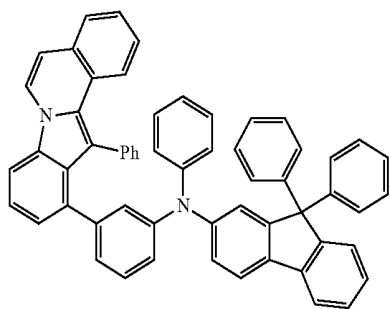


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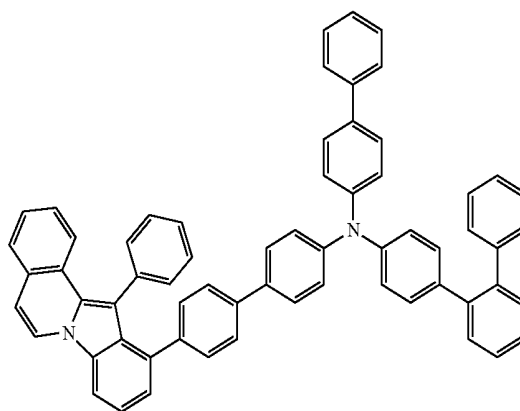
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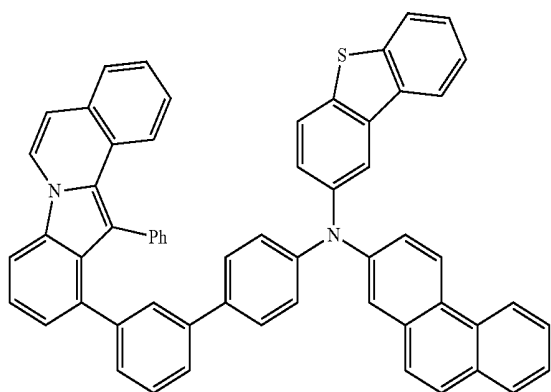
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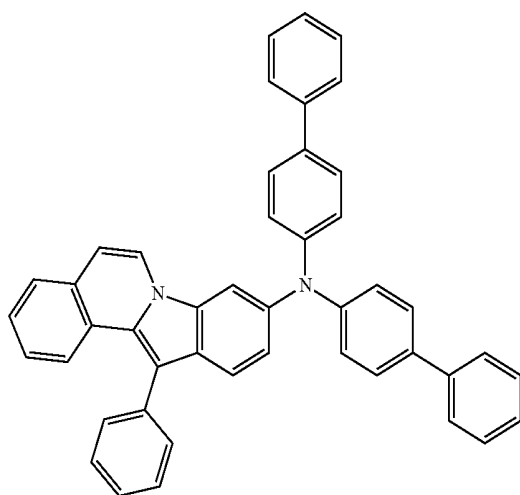
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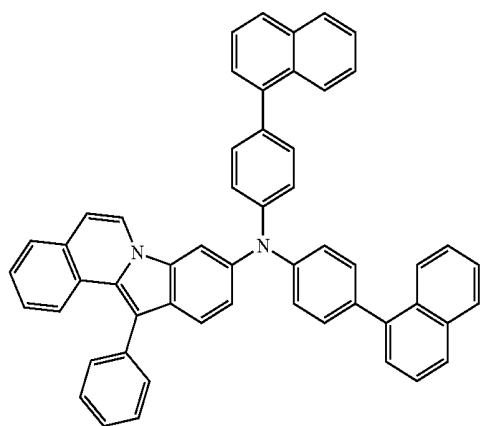
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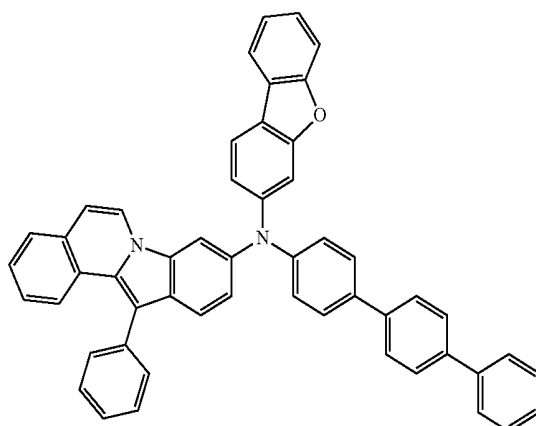
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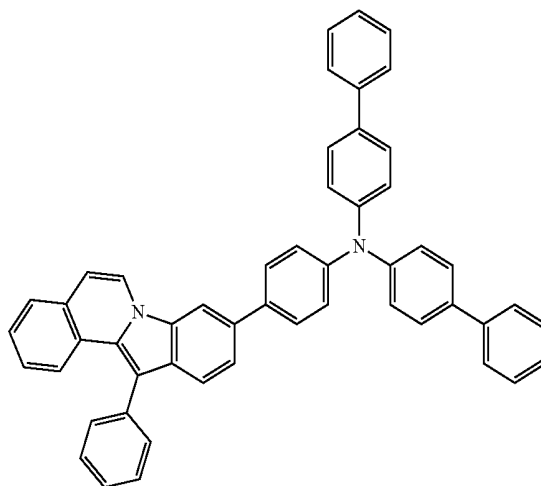
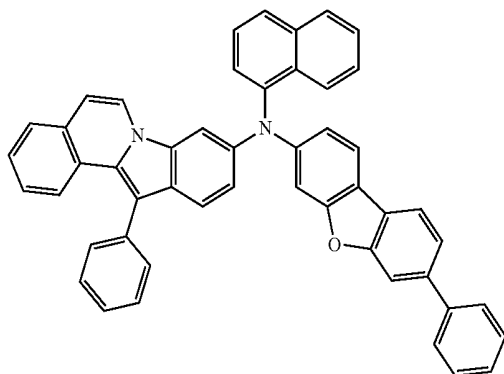
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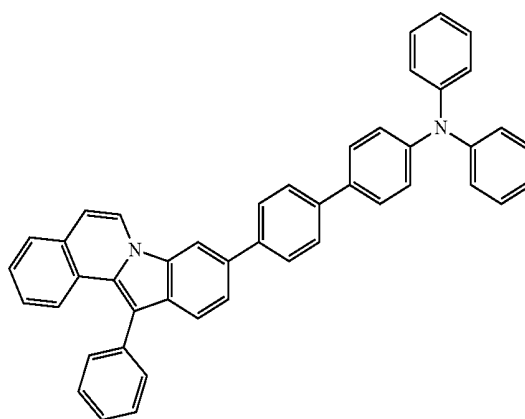
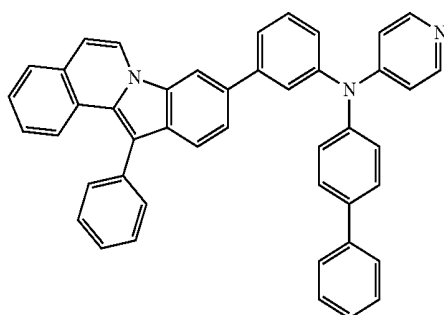
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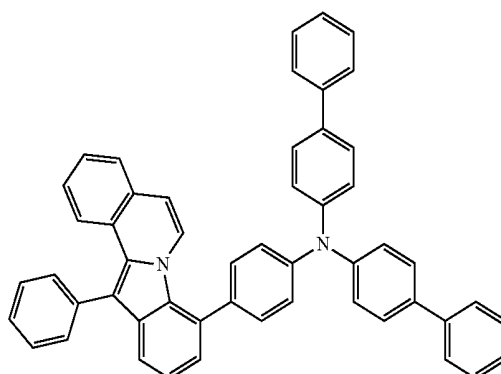
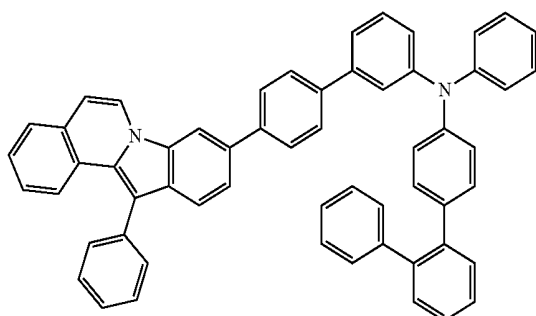
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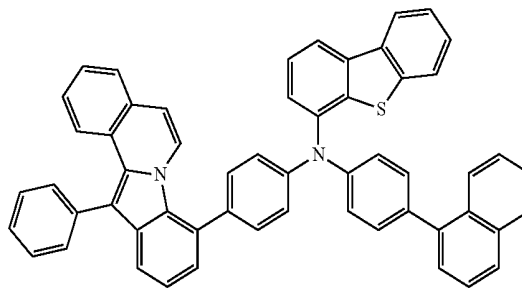
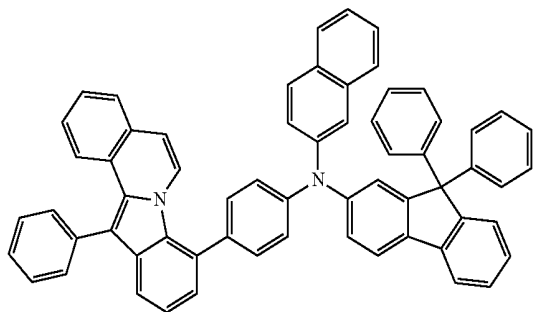
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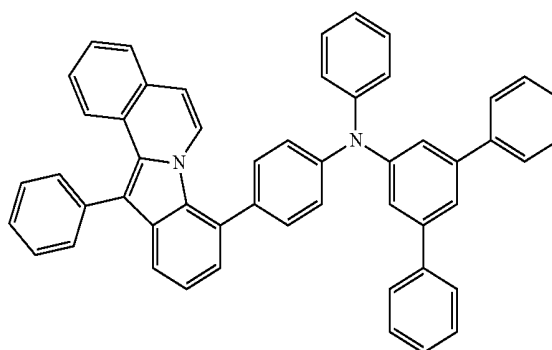
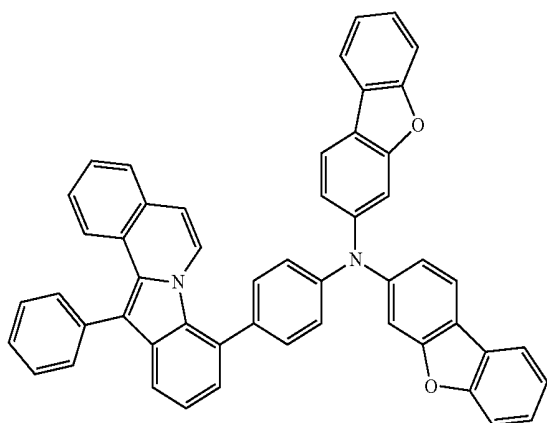
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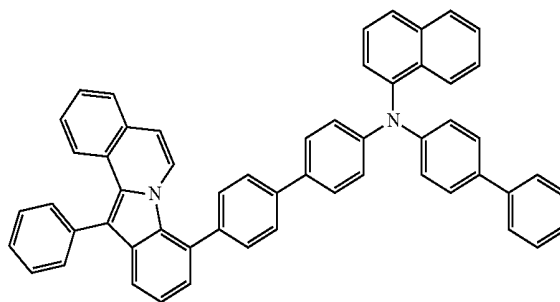
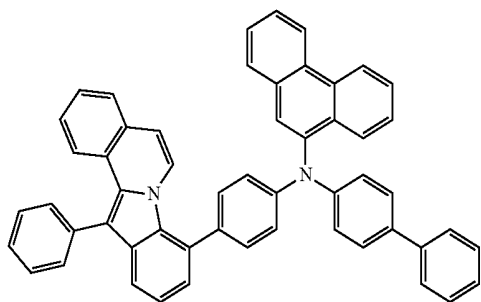
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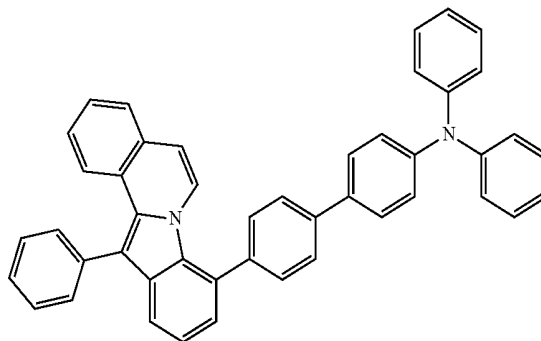
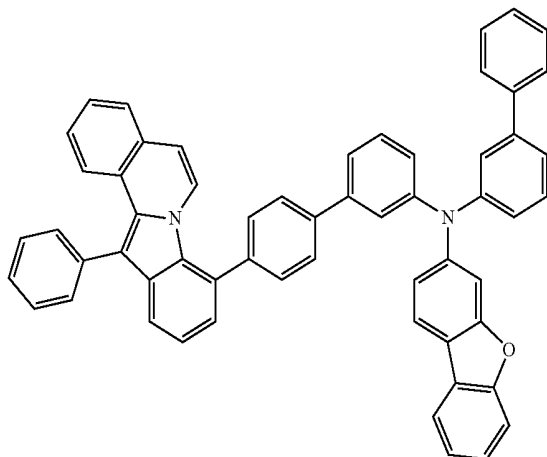
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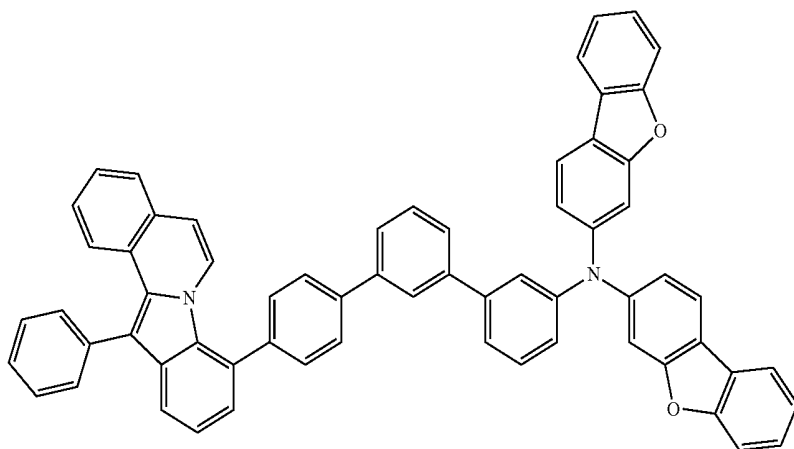
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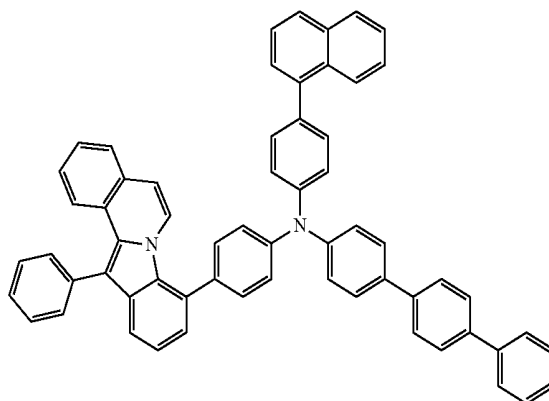
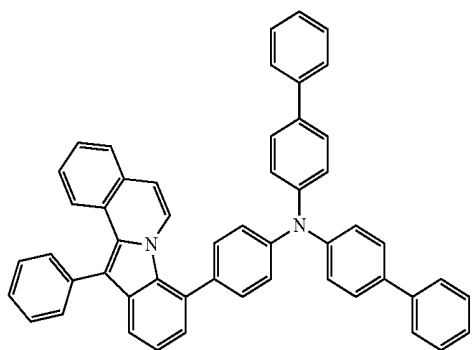
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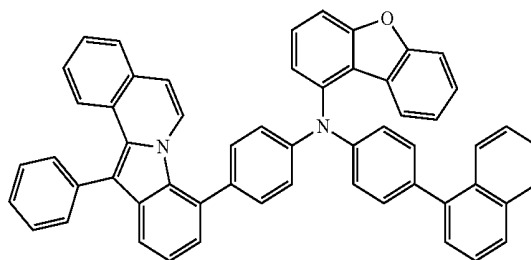
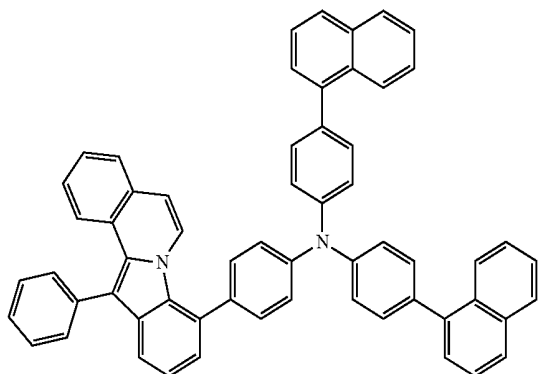
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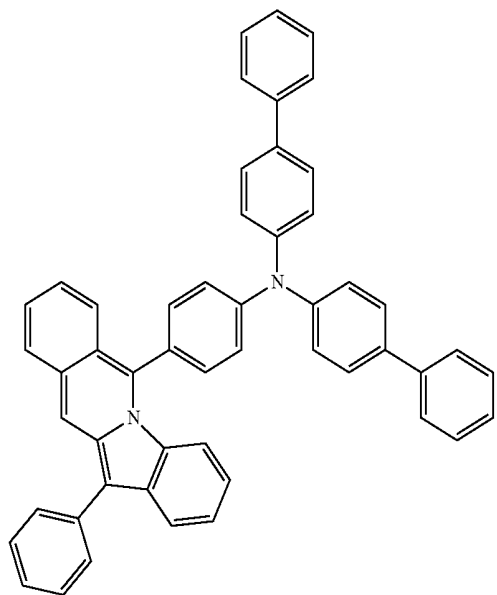


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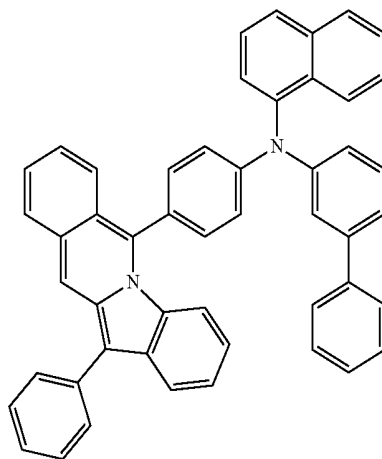
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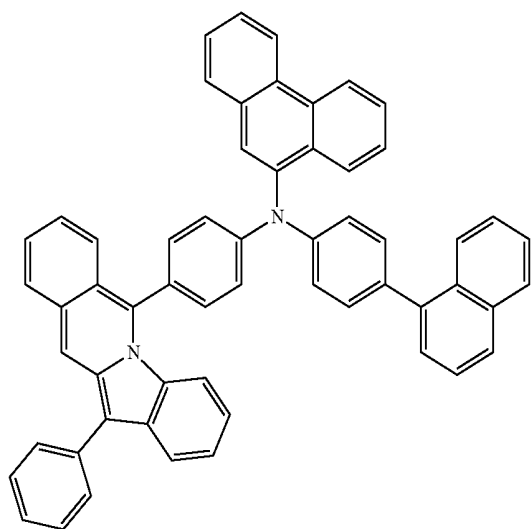
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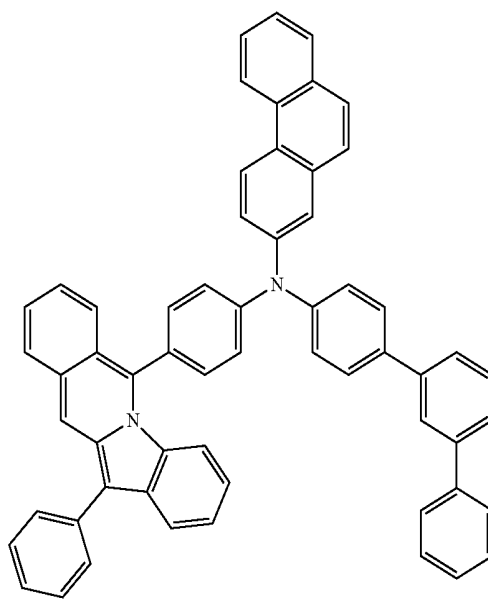
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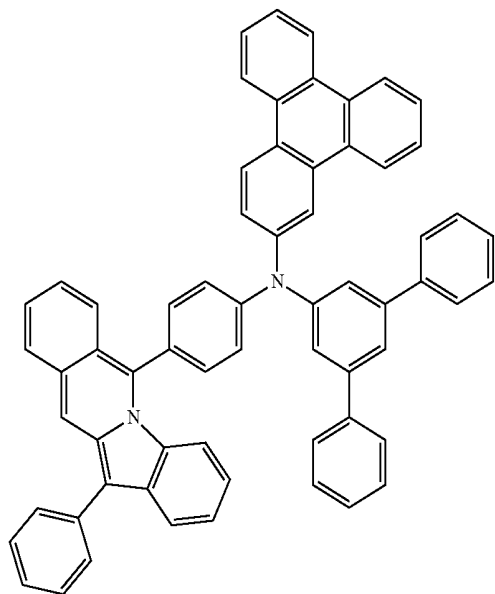
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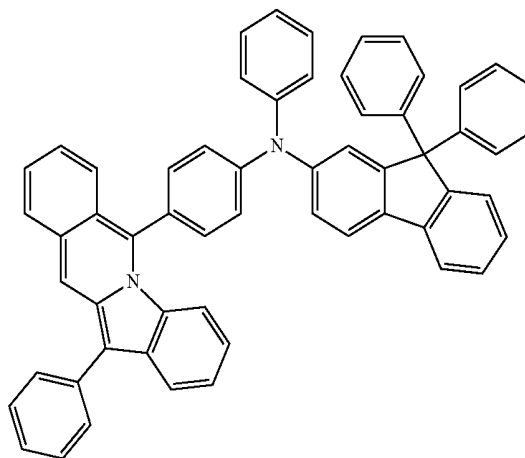
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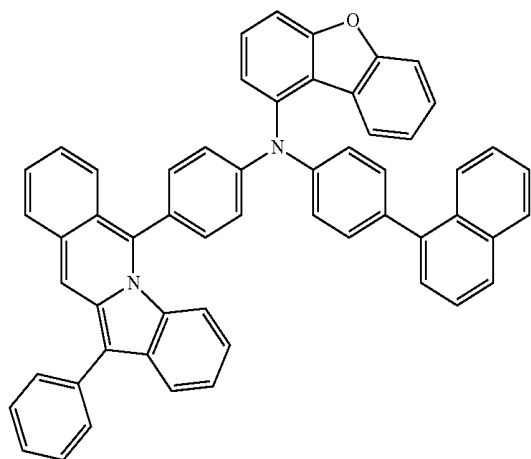
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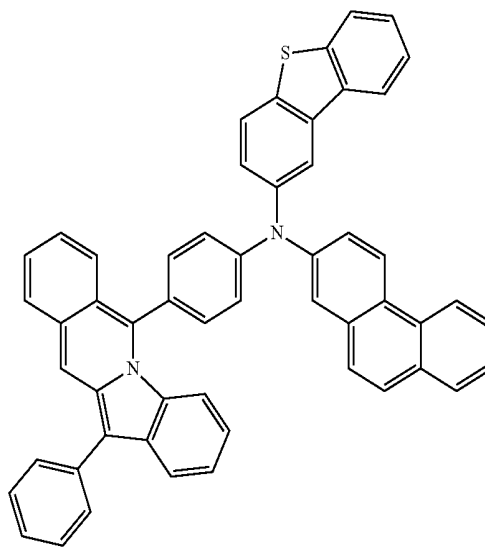
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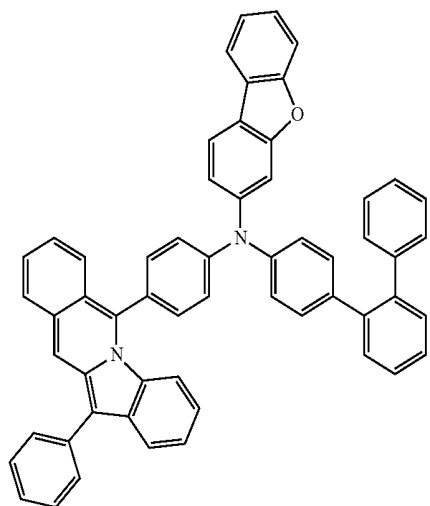
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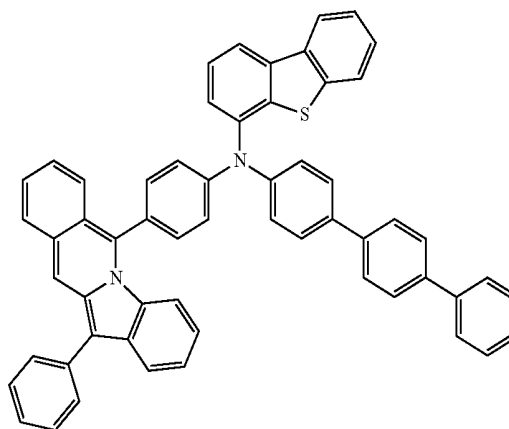
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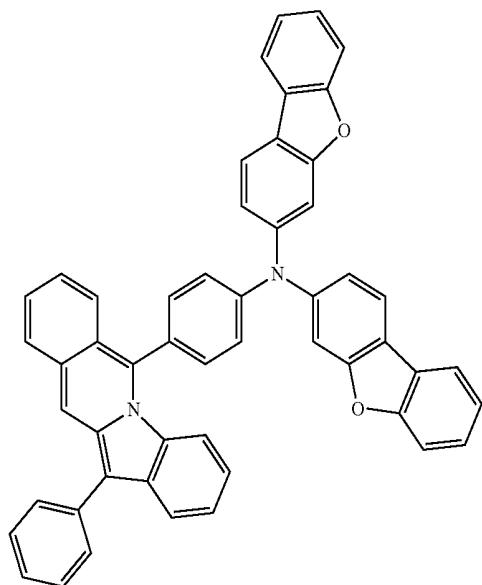


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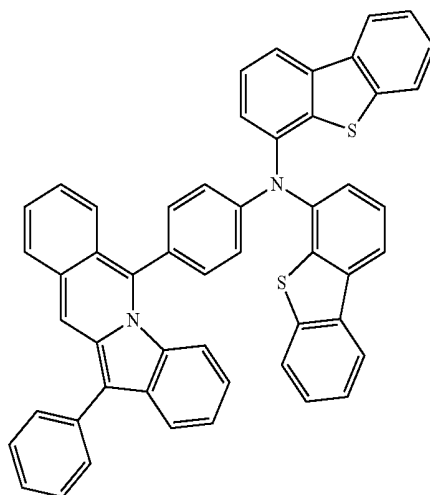


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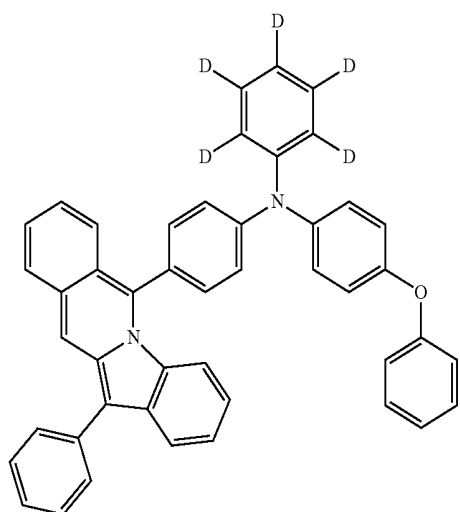
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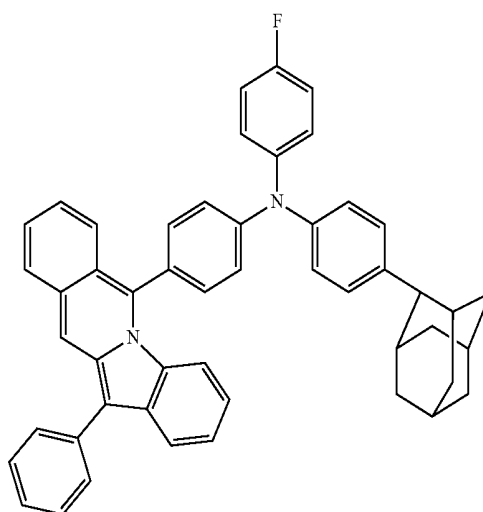
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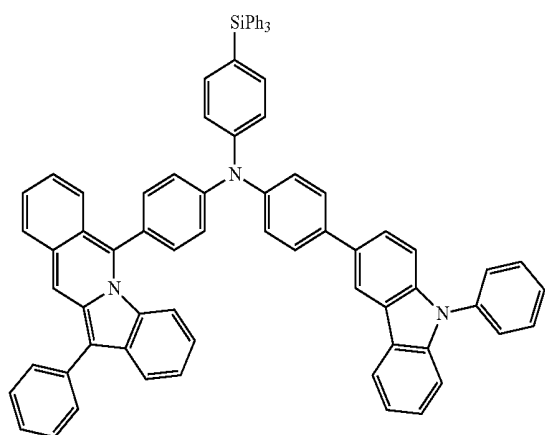
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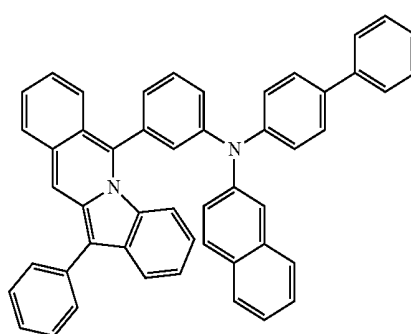
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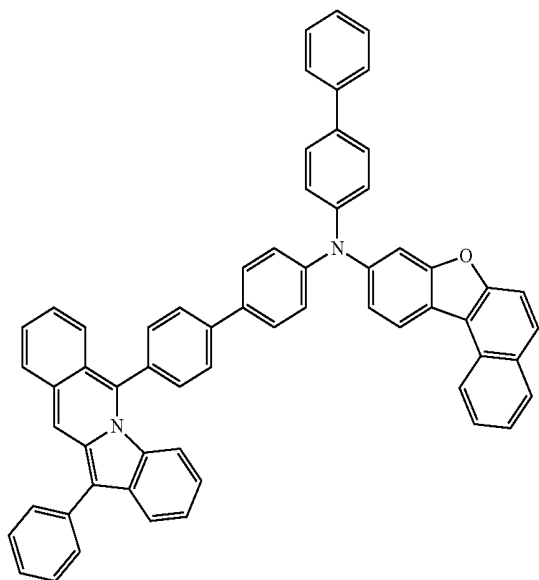


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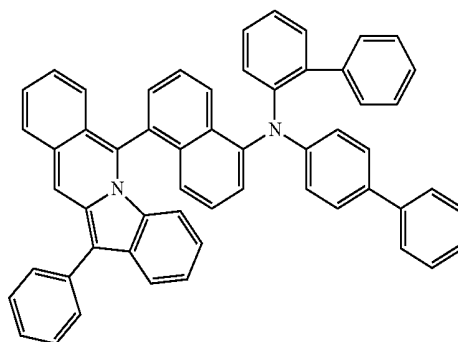


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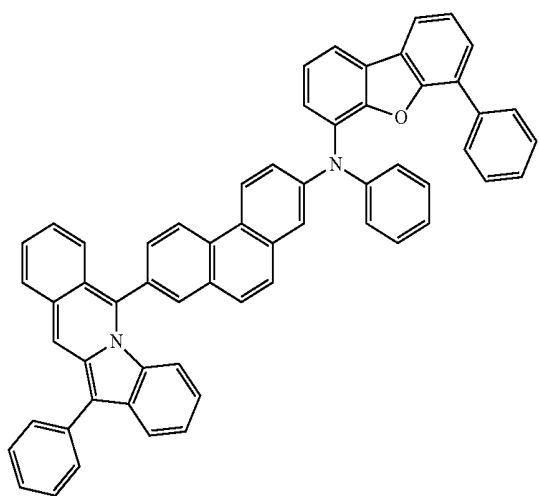
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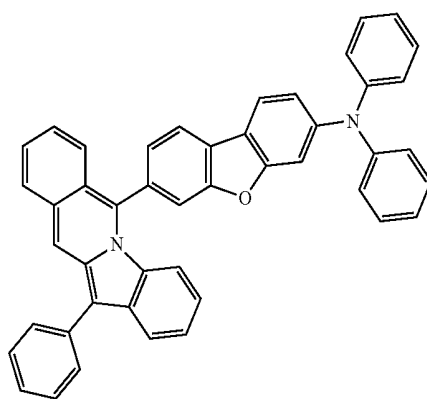
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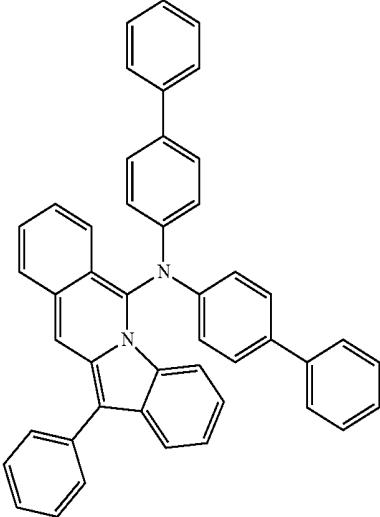


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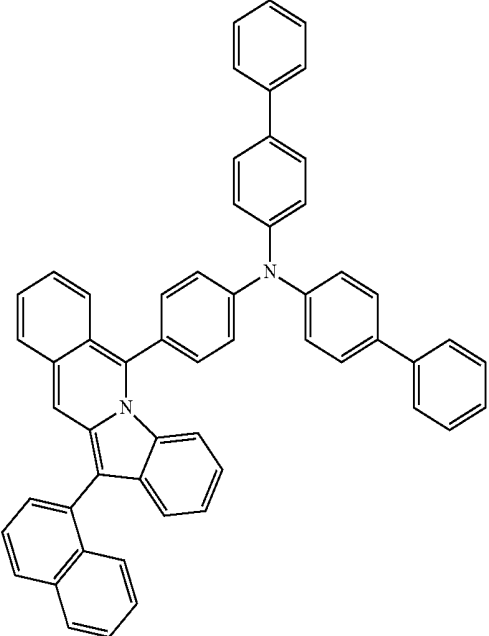


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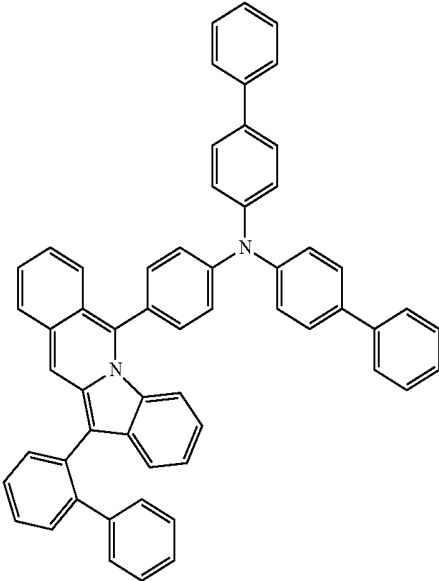
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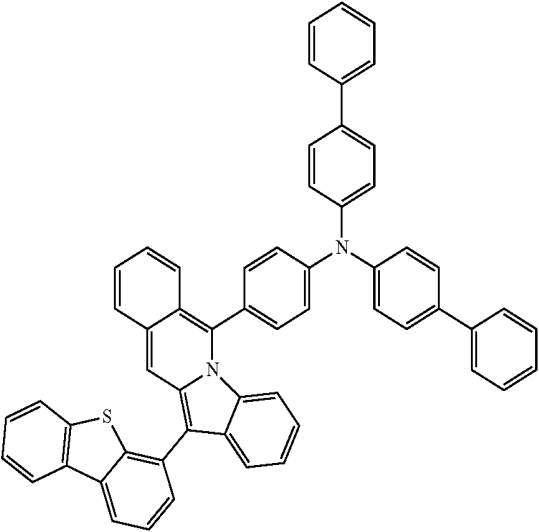
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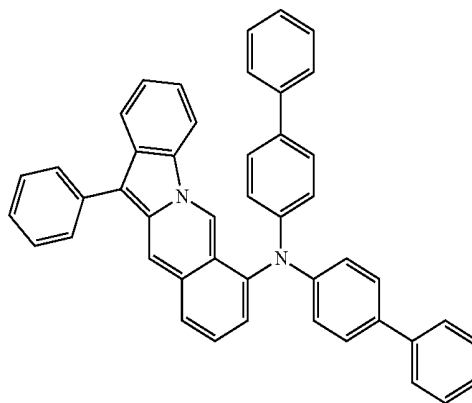
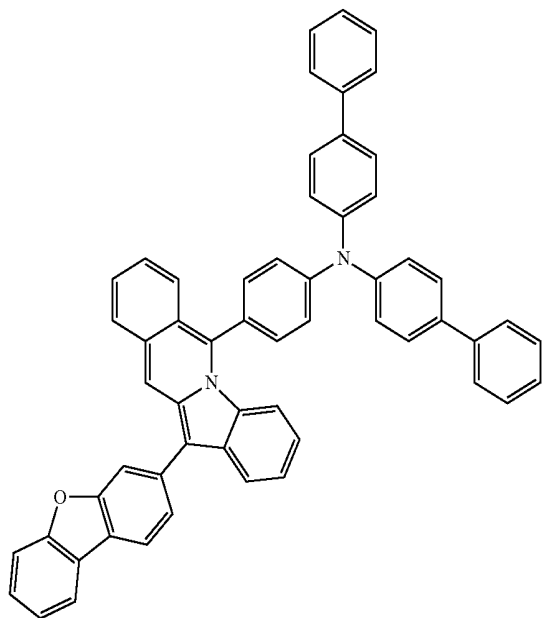


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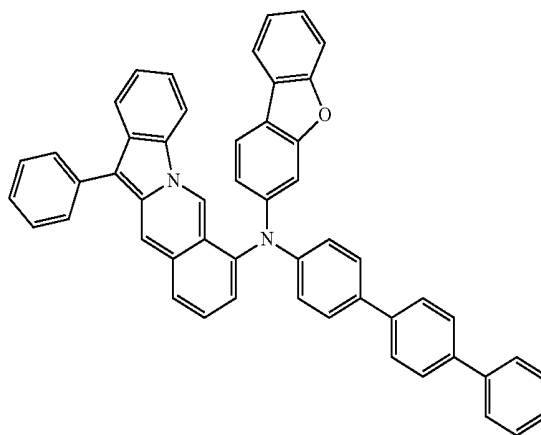
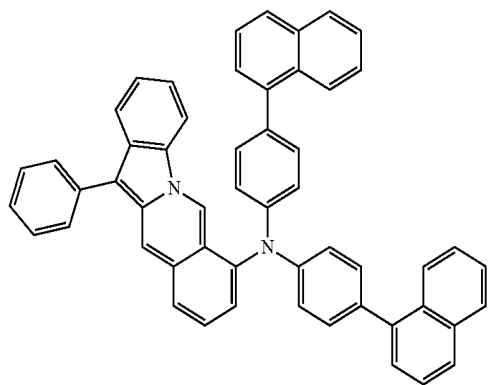
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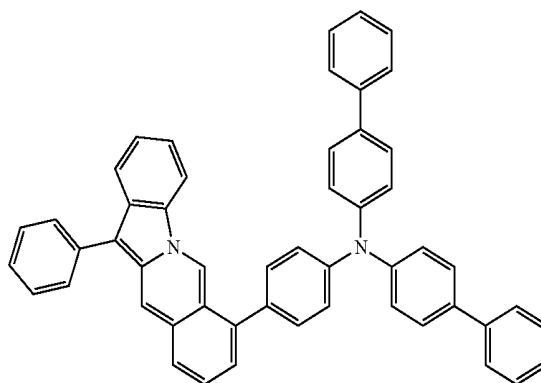
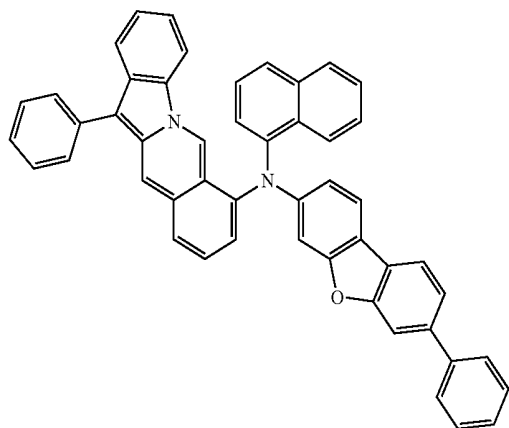
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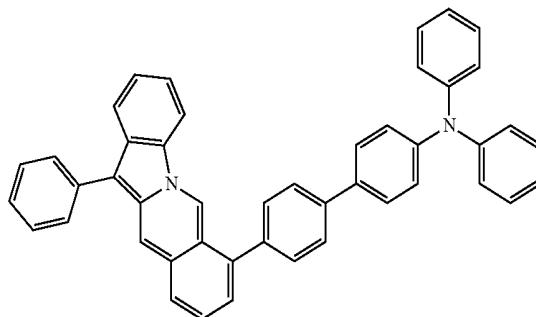
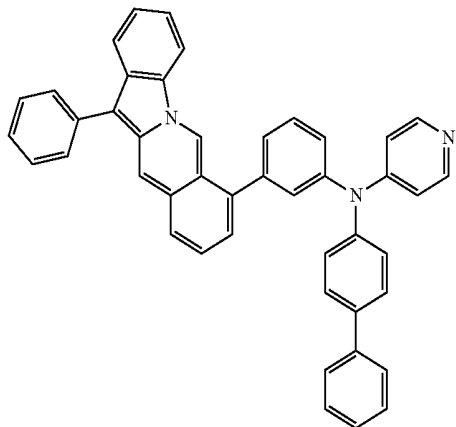
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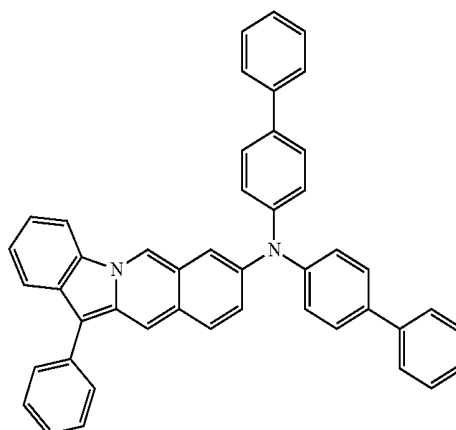
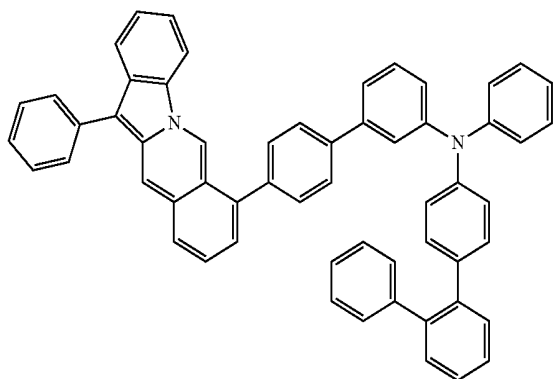
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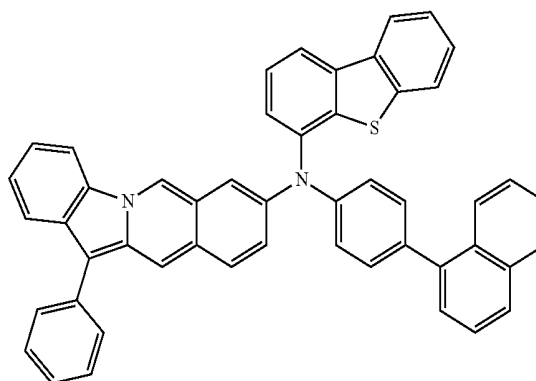
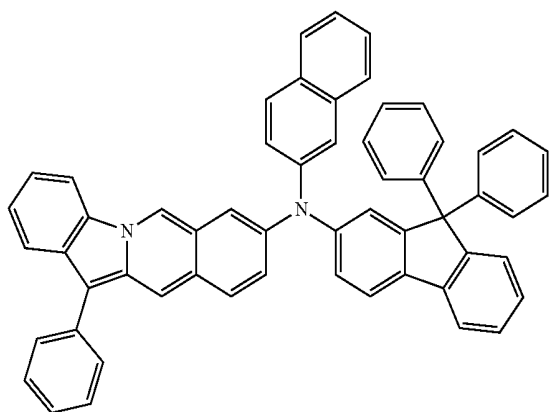
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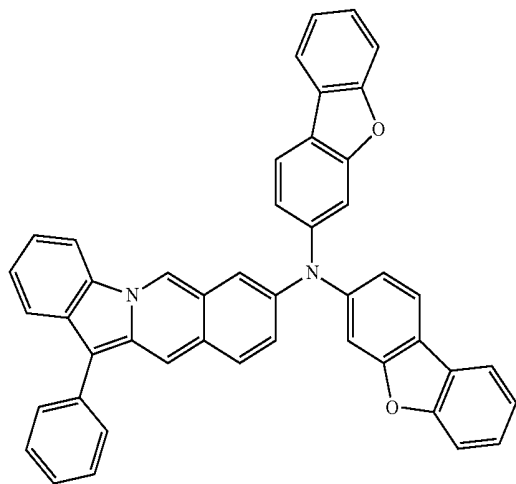
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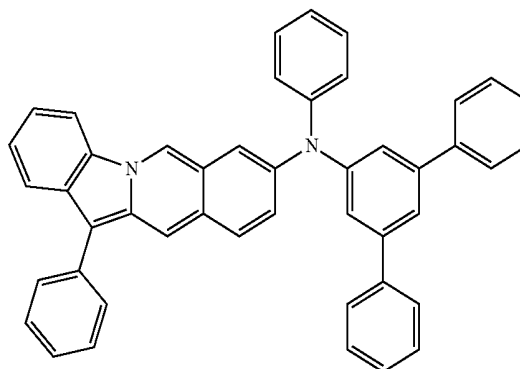


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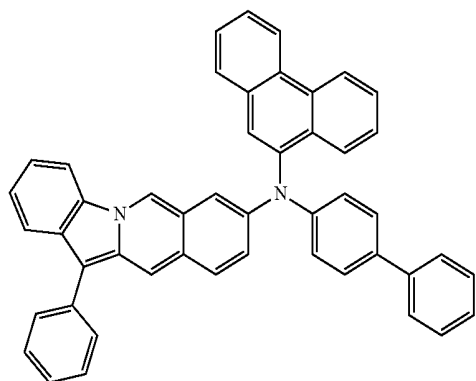
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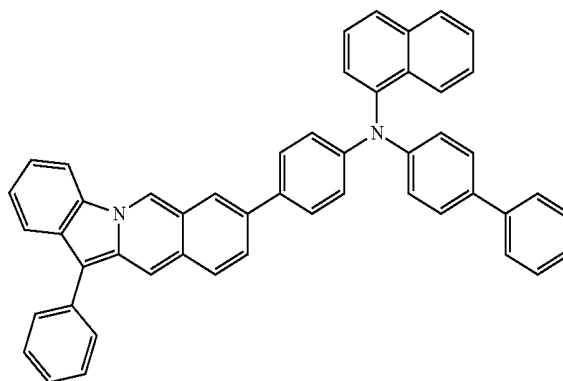
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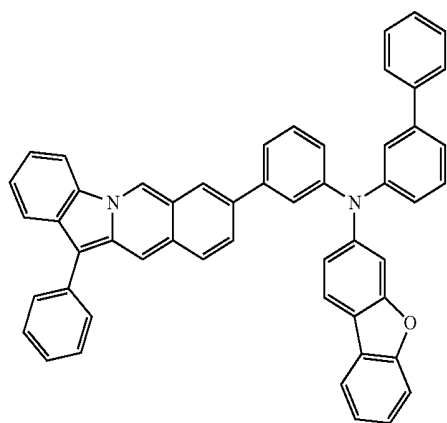
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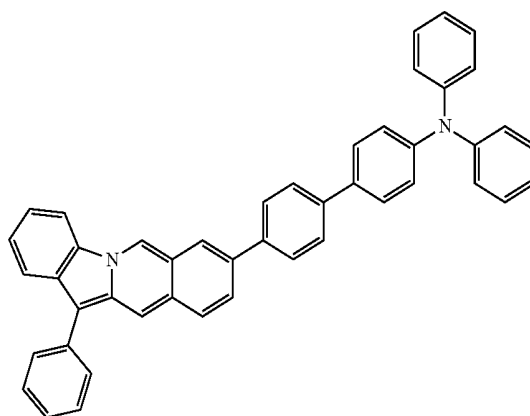
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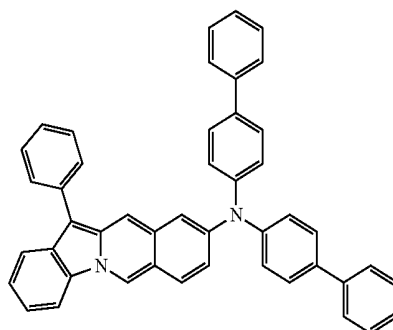
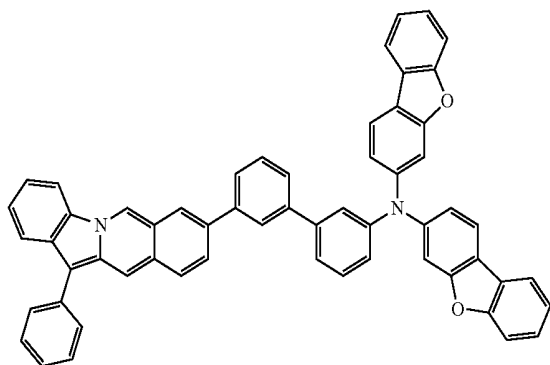
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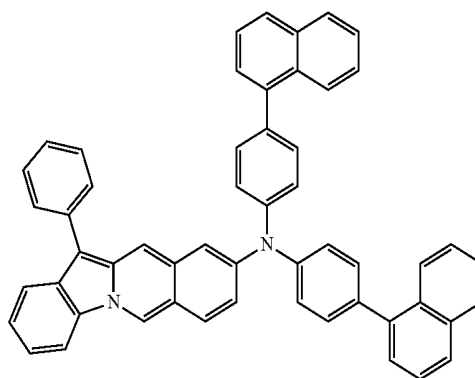
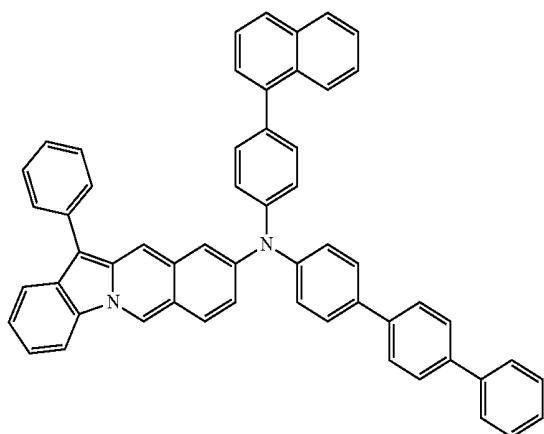
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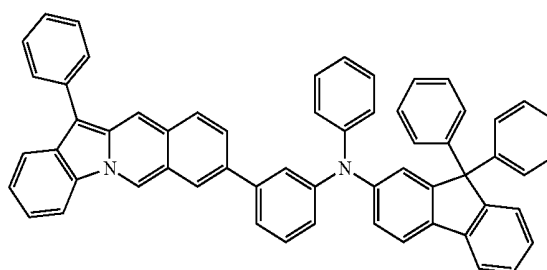
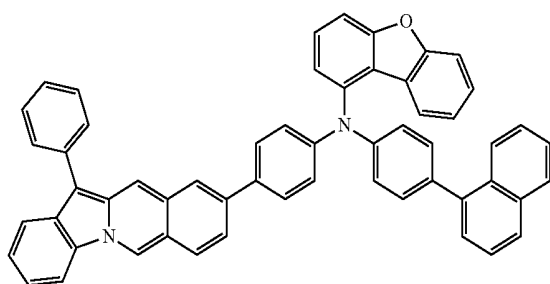
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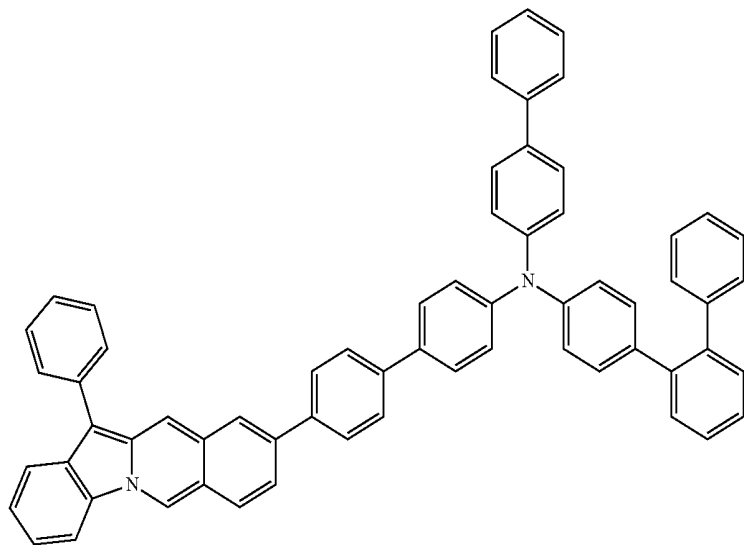
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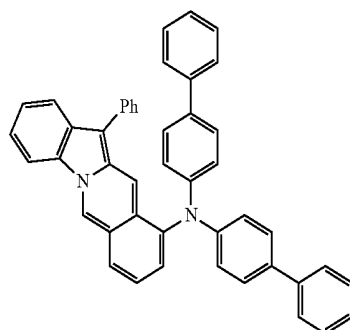
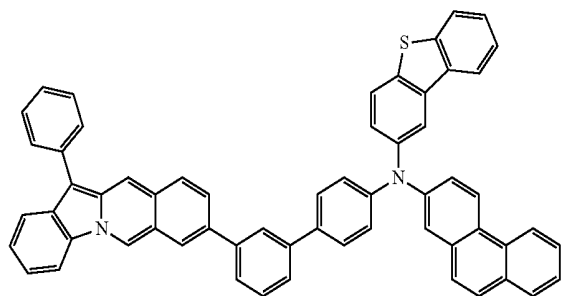
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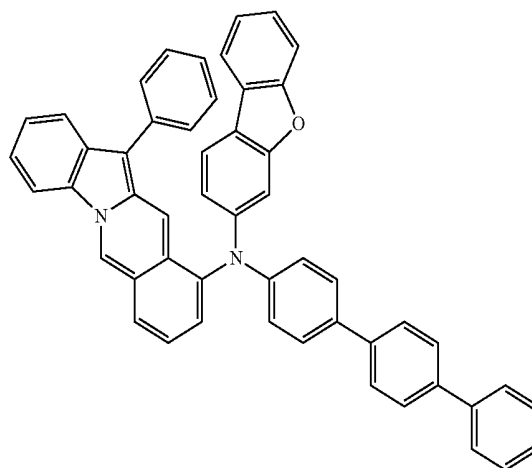
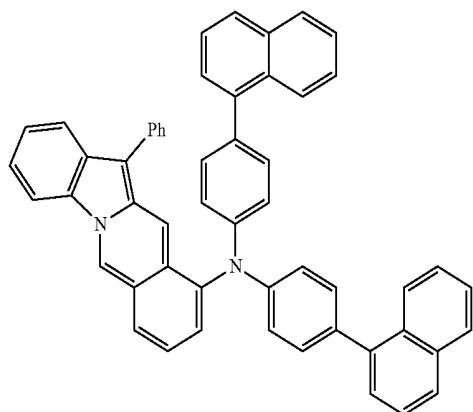
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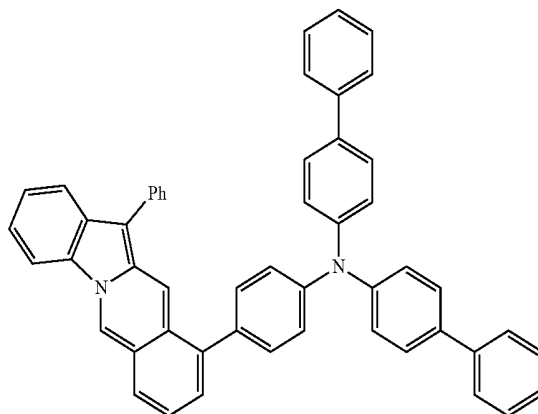
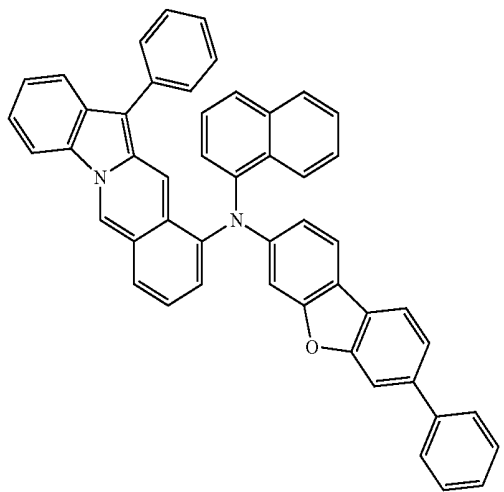
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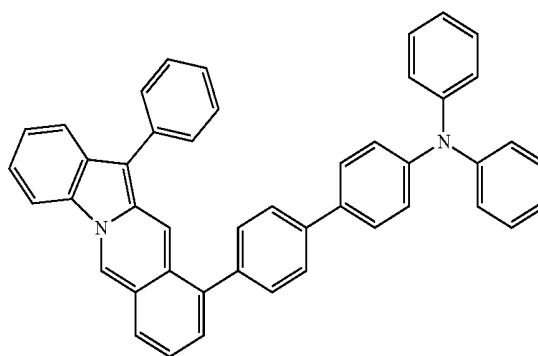
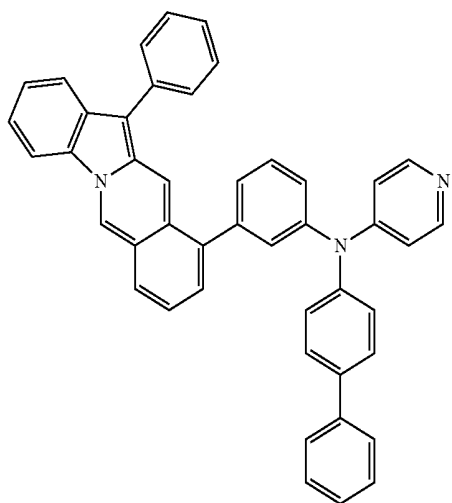
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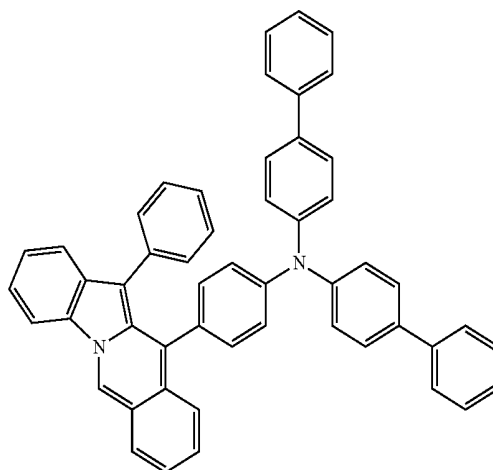
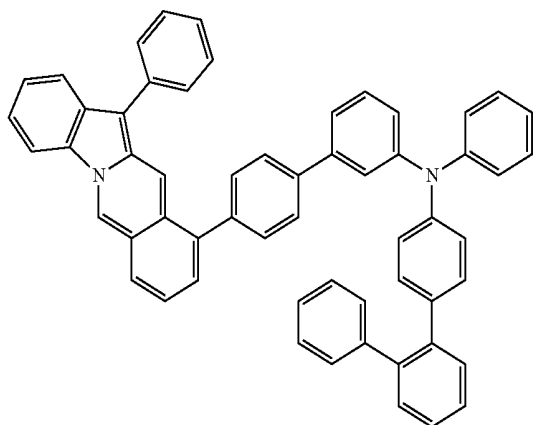
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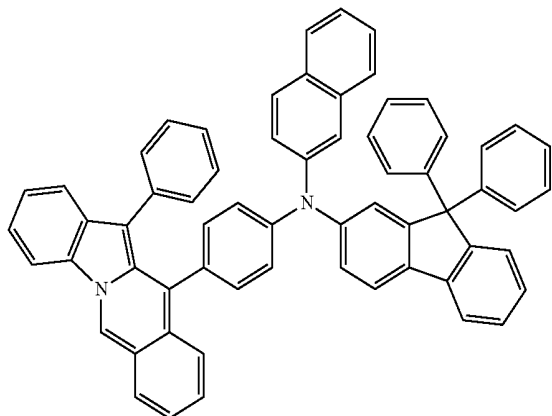


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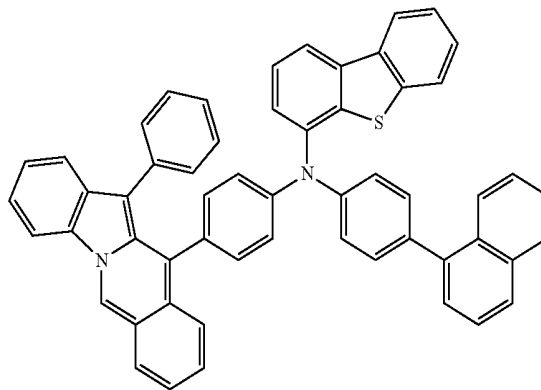
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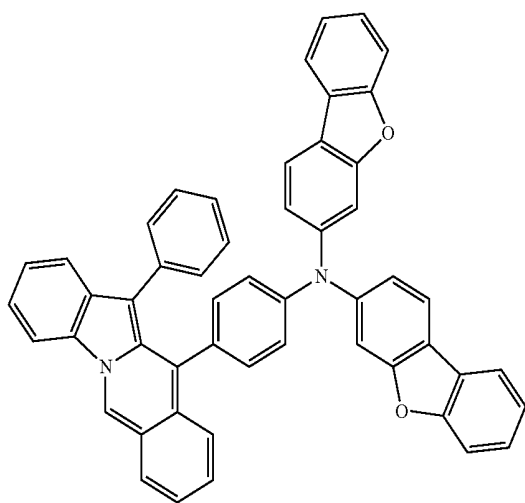
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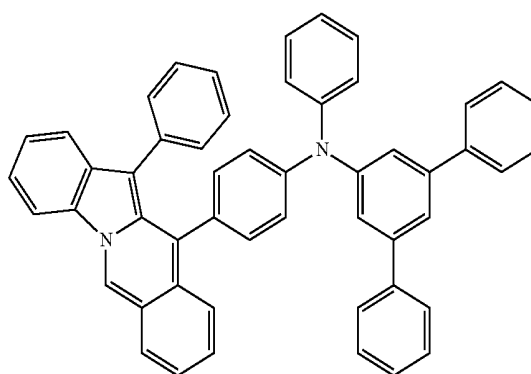
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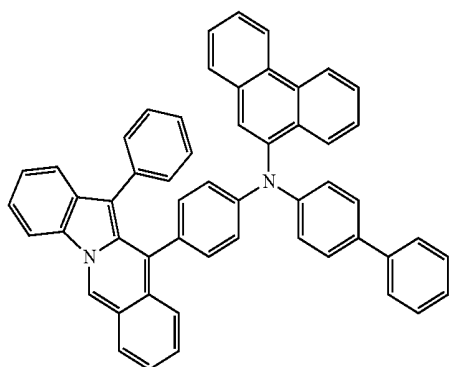
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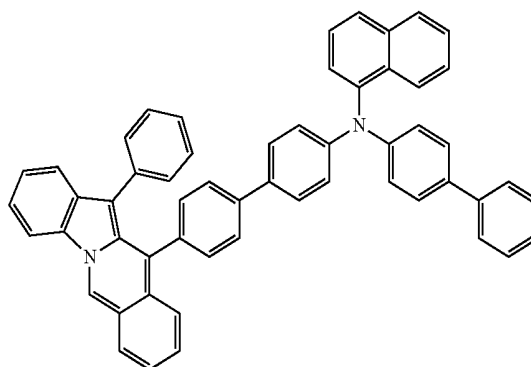
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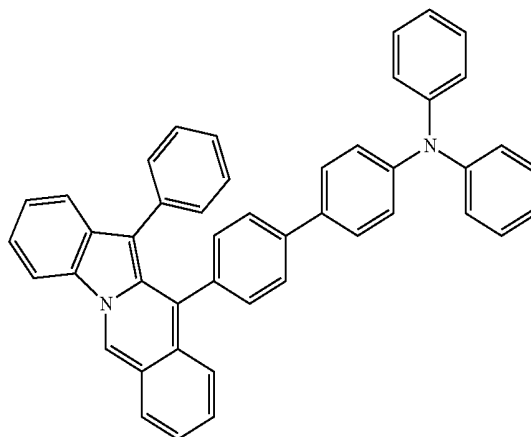
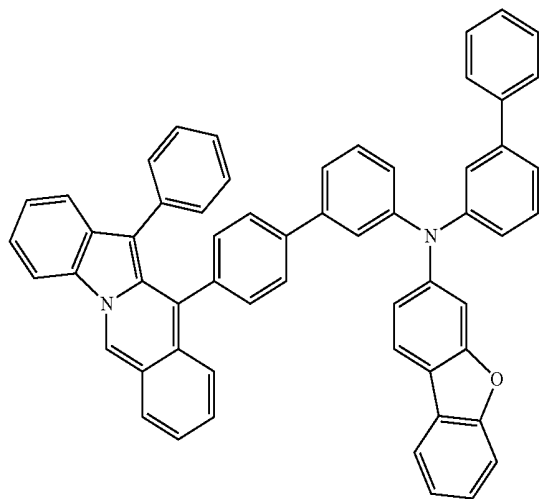
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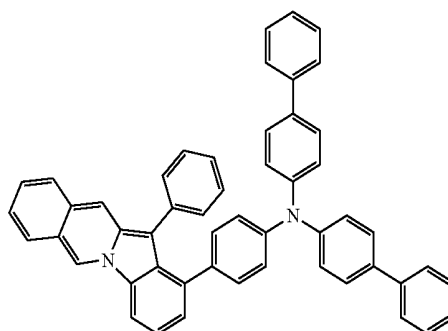
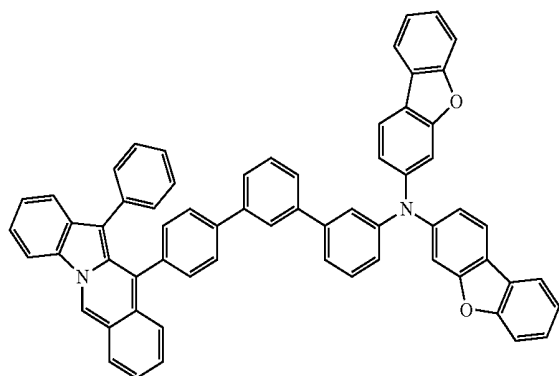
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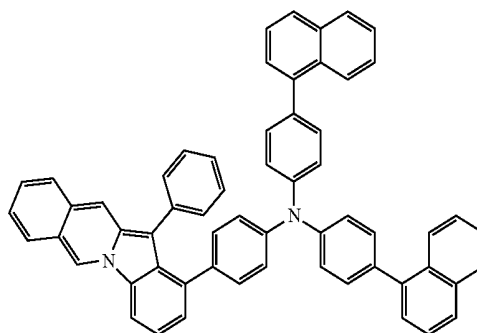
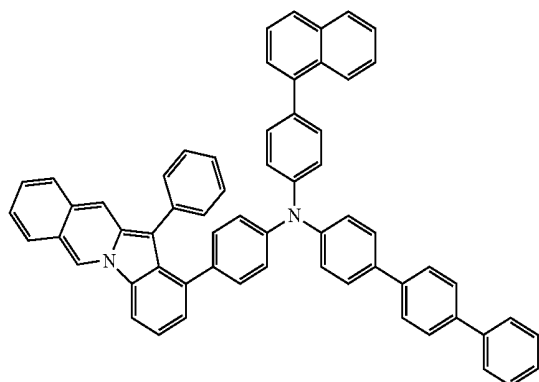
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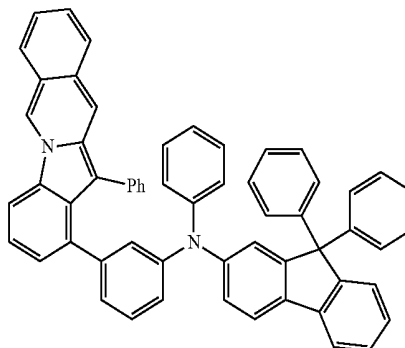
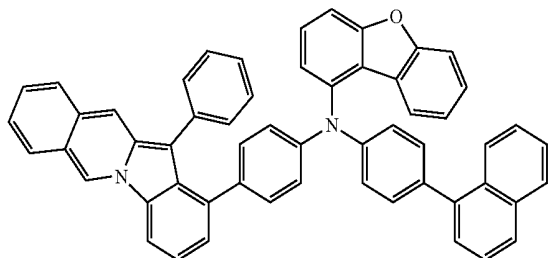
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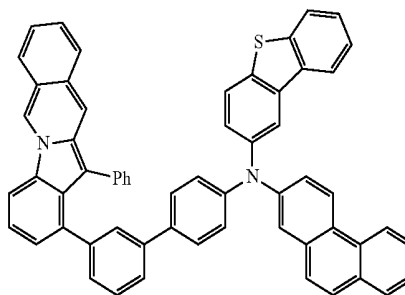
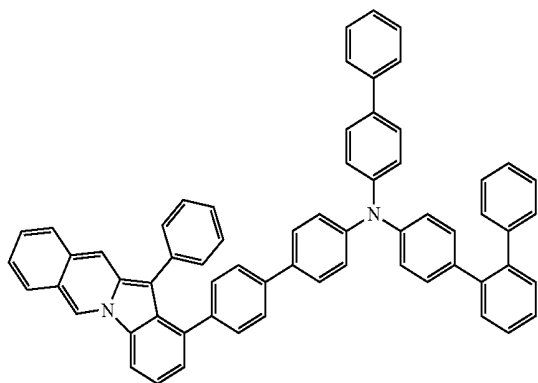
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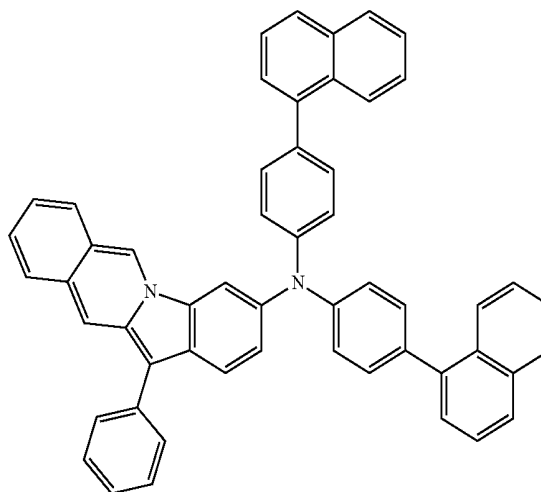
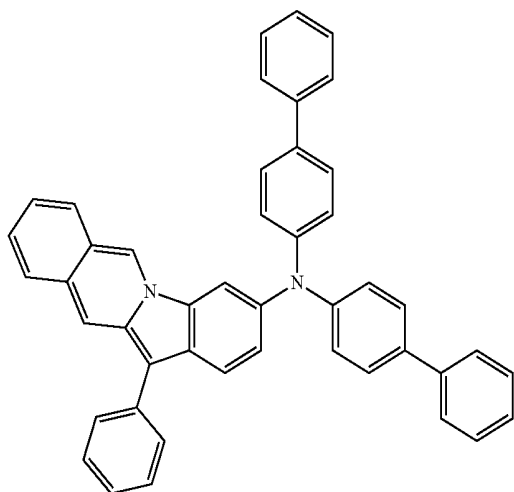
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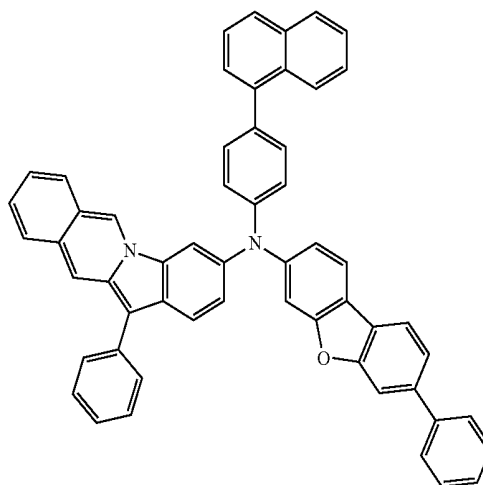
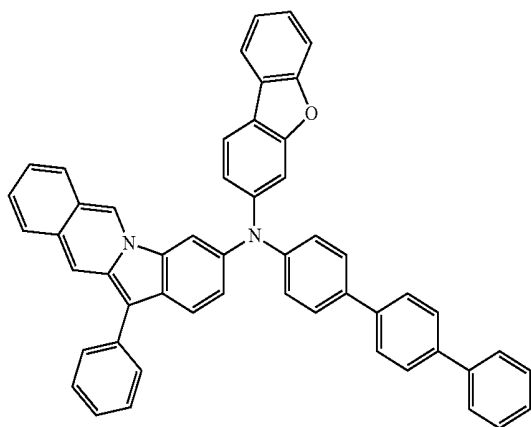
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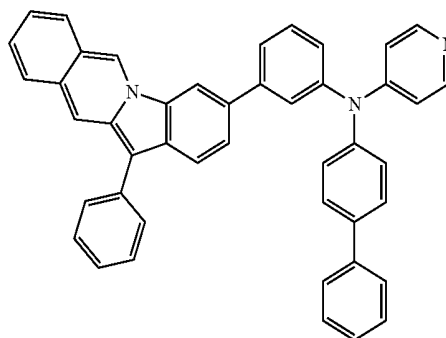
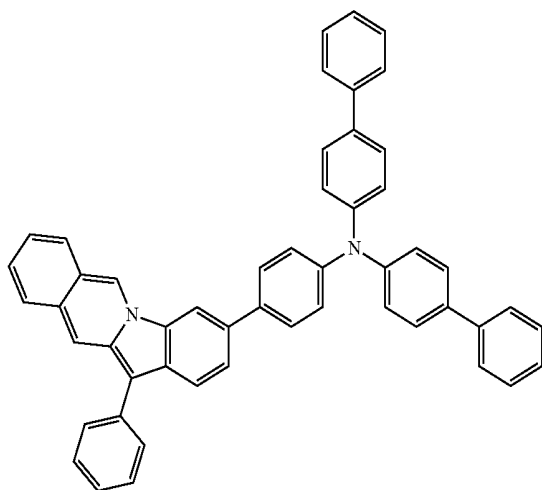
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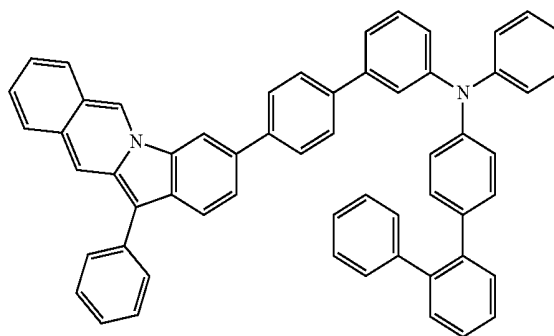
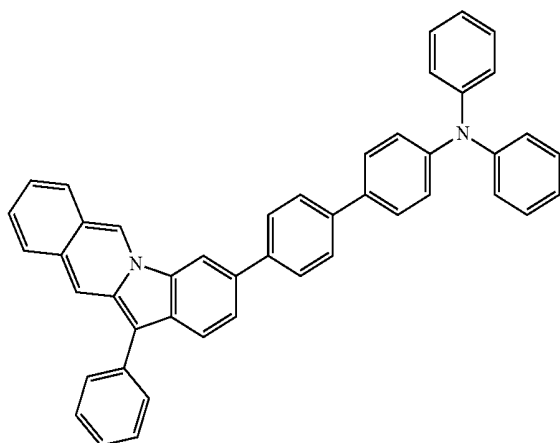
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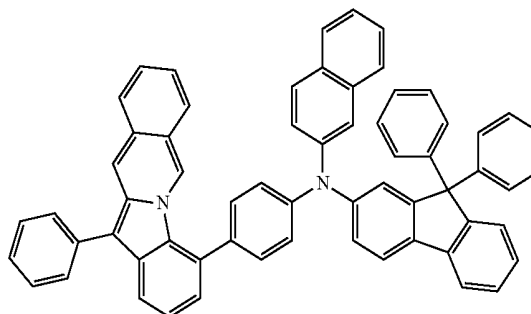
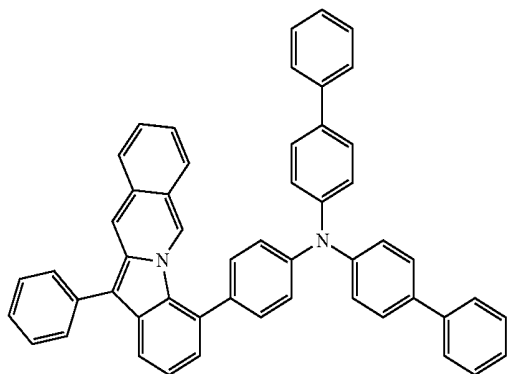
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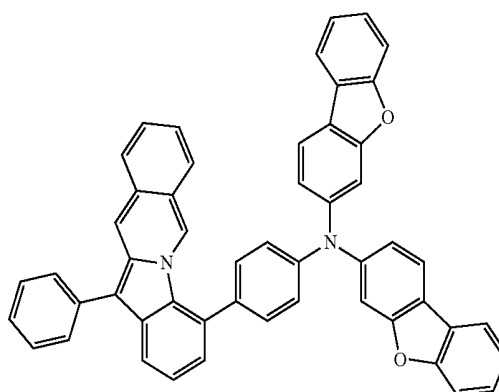
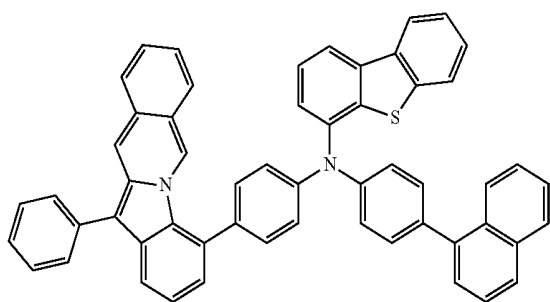
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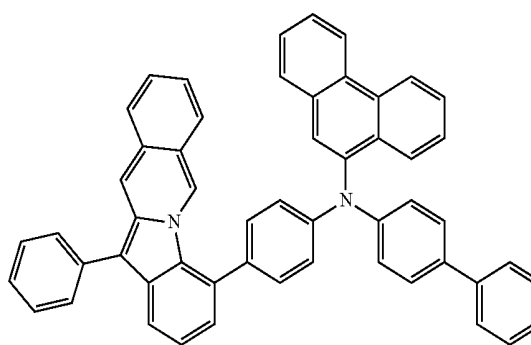
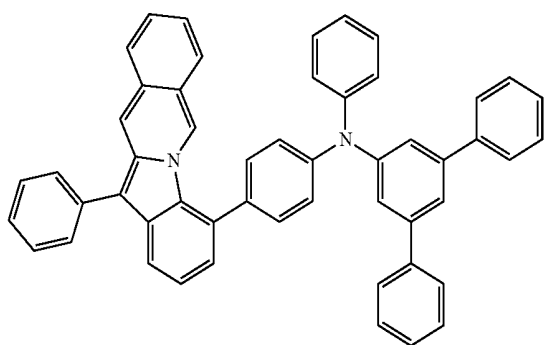
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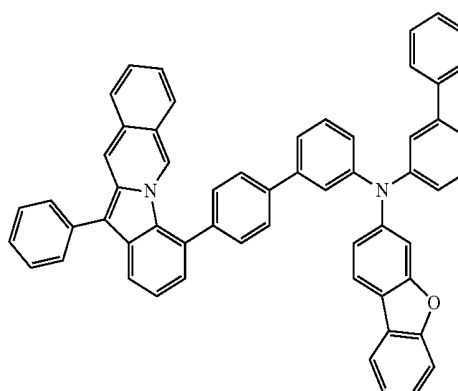
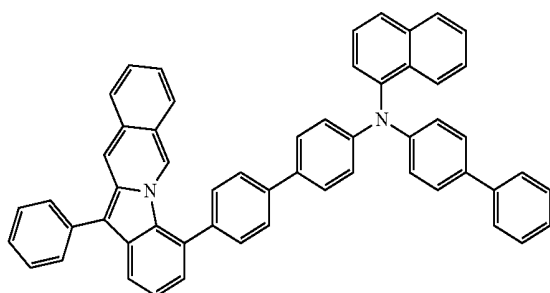
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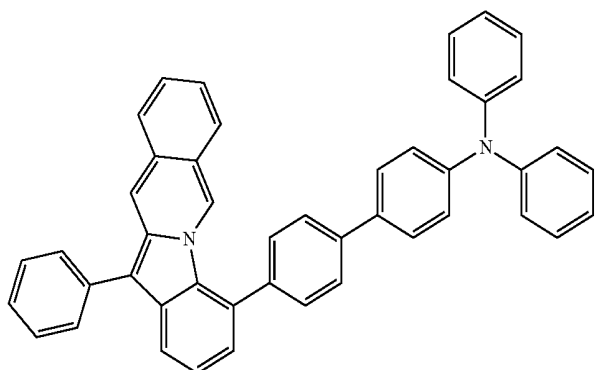
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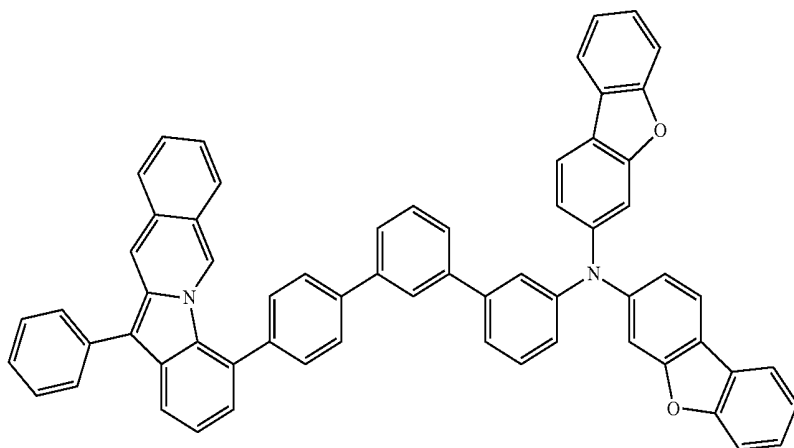


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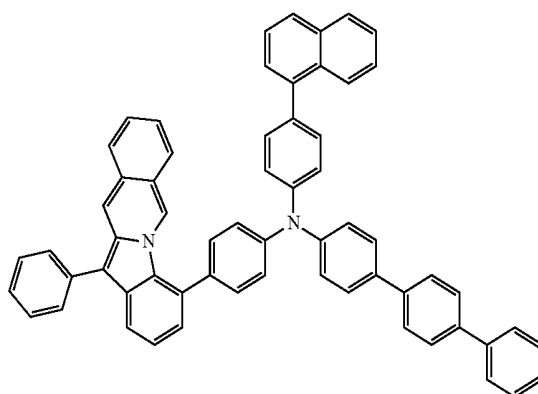
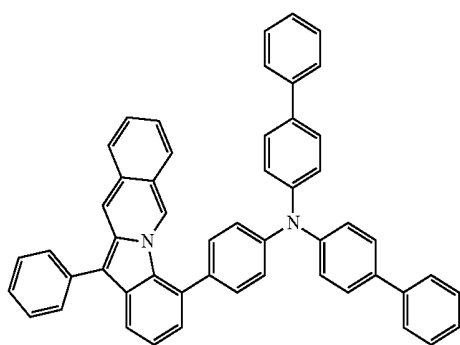


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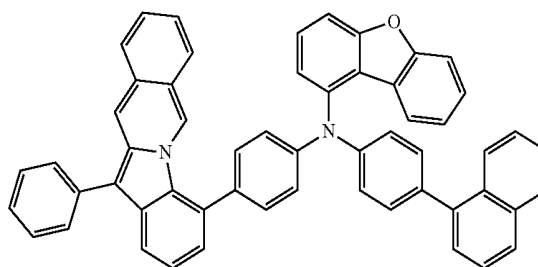
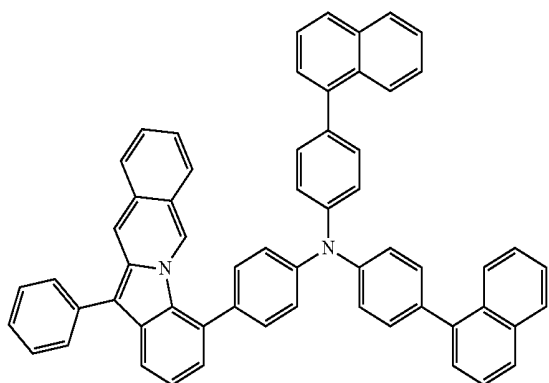
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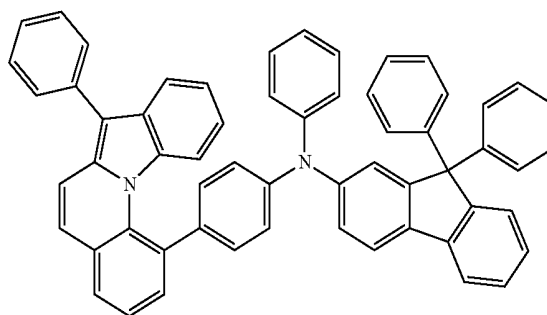
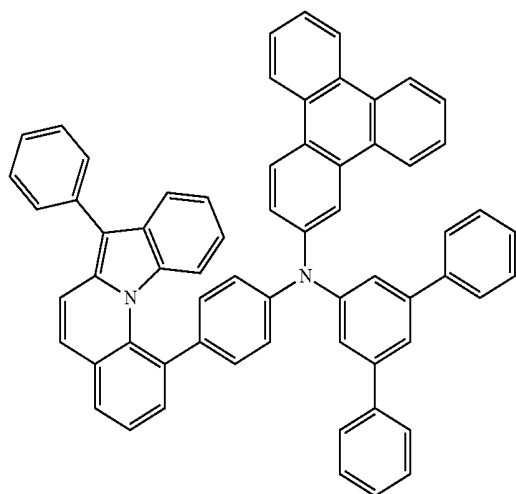
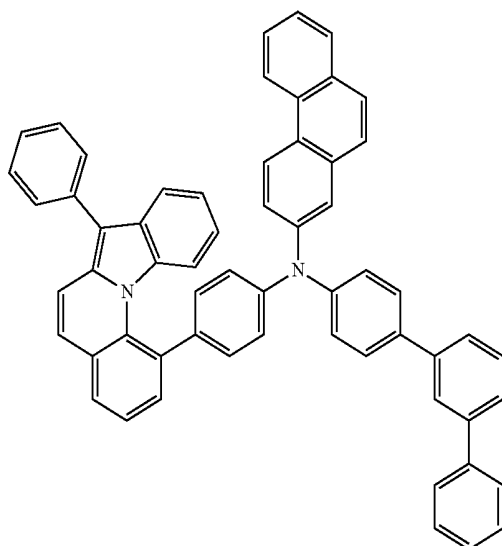
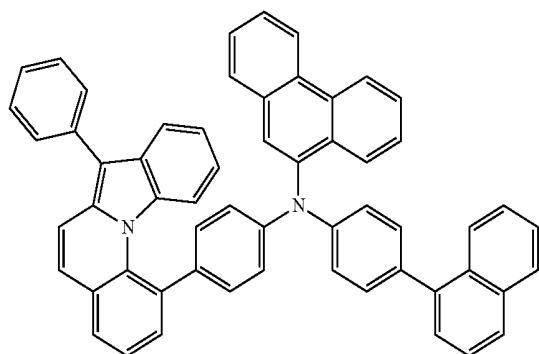
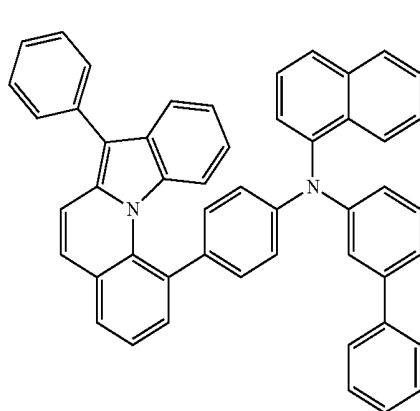
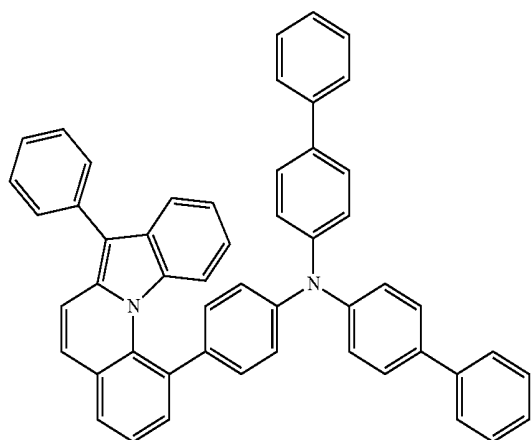


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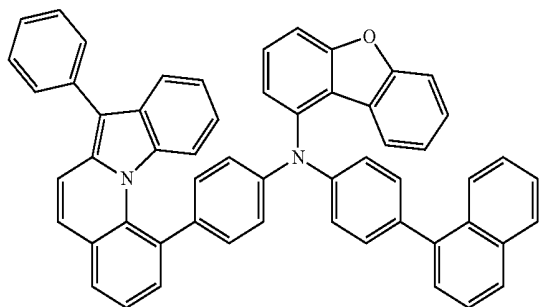
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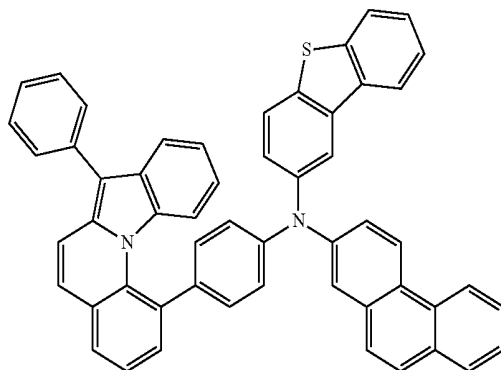
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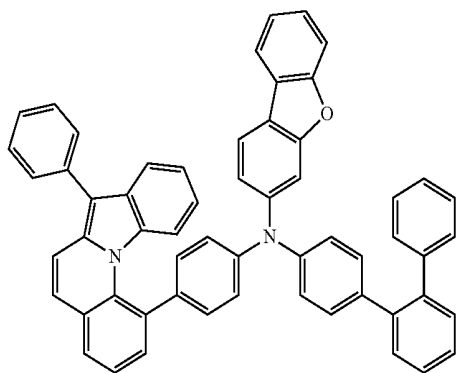
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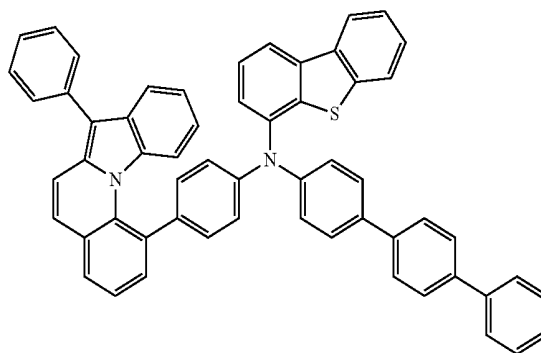
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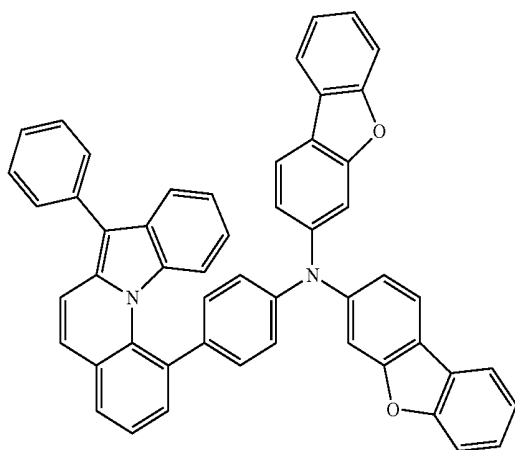
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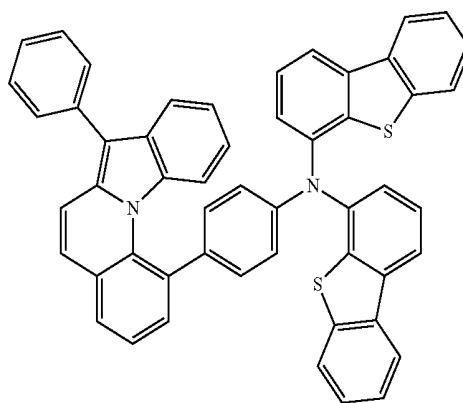
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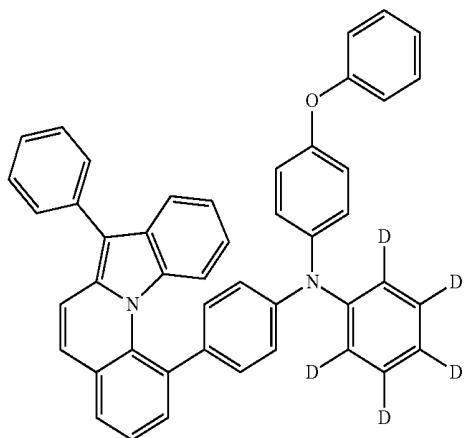
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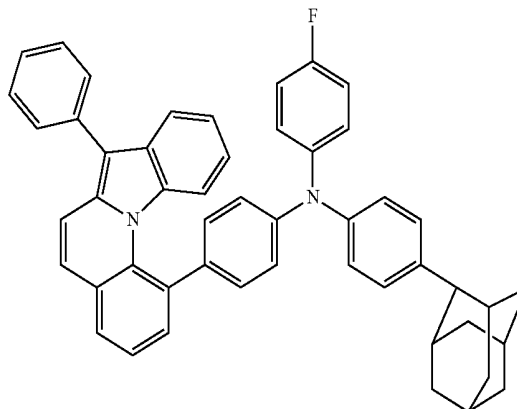
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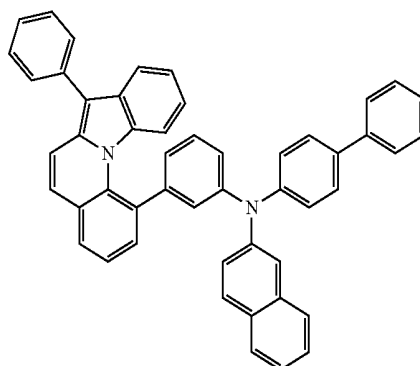
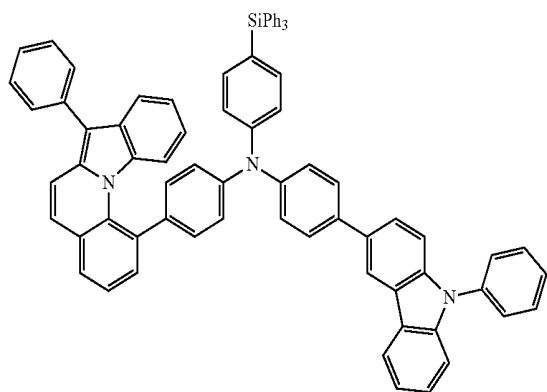


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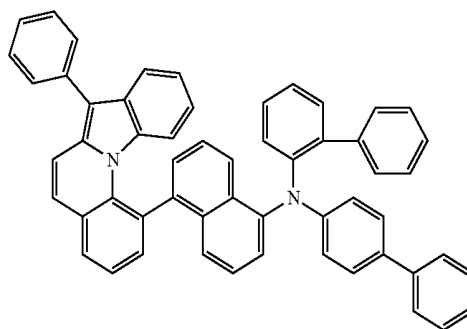
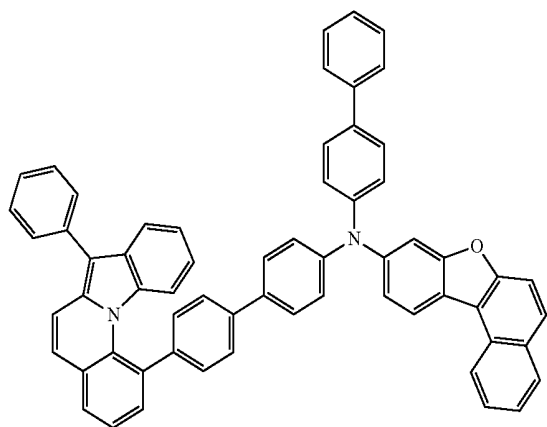
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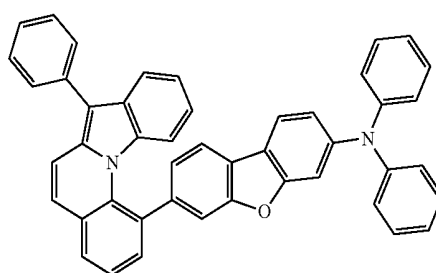
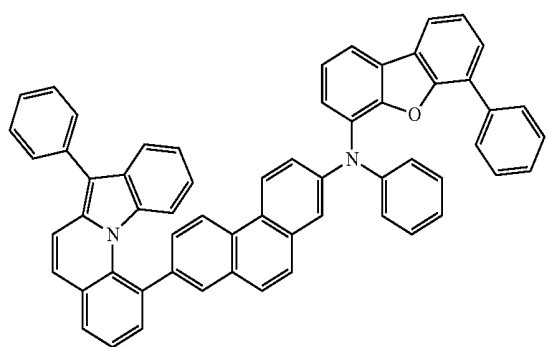
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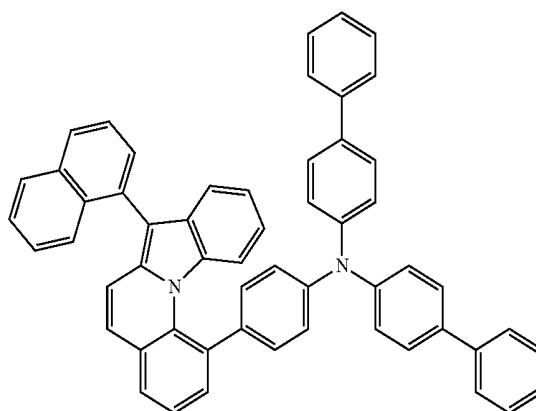
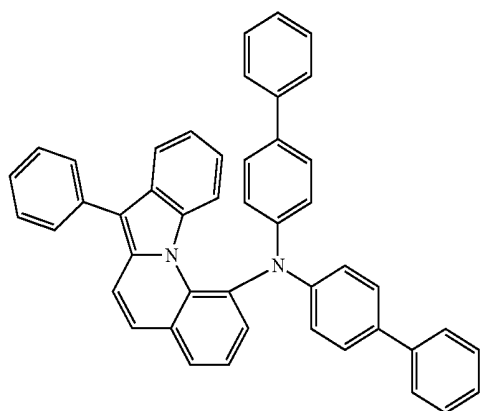
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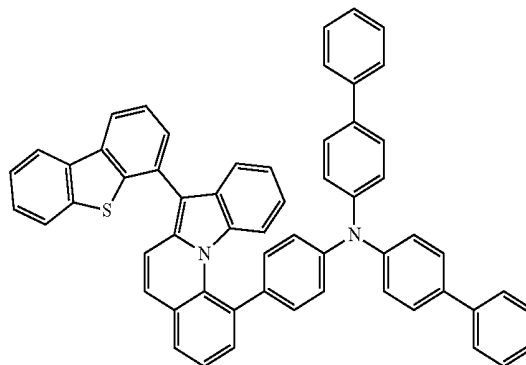
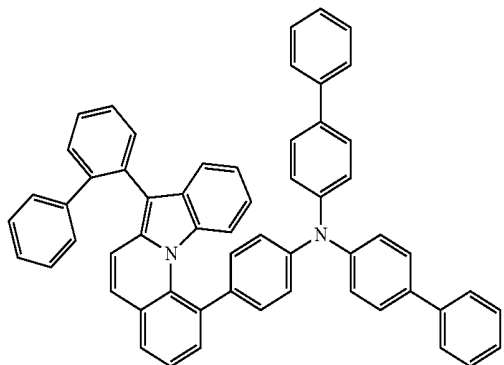
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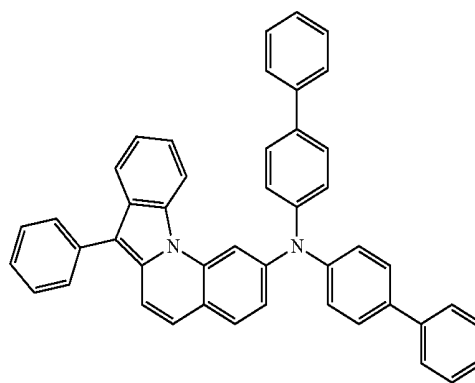
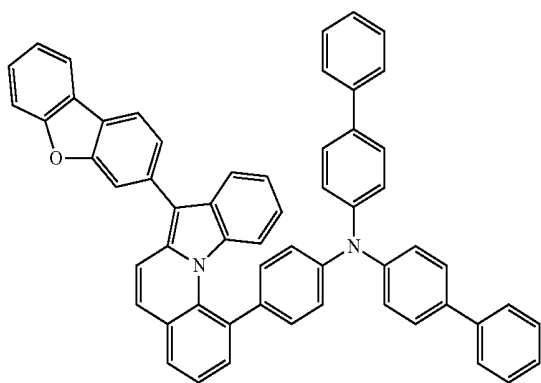
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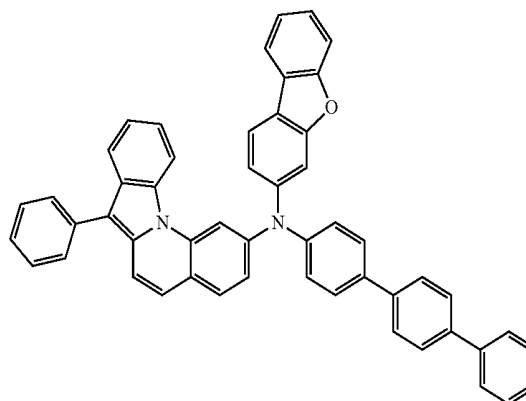
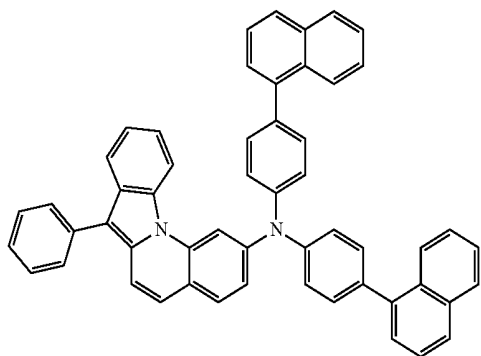
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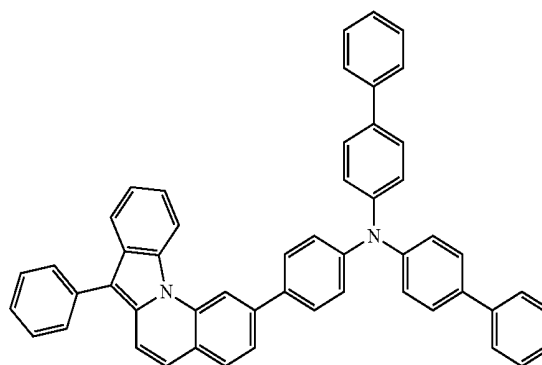
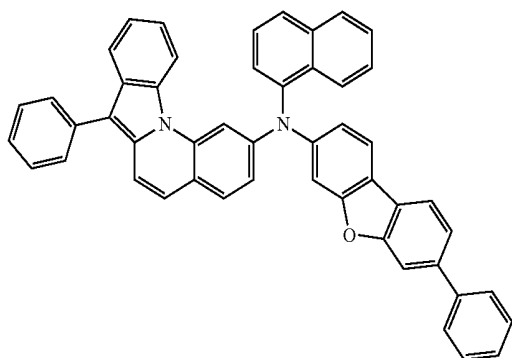
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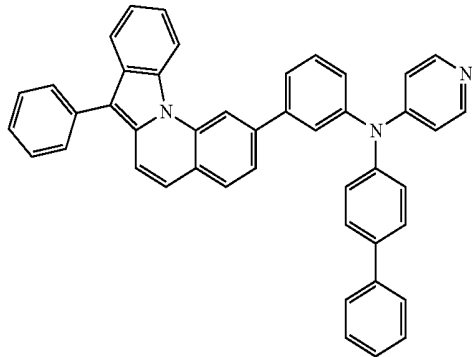
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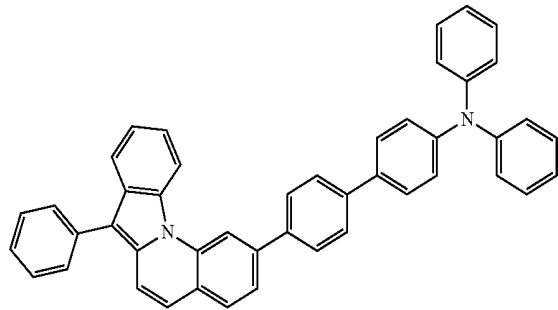


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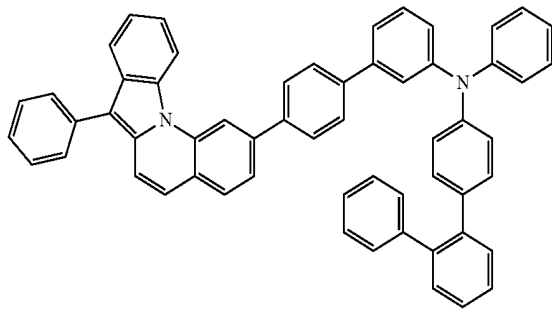
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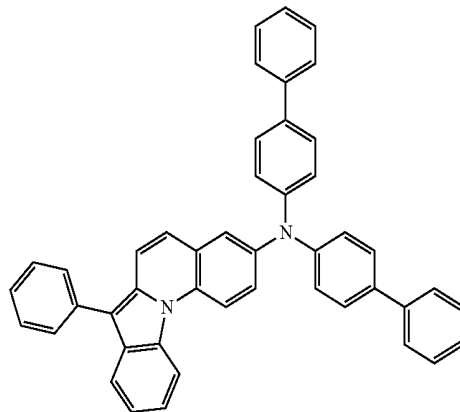
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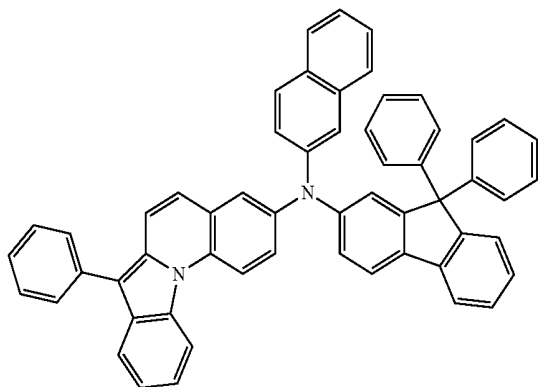
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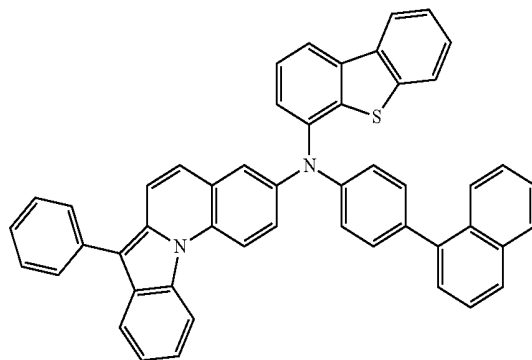
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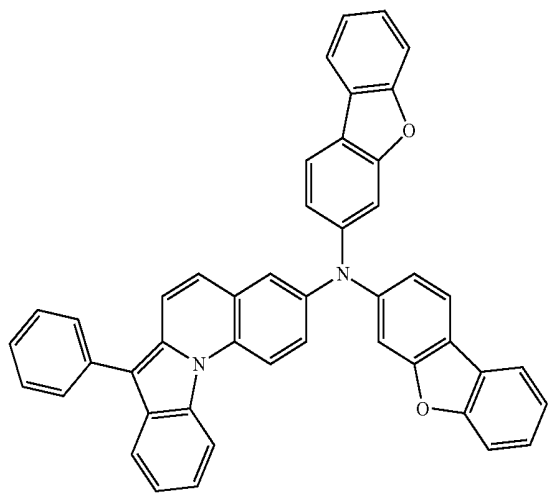


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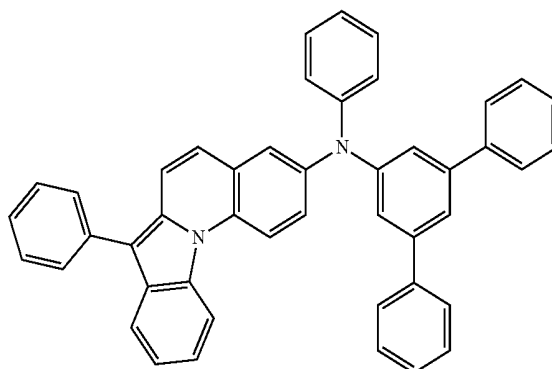


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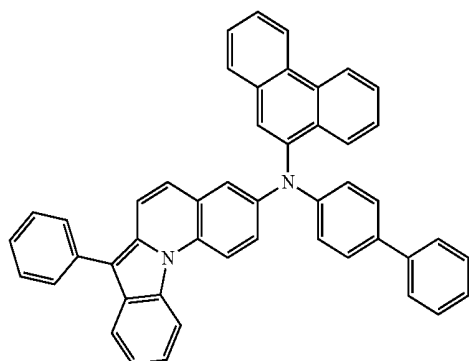
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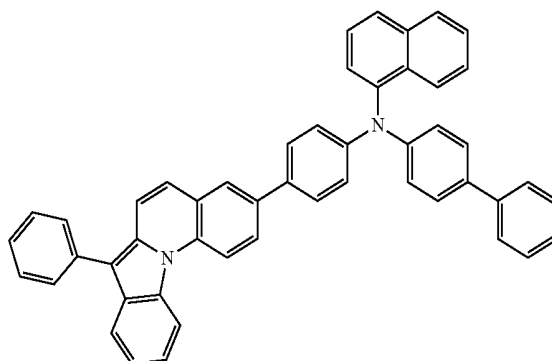
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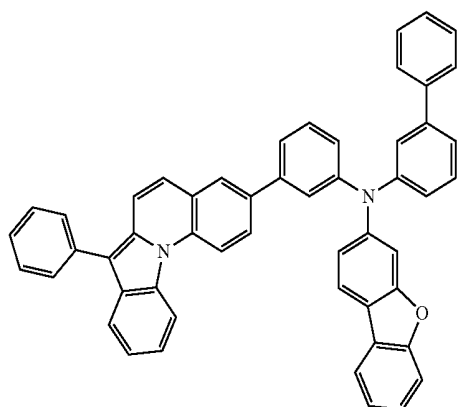
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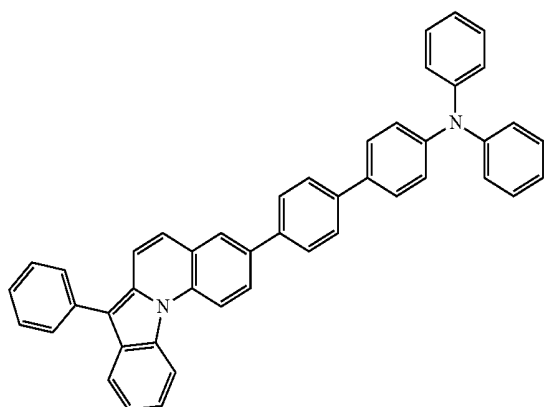
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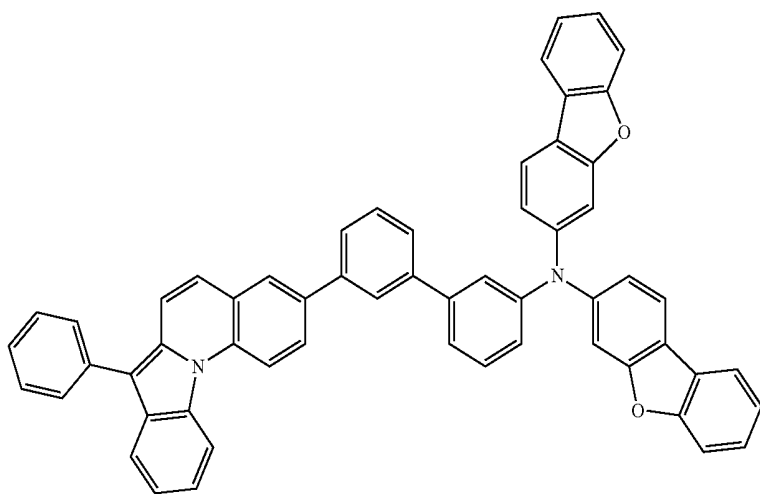


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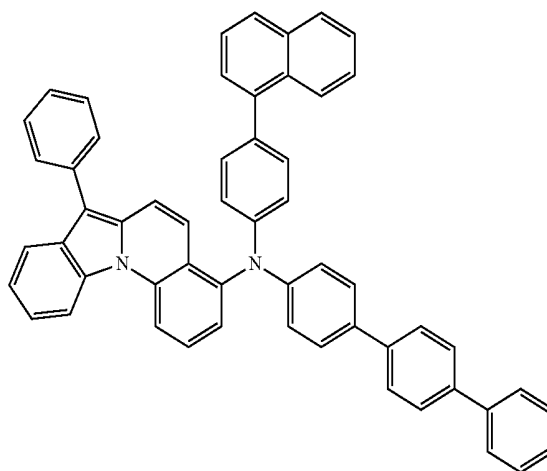
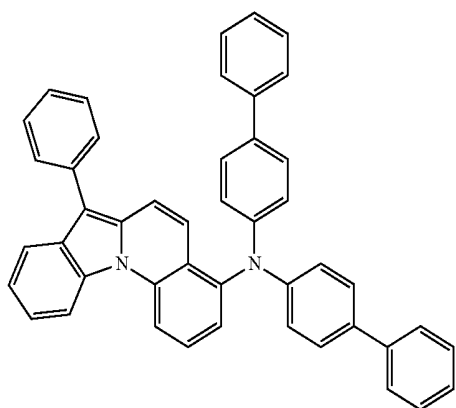
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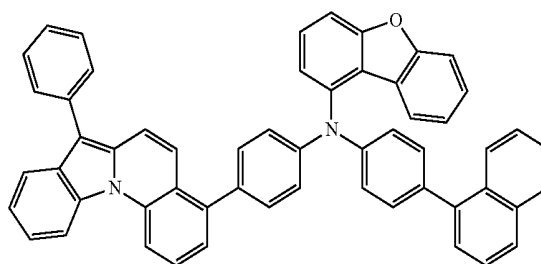
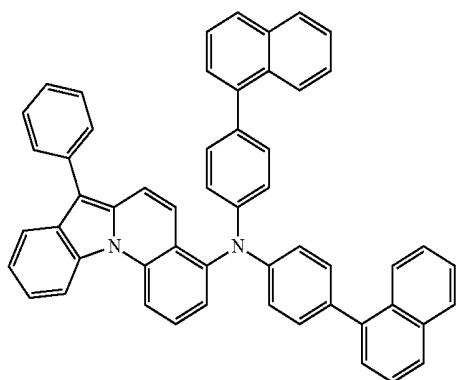
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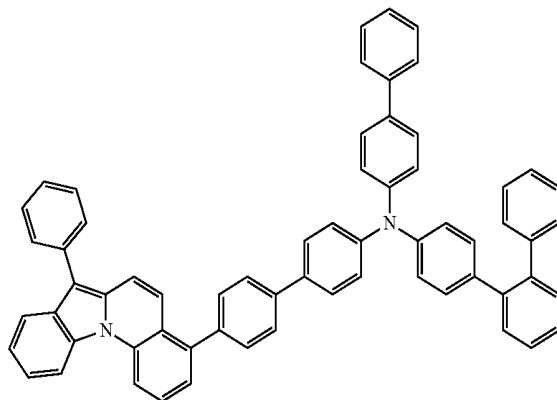
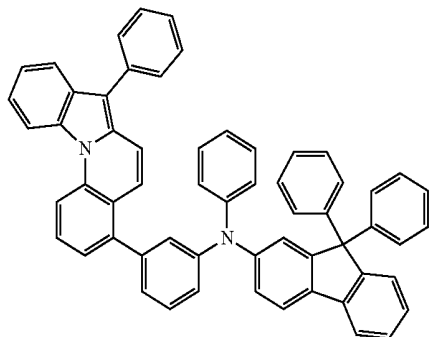
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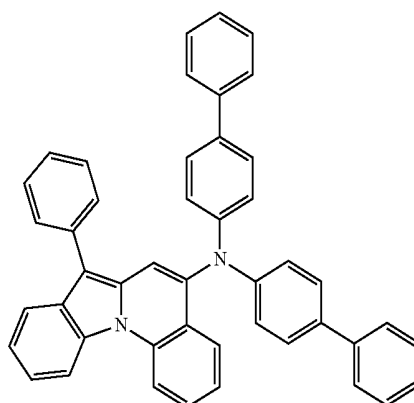
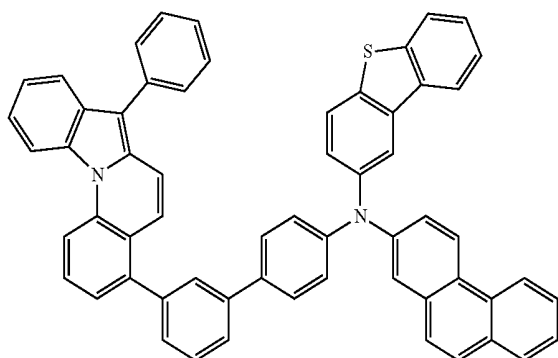
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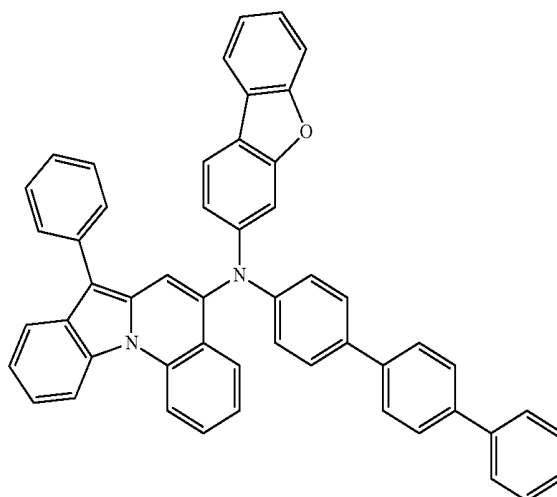
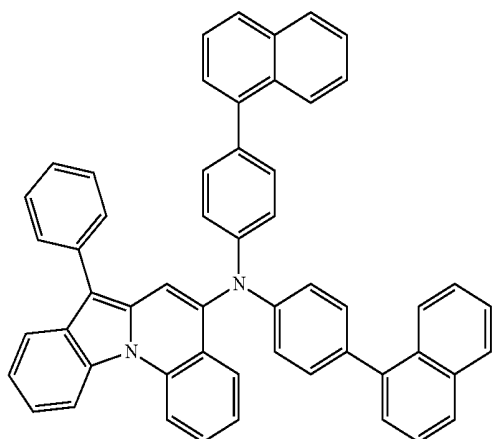
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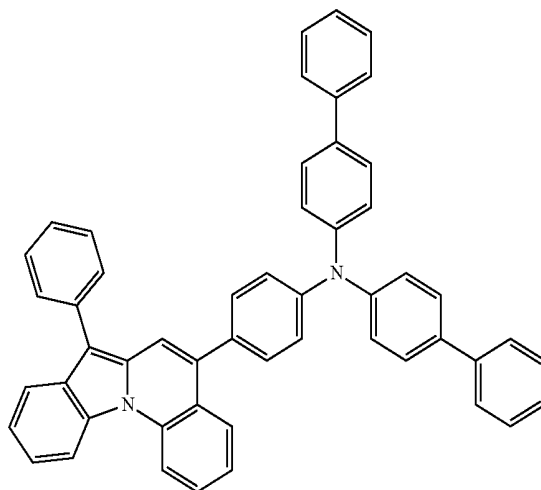
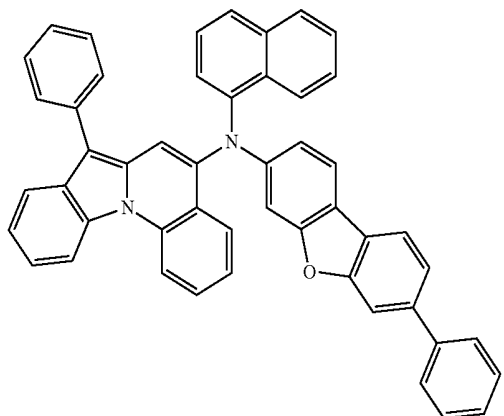
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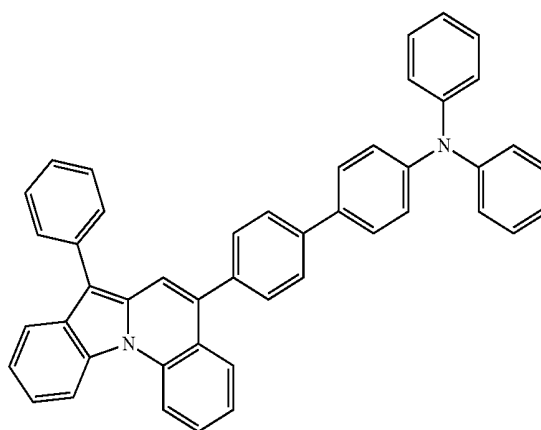
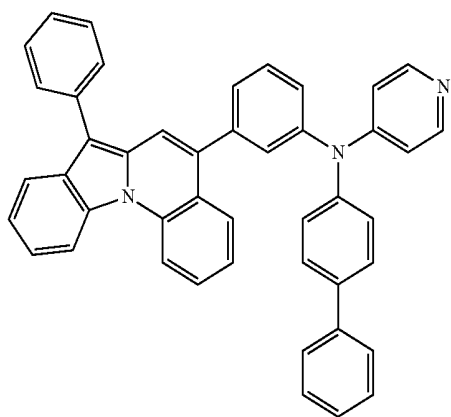
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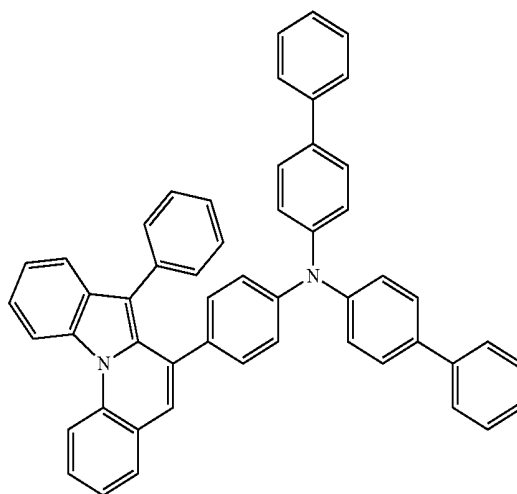
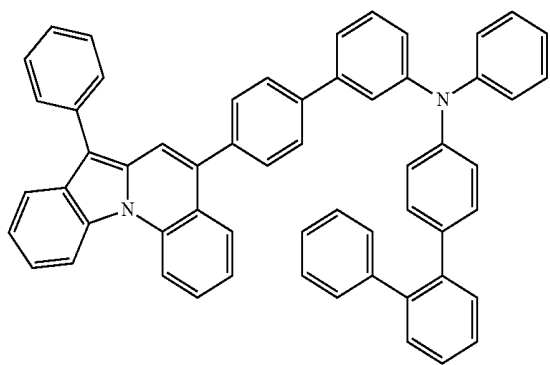
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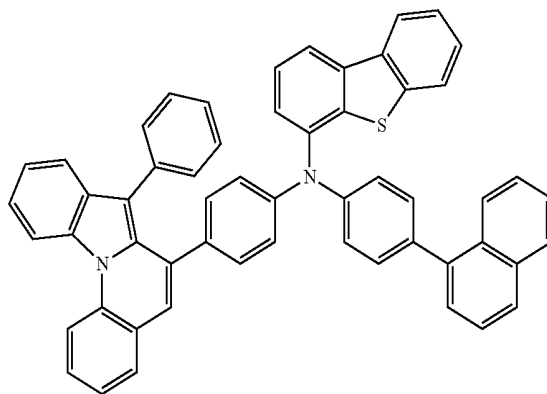
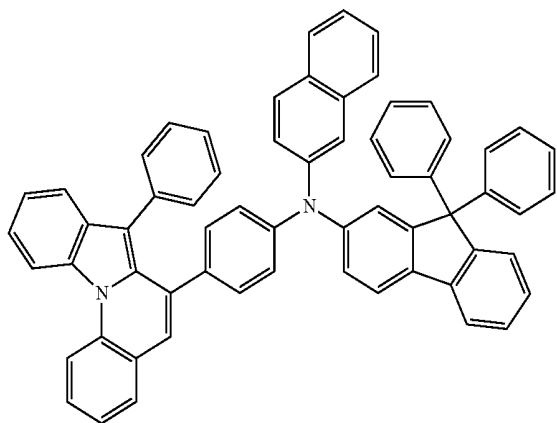
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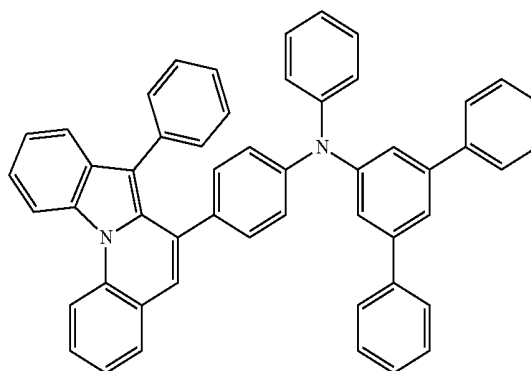
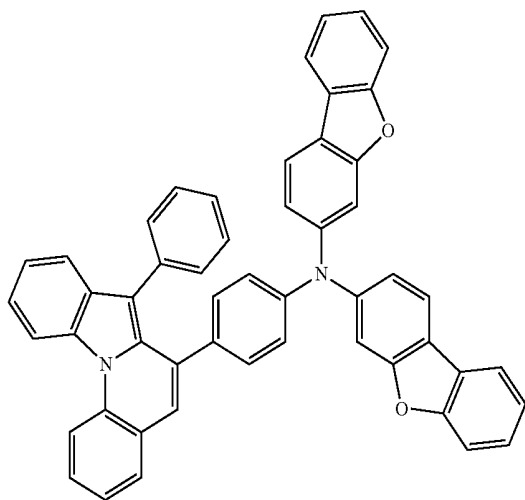
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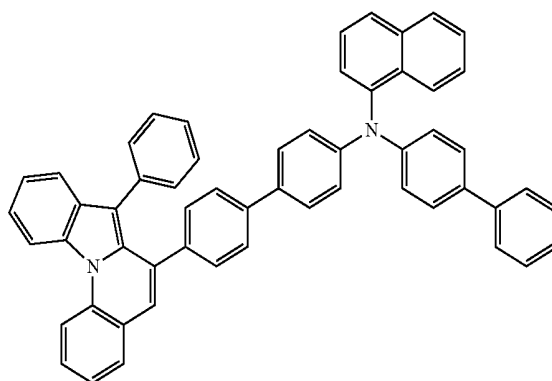
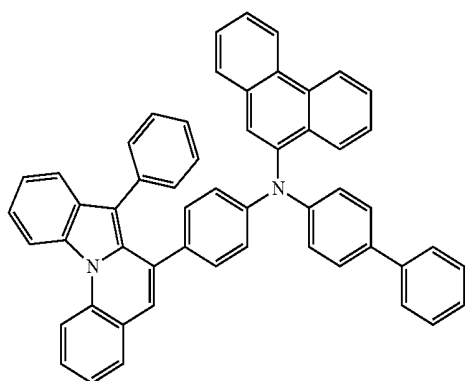
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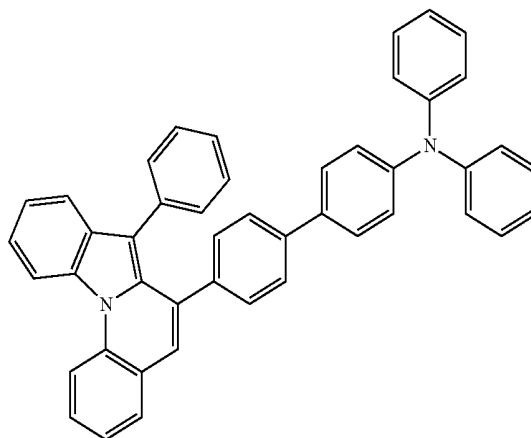
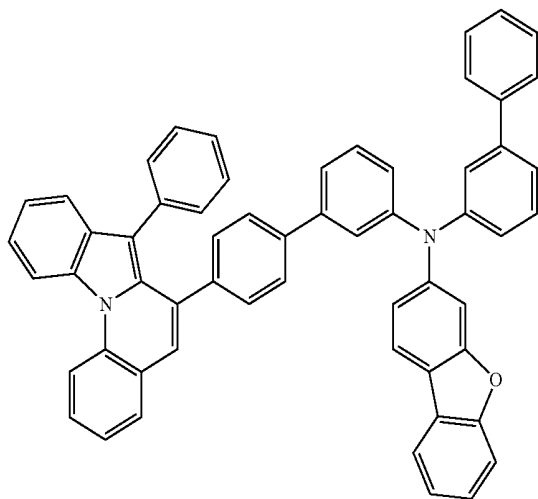
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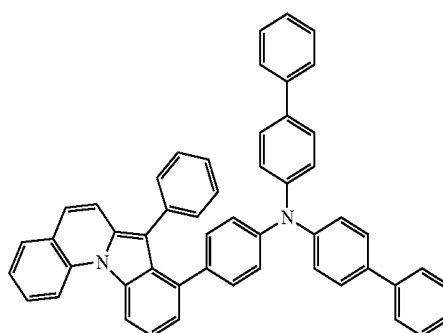
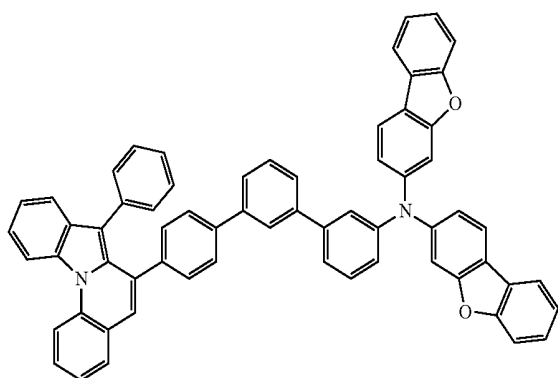
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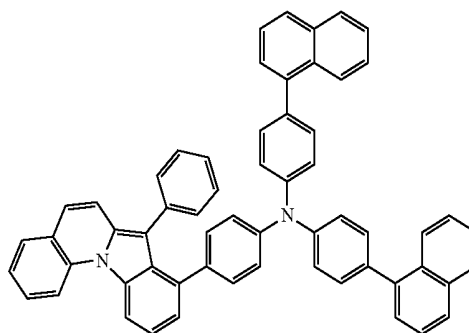
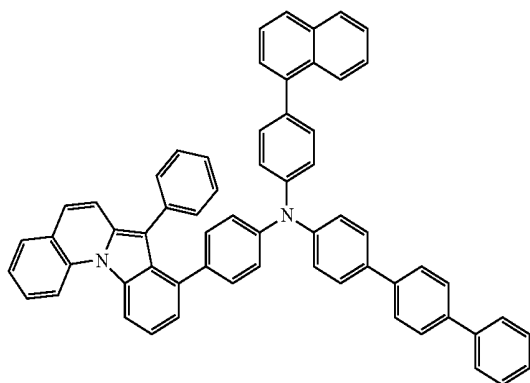
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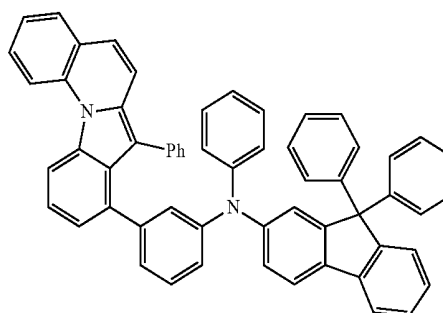
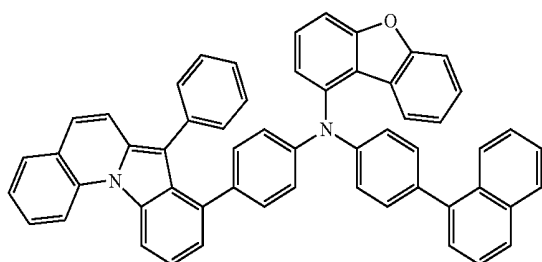
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C71



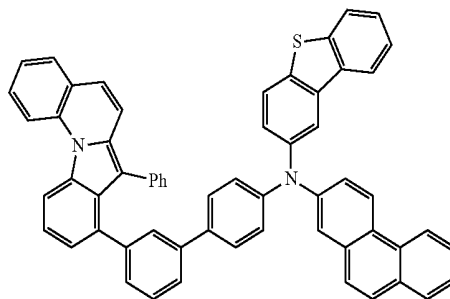
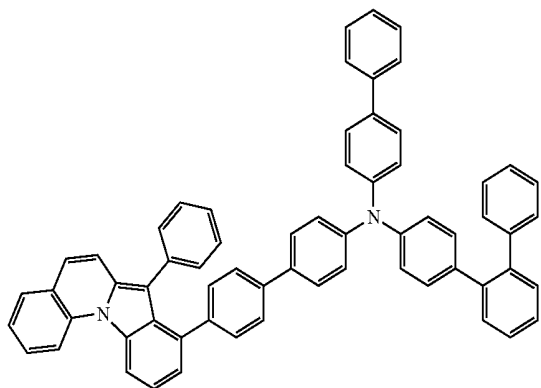
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C73



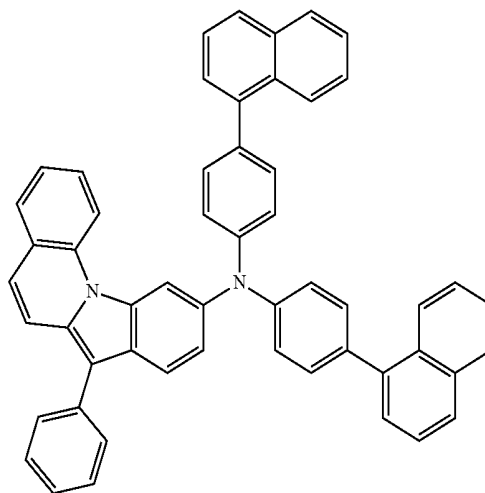
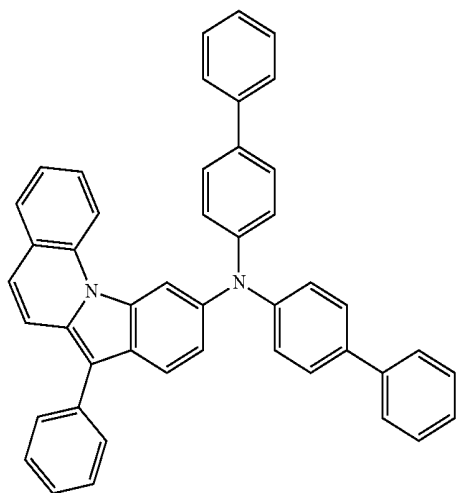
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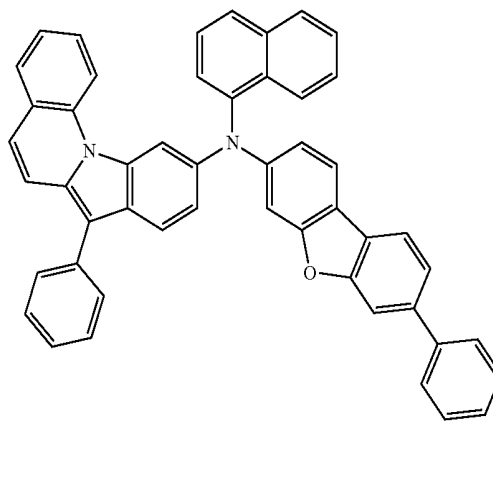
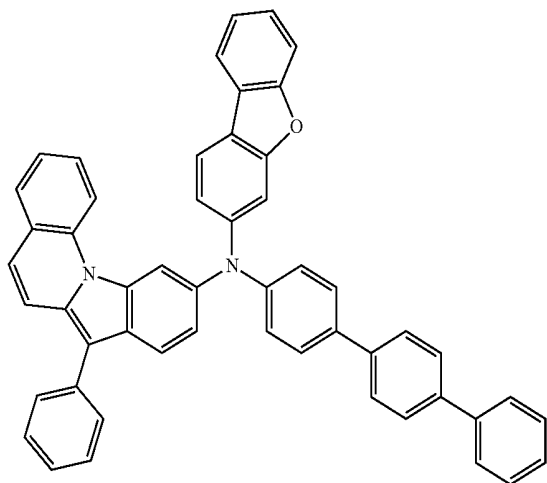
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C77



C78

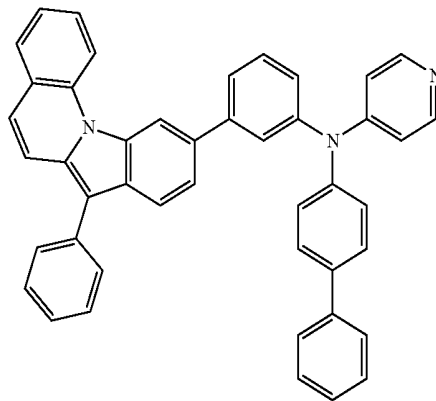
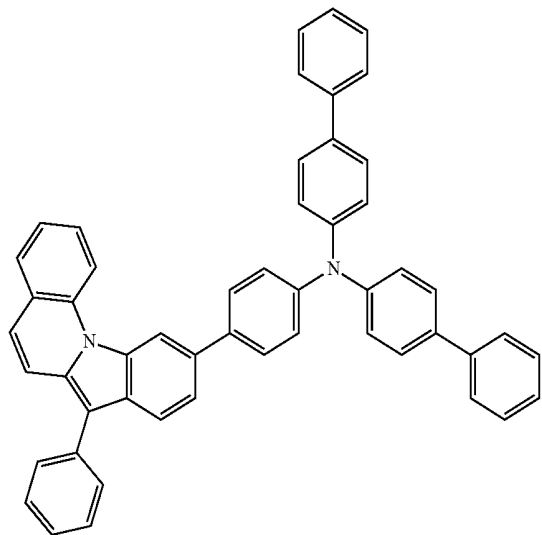
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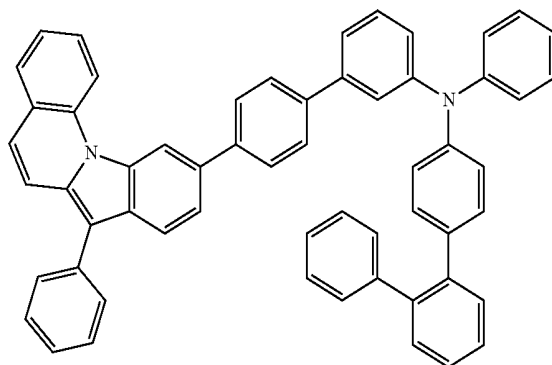
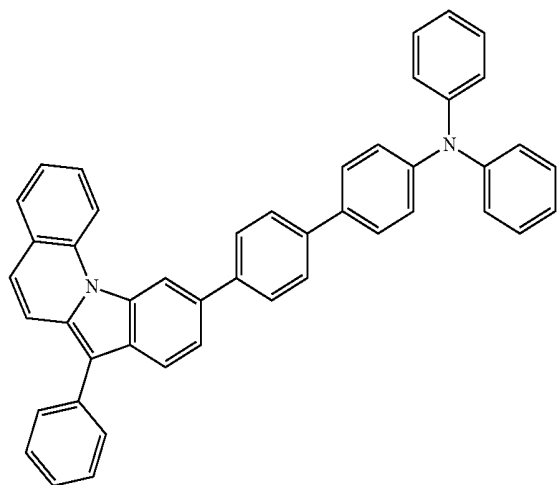
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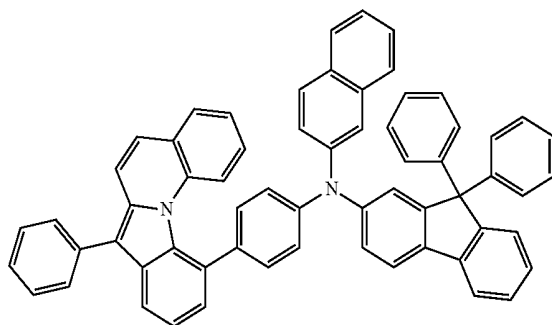
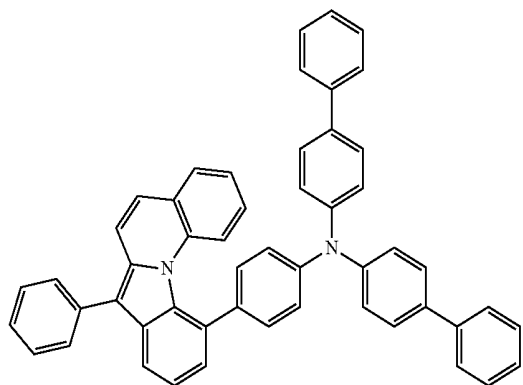
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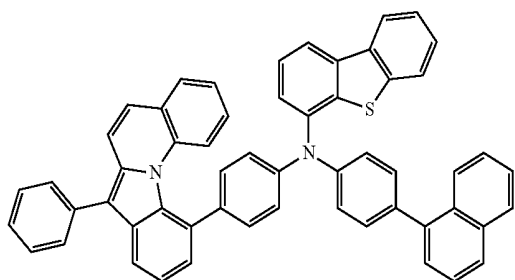


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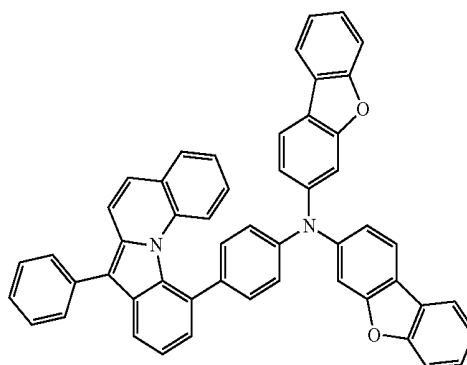
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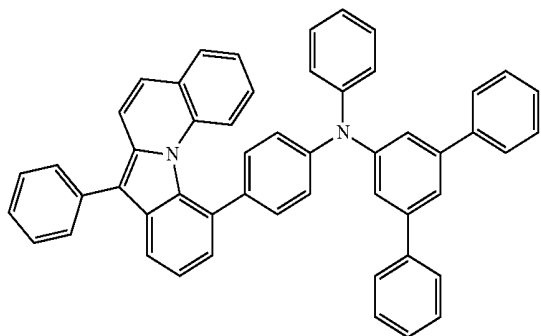
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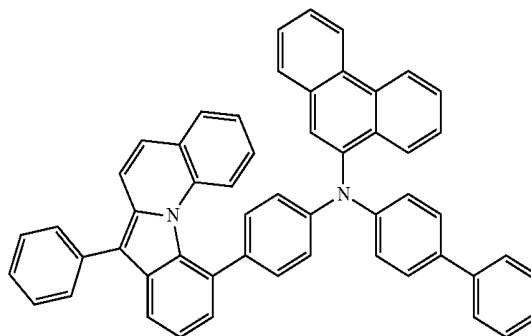
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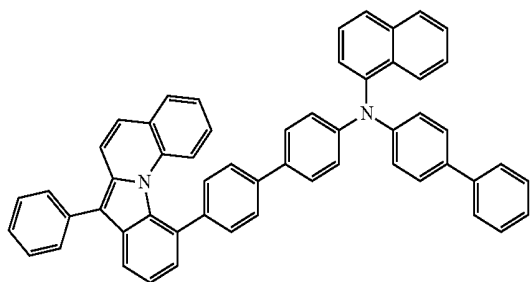
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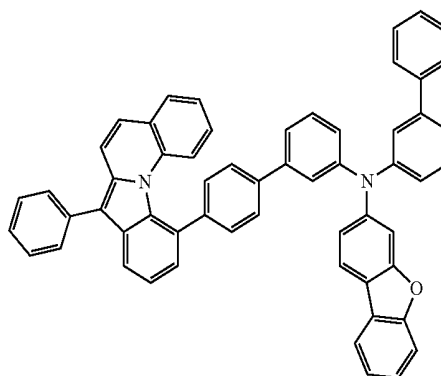
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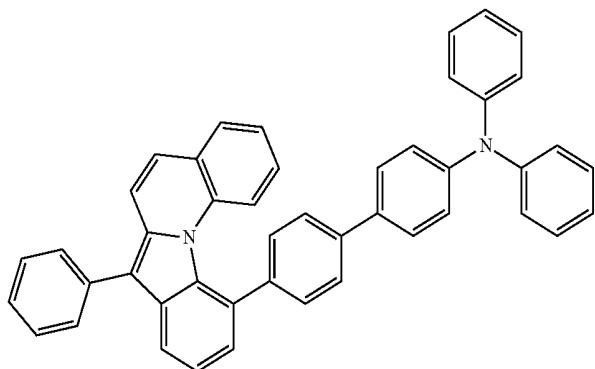
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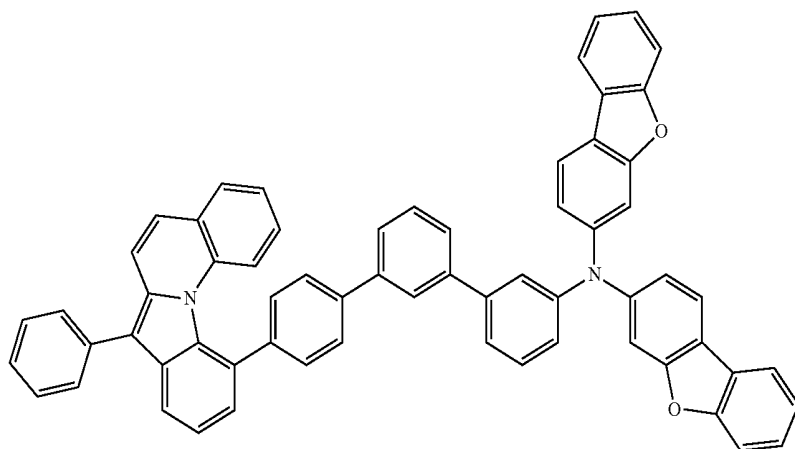


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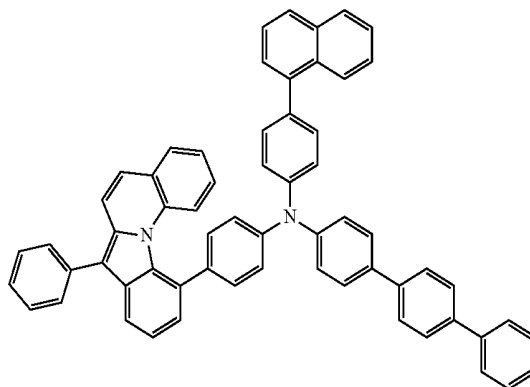
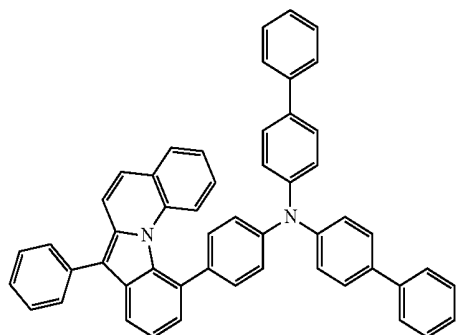
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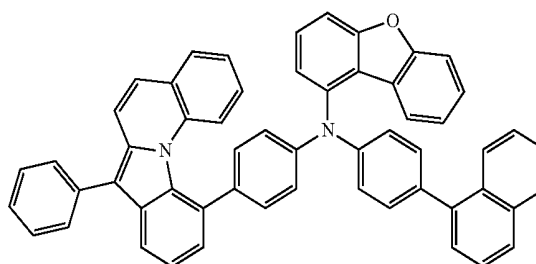
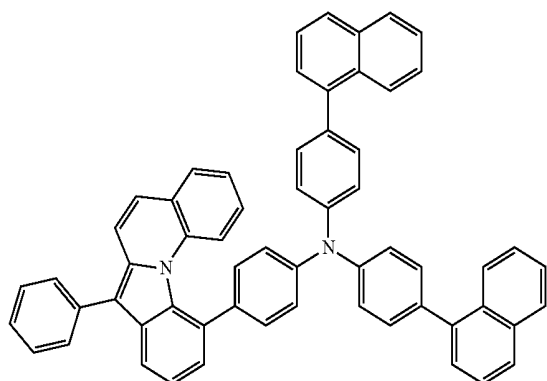
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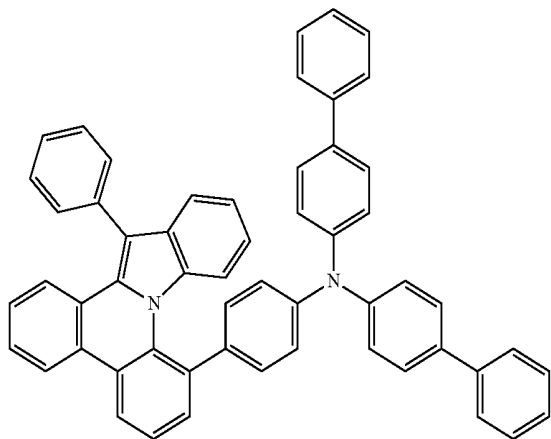


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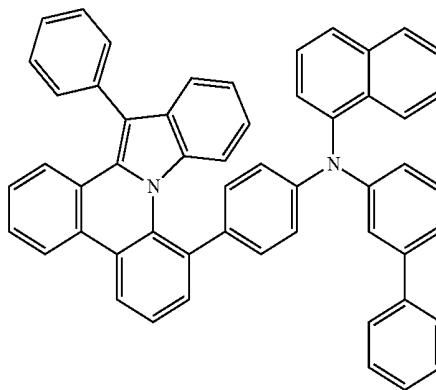
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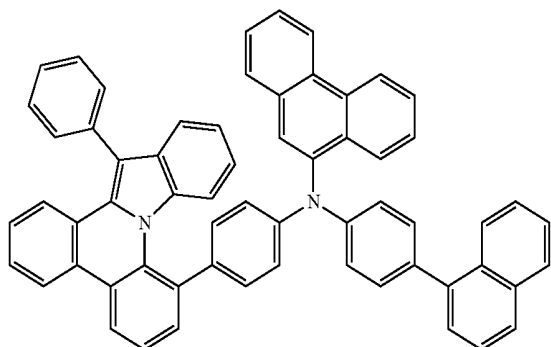
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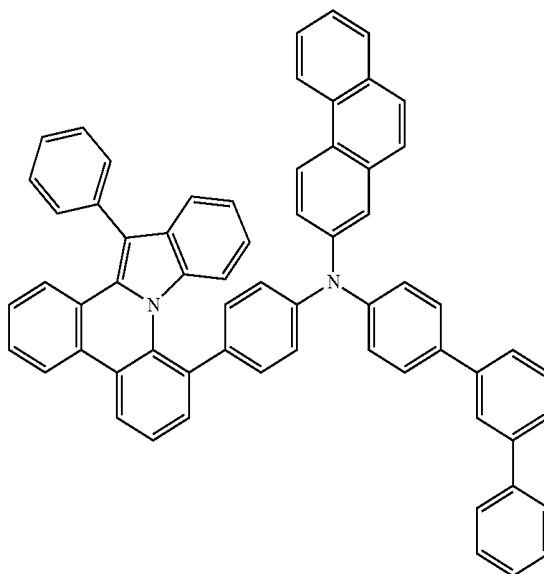
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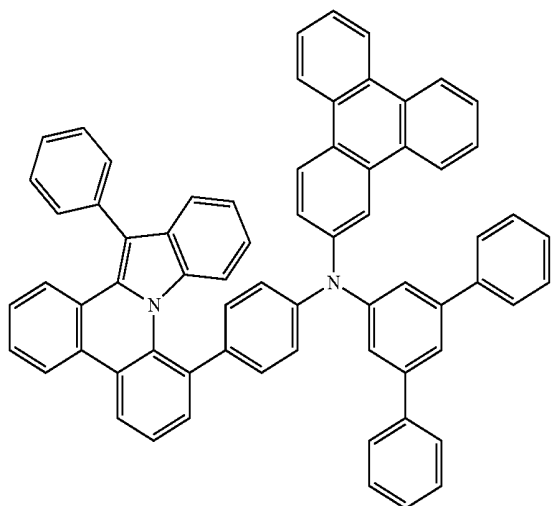
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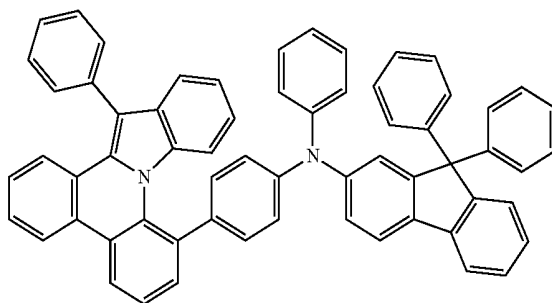
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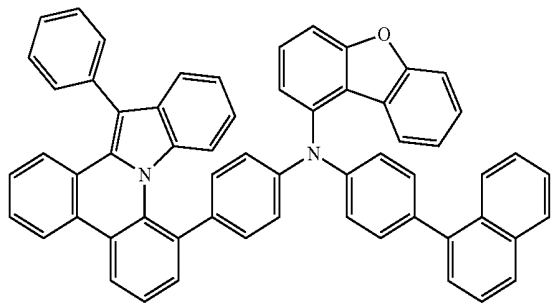


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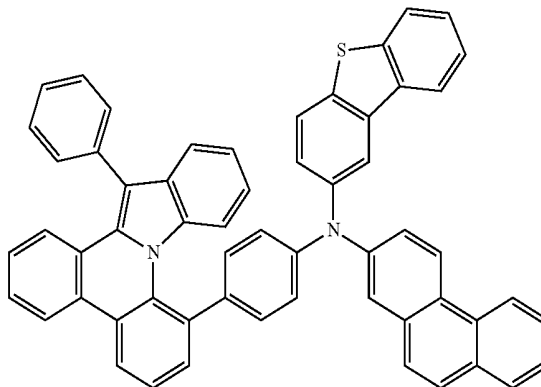


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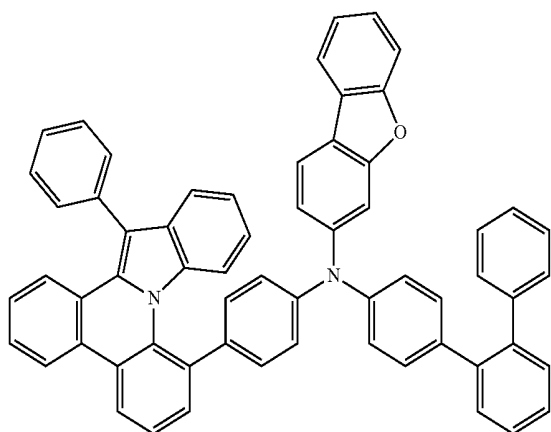
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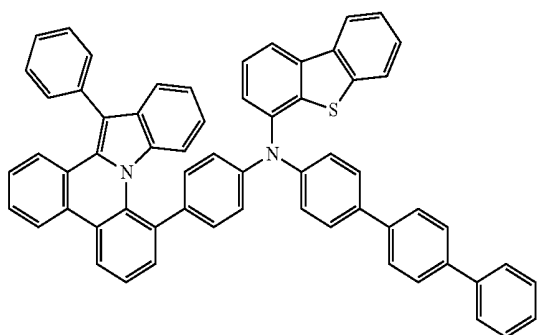
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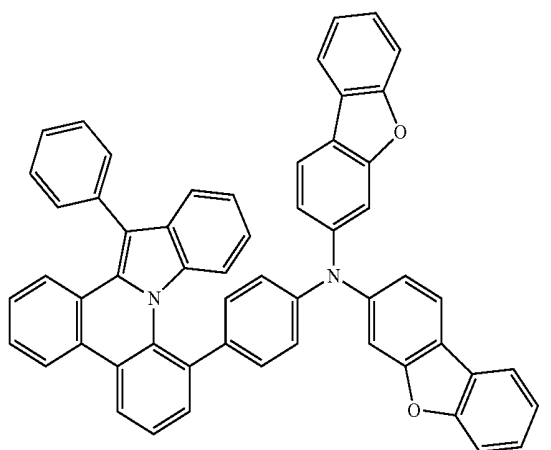
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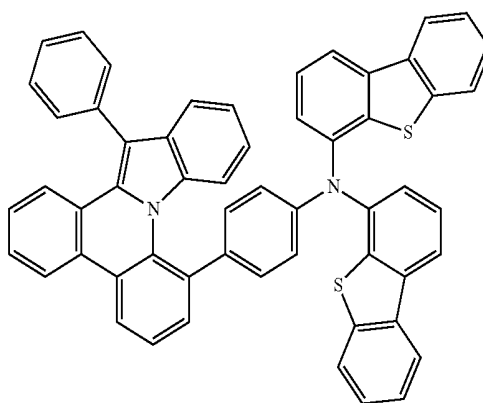
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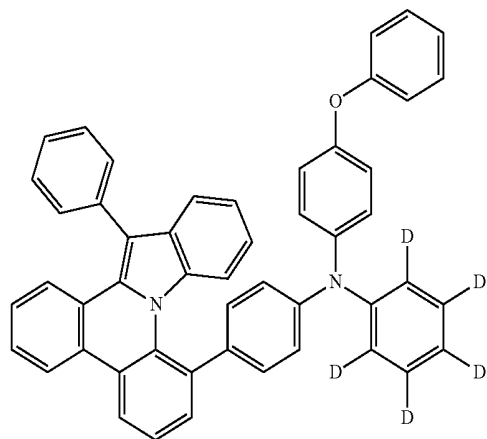


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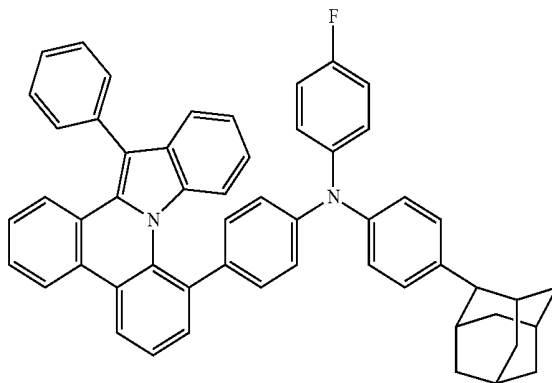


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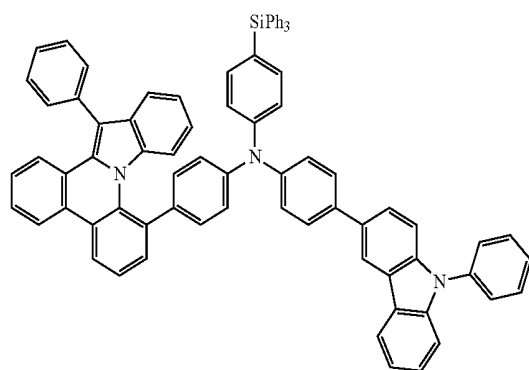


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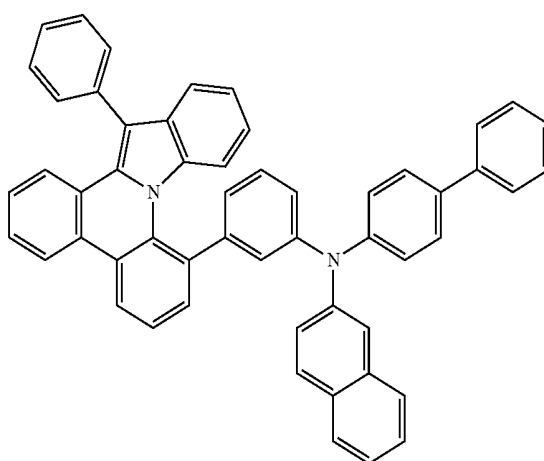
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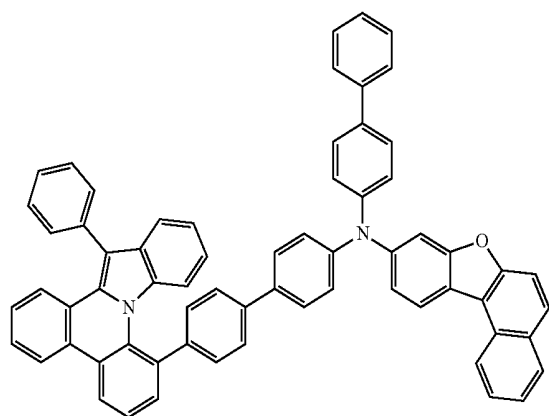
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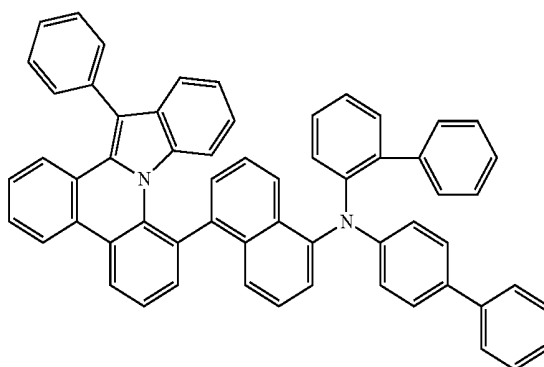
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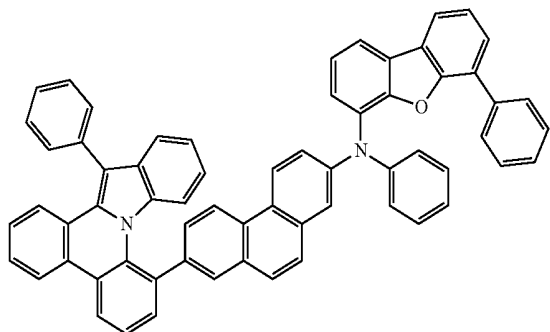
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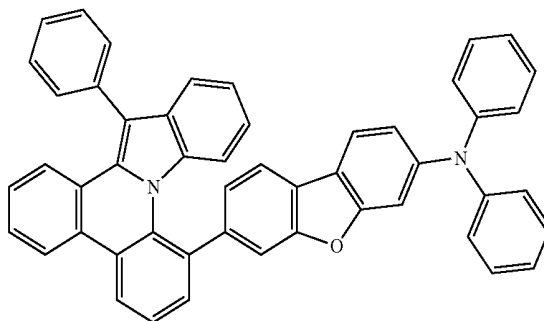
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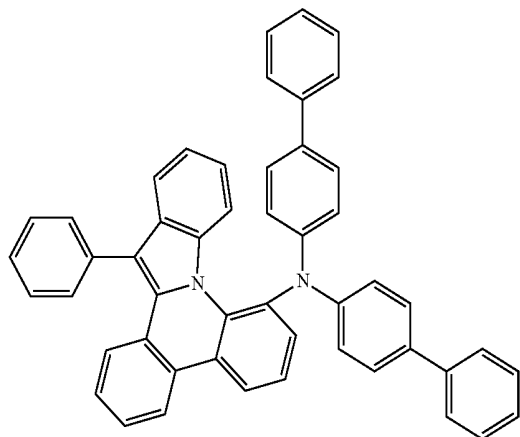
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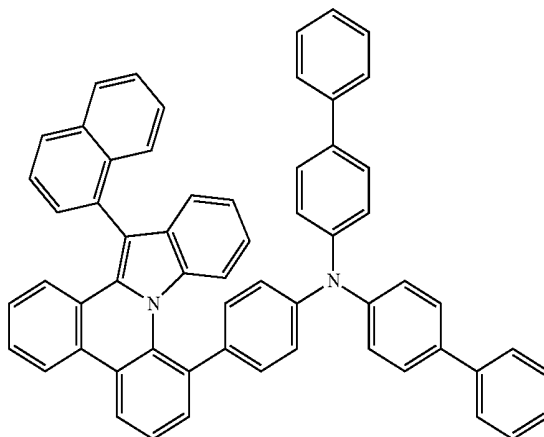
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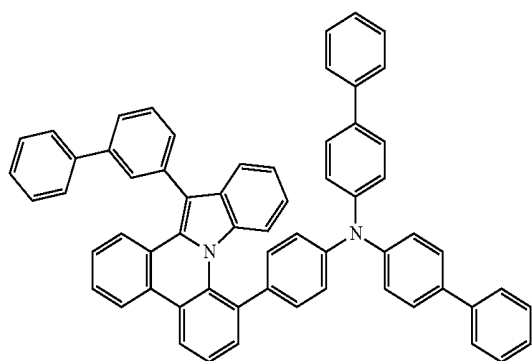
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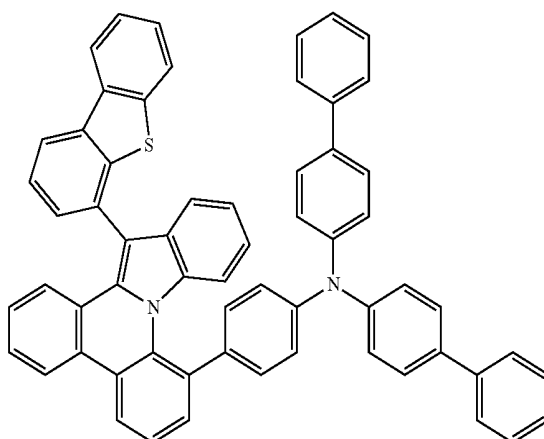
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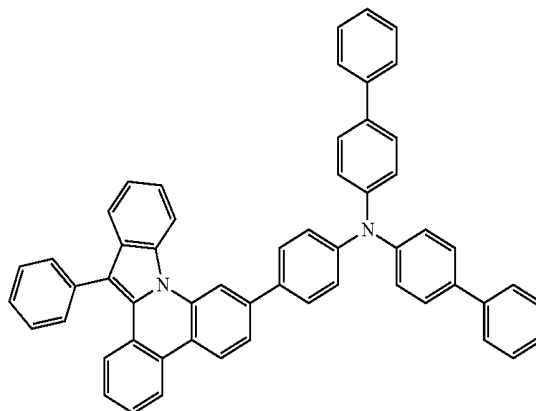
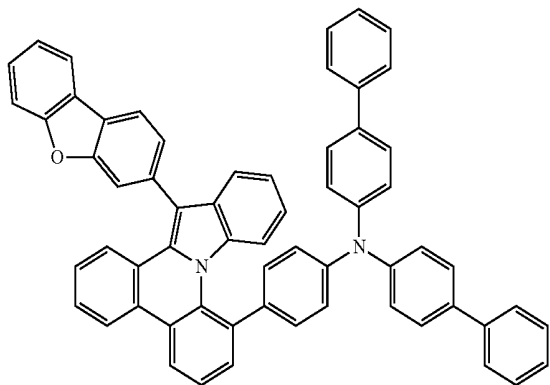


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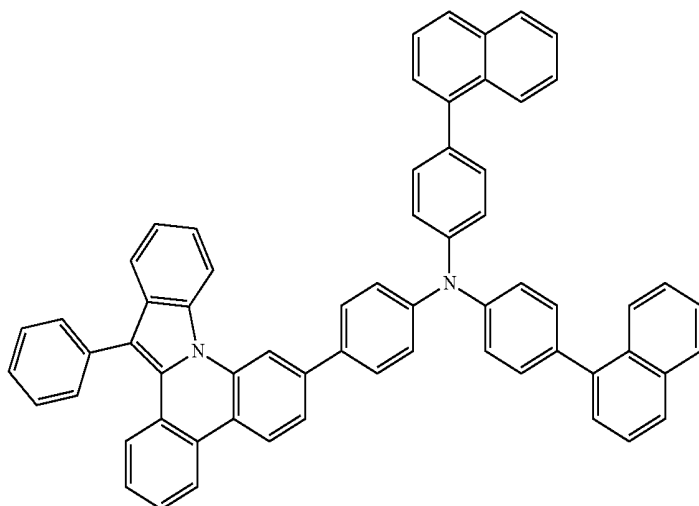


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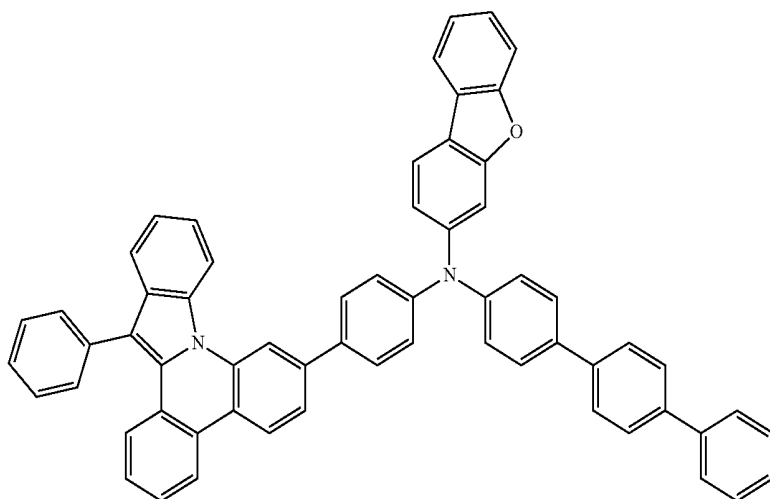
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D27

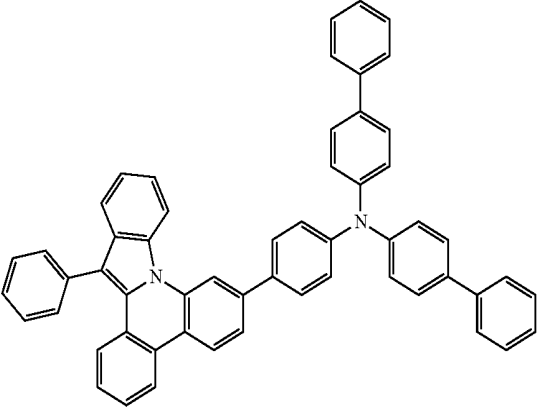
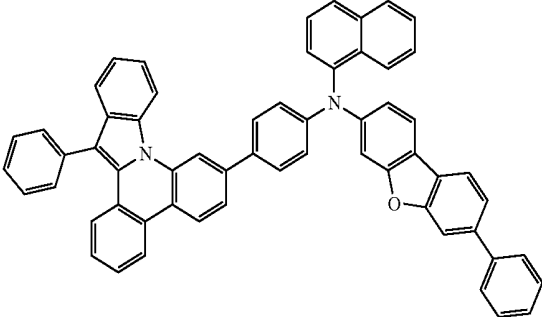


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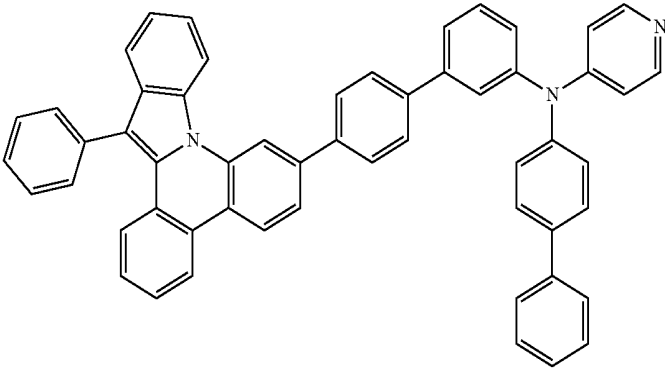


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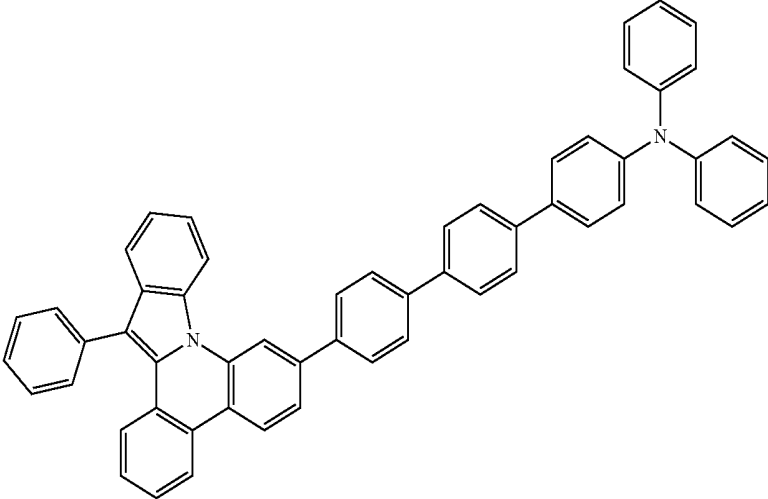
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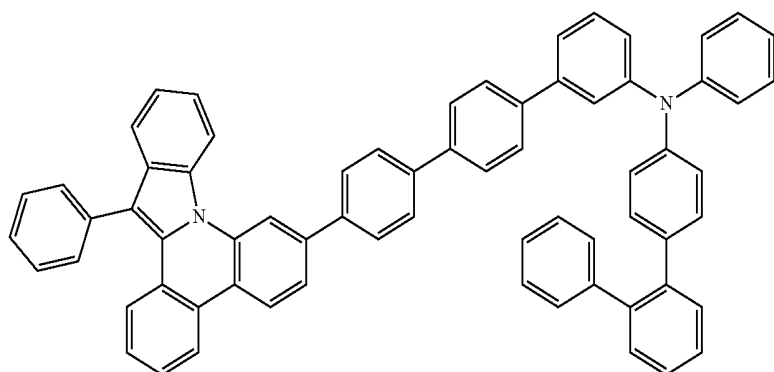


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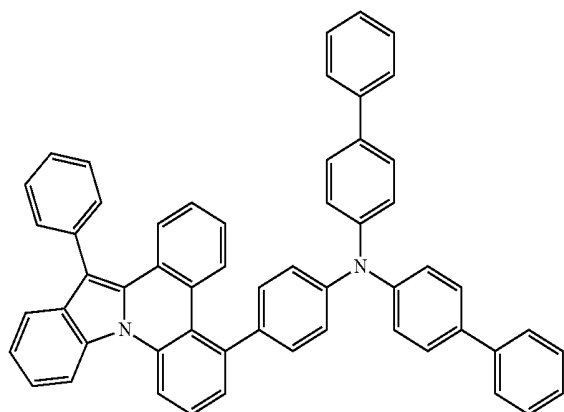
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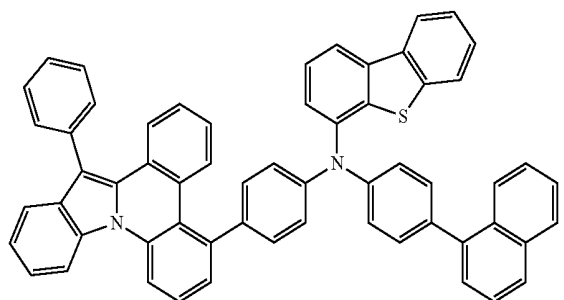
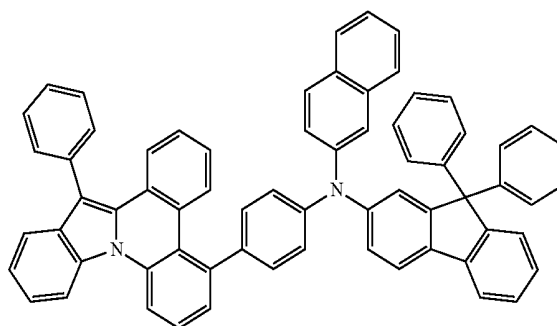
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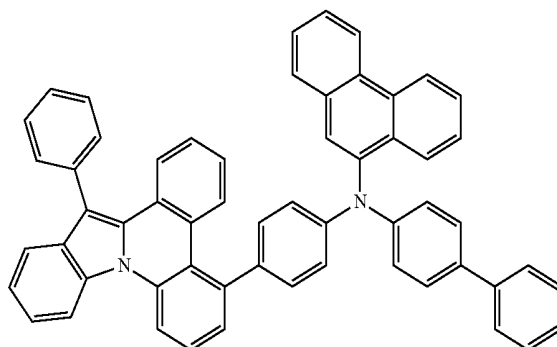
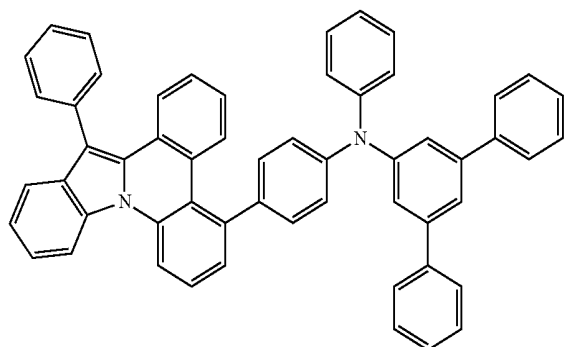
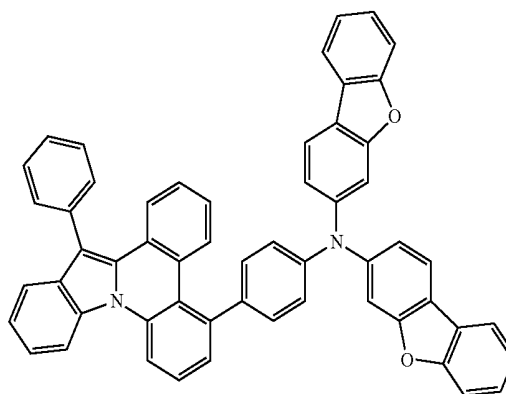
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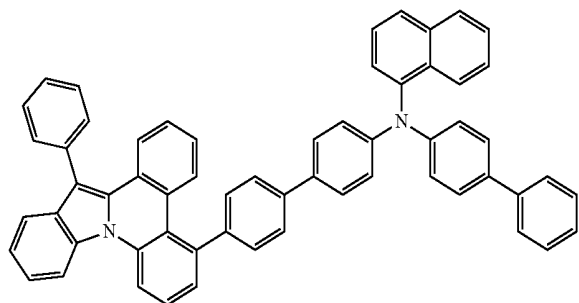


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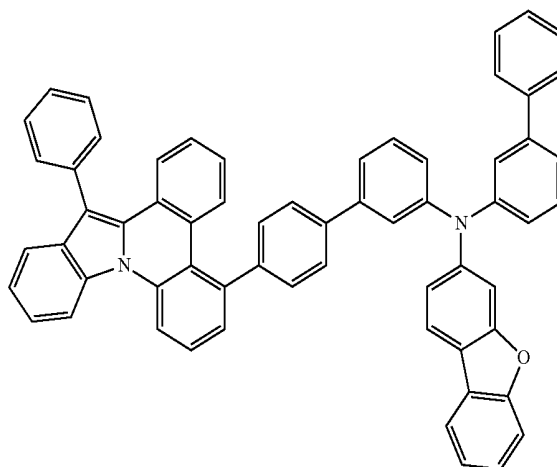
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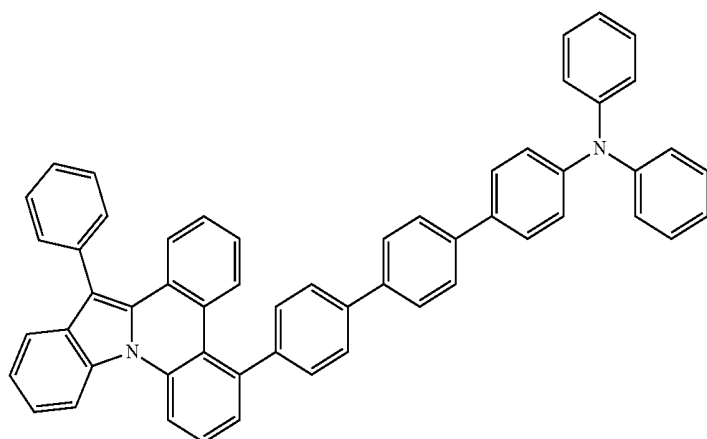
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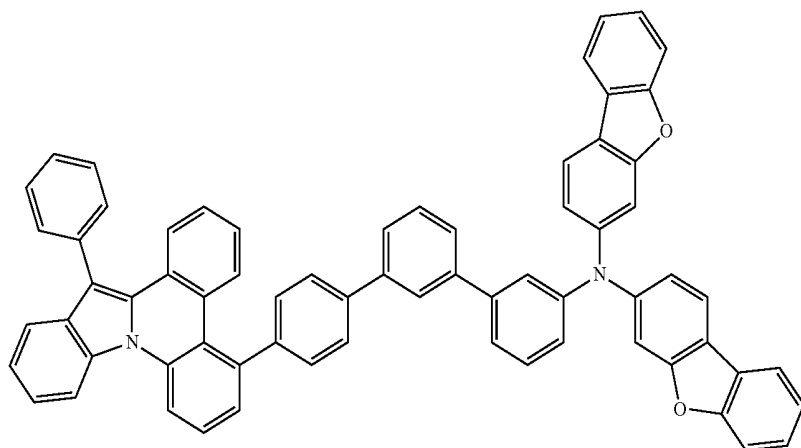
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D42

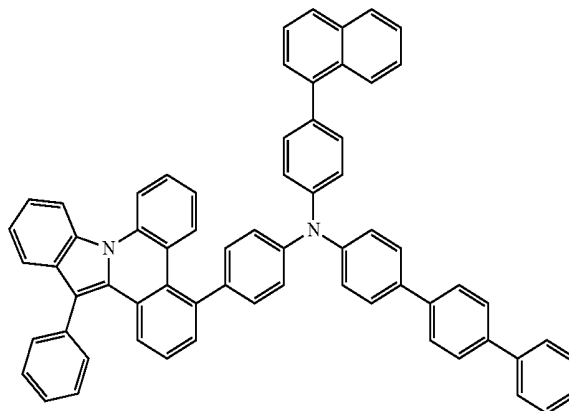
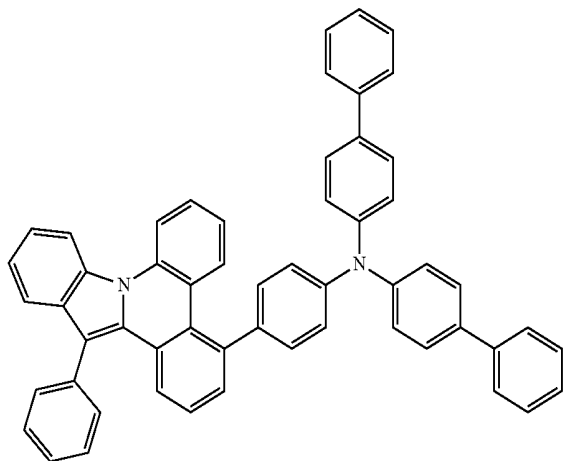


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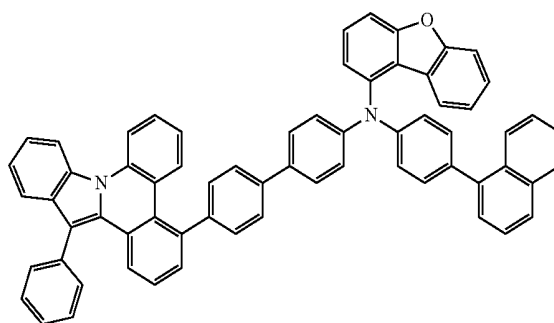
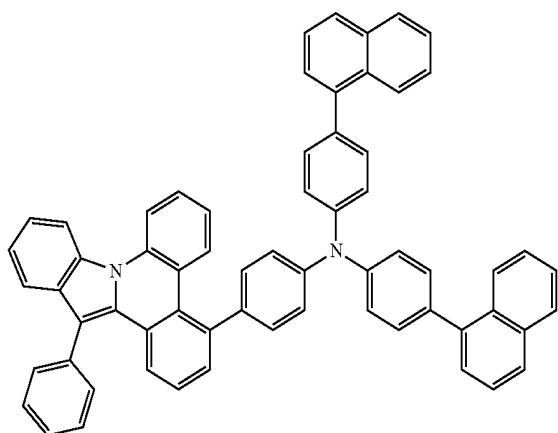
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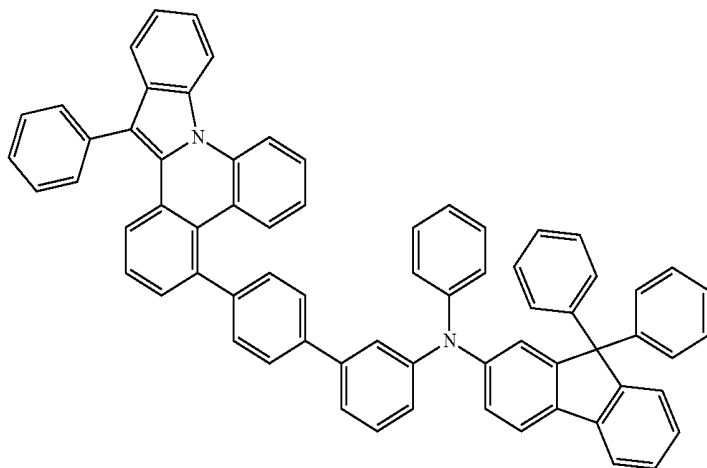


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D47

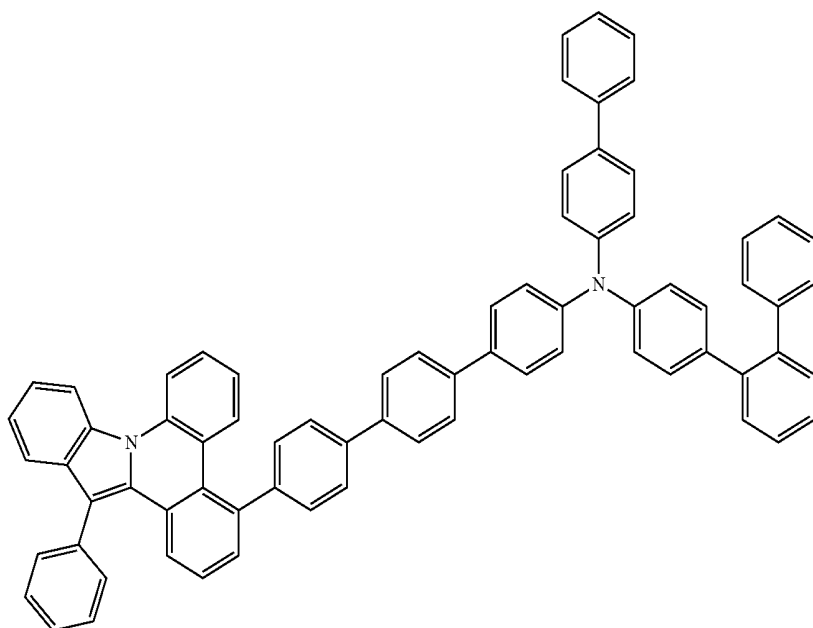


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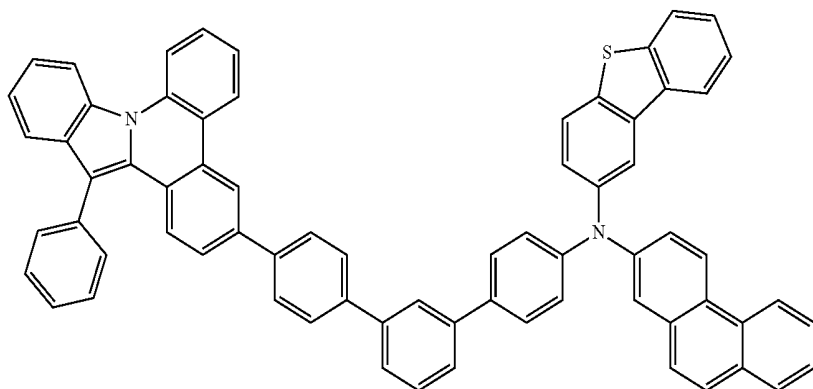


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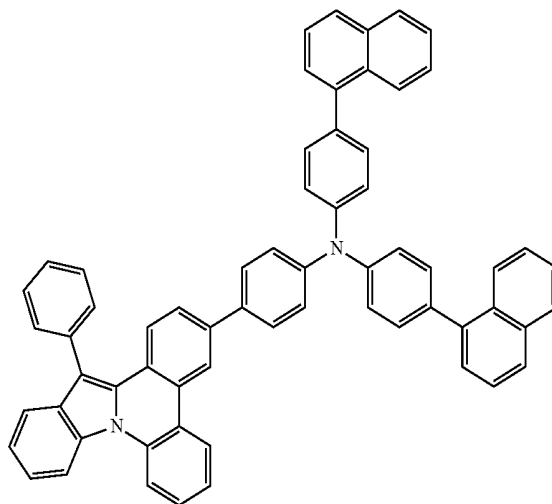
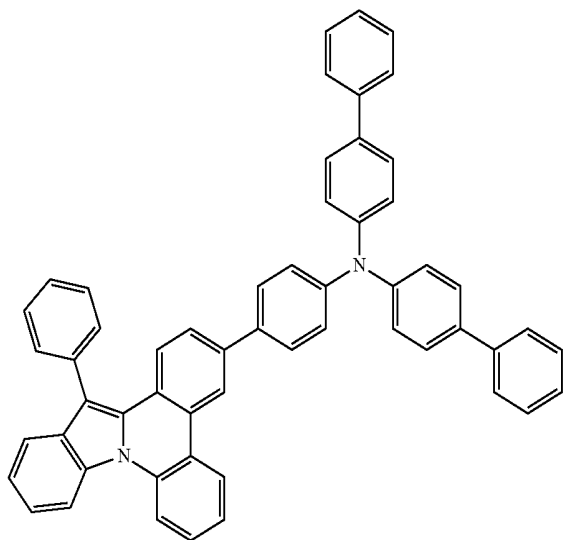


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D51

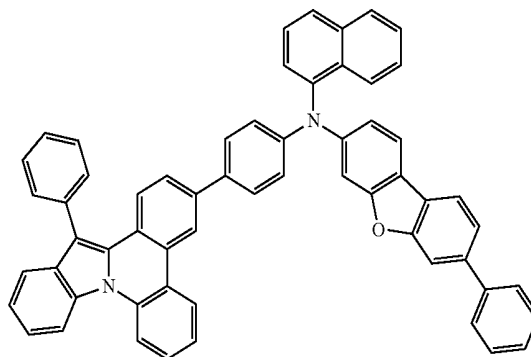
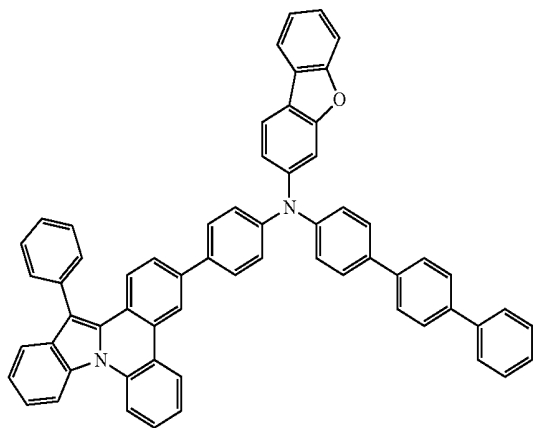
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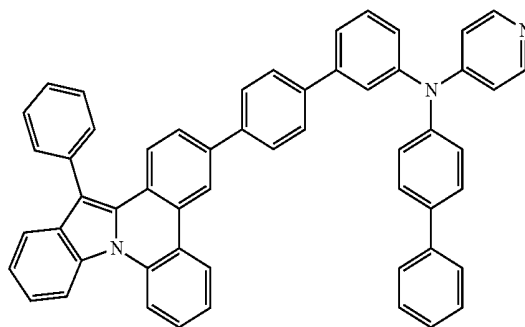
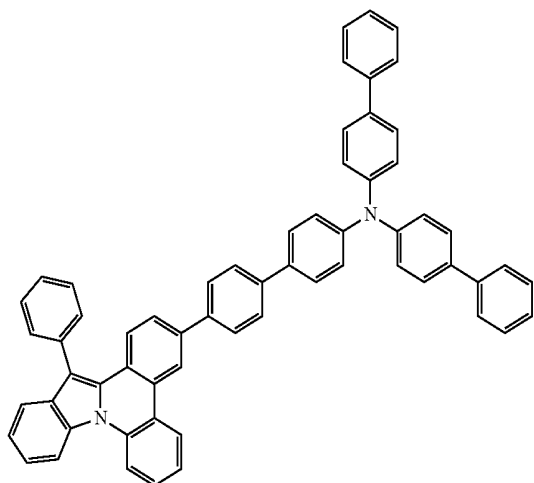
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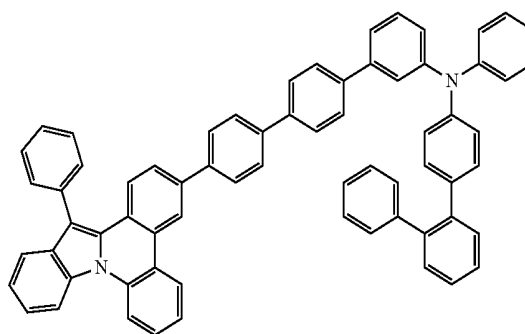
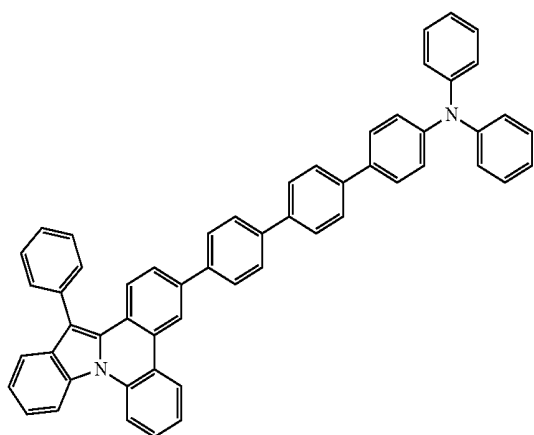
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D56



D57

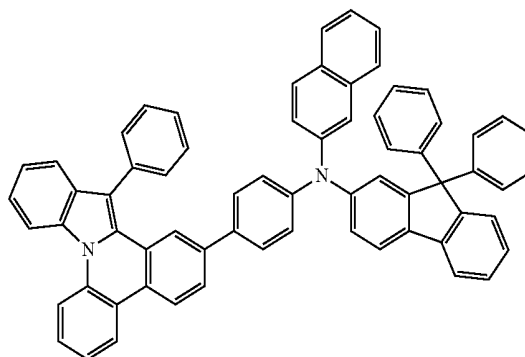
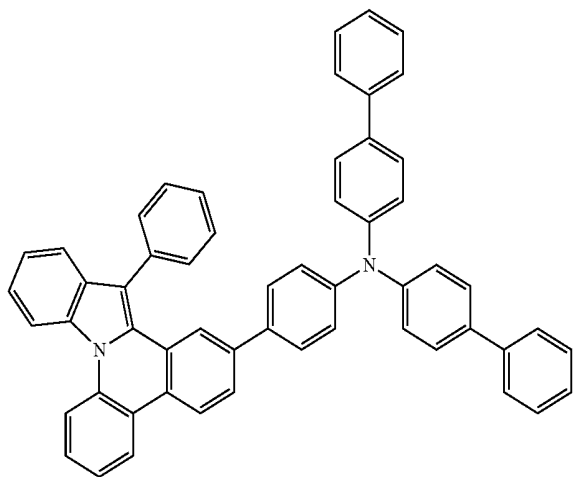
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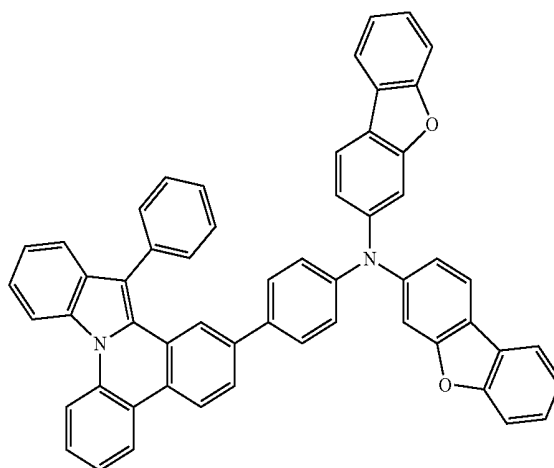
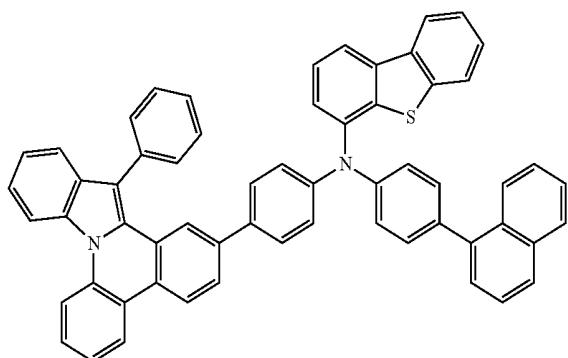
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D60



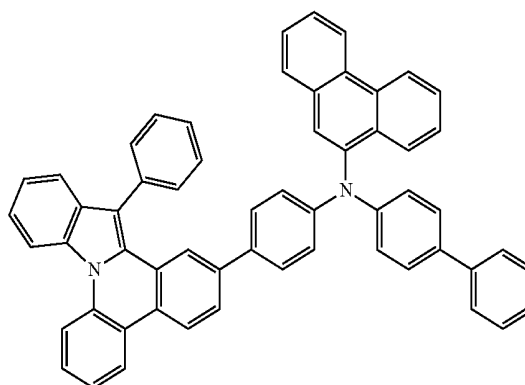
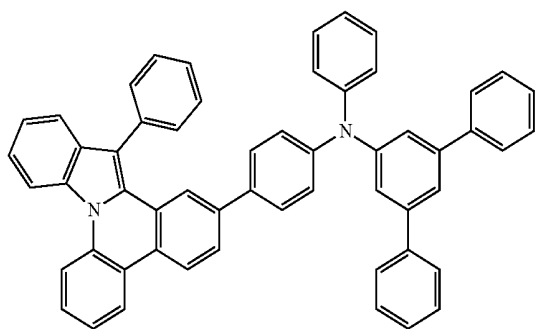
D61

D62

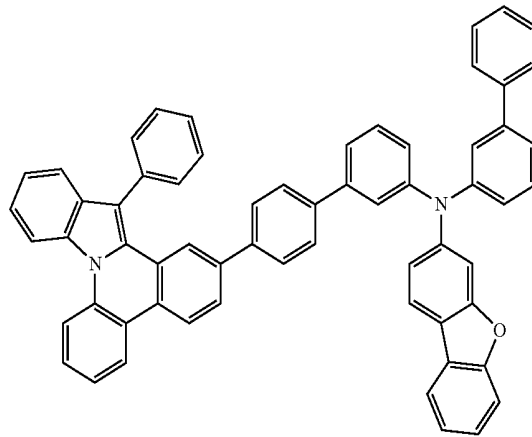
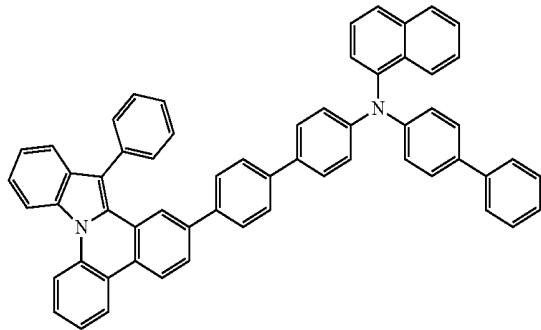


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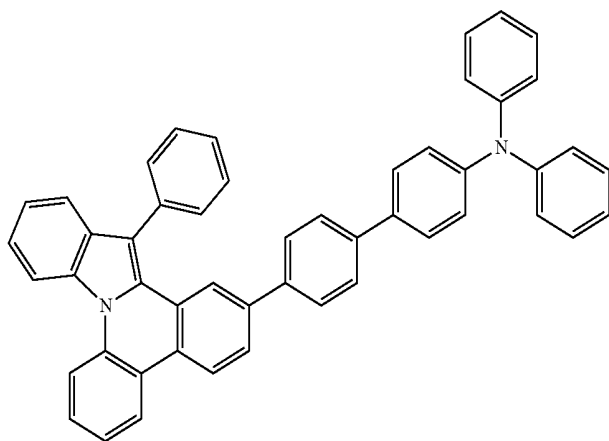
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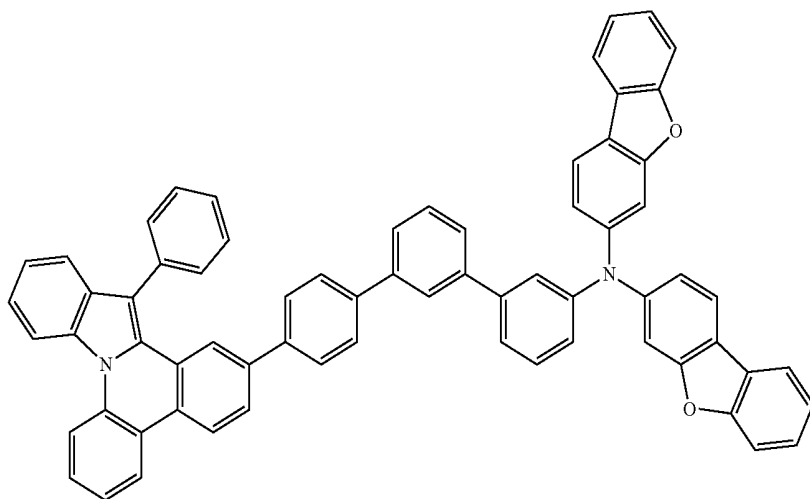
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D66



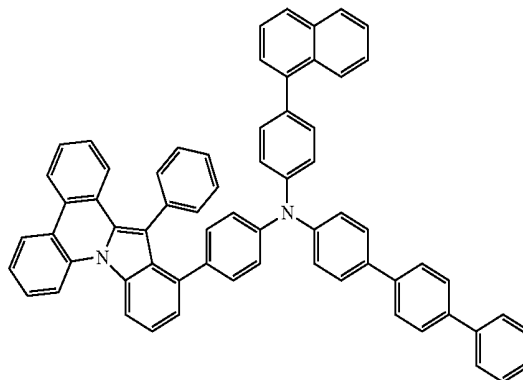
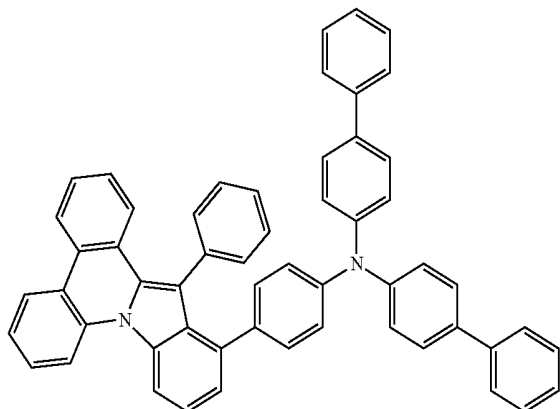
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D68

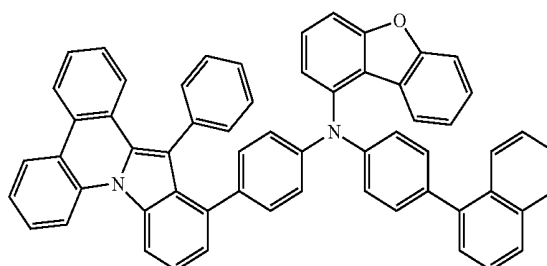
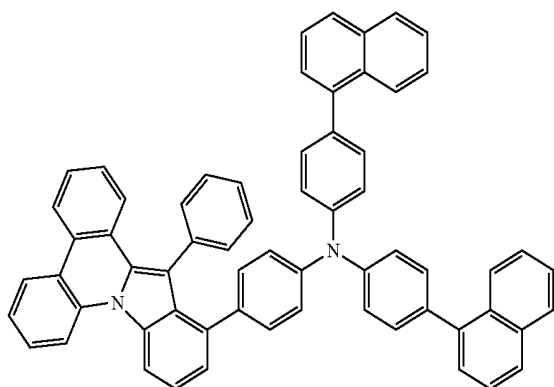
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D70



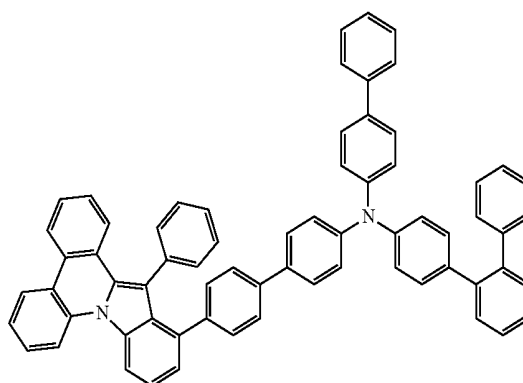
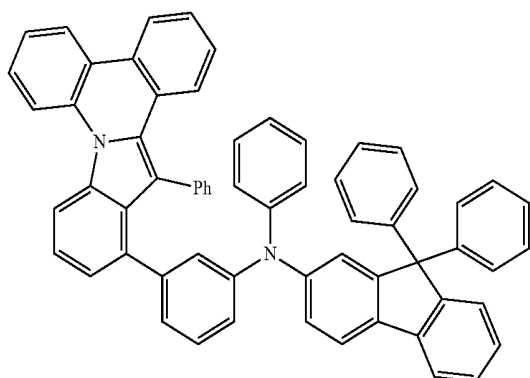
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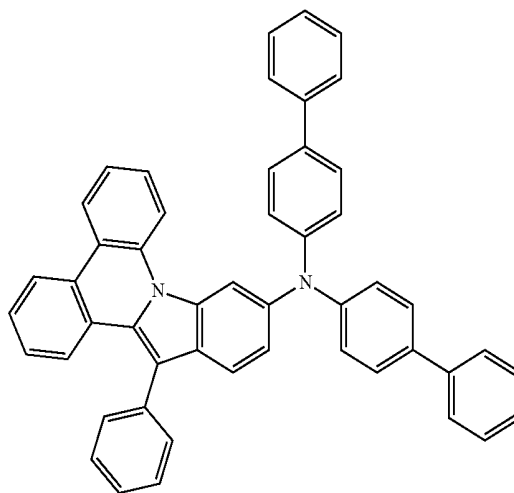
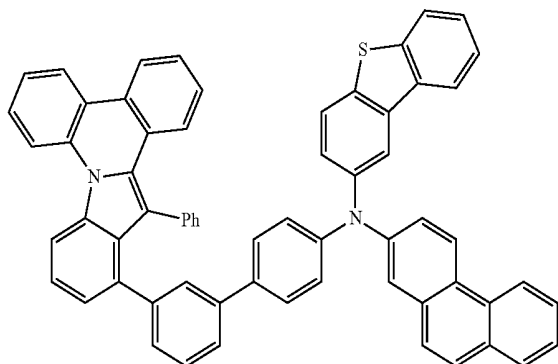
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D74



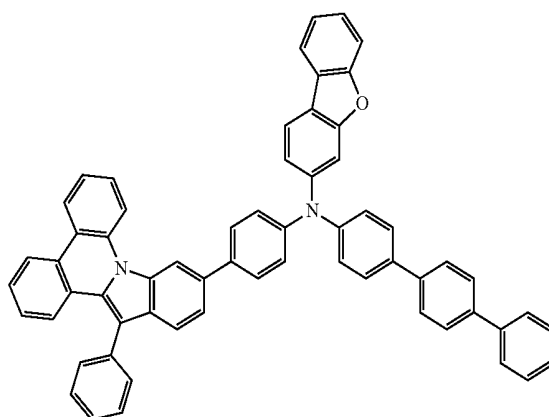
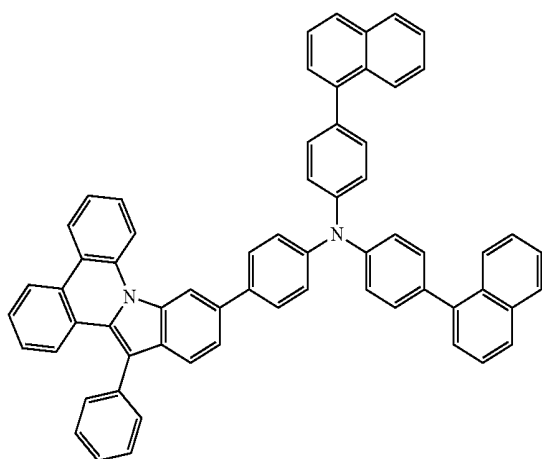
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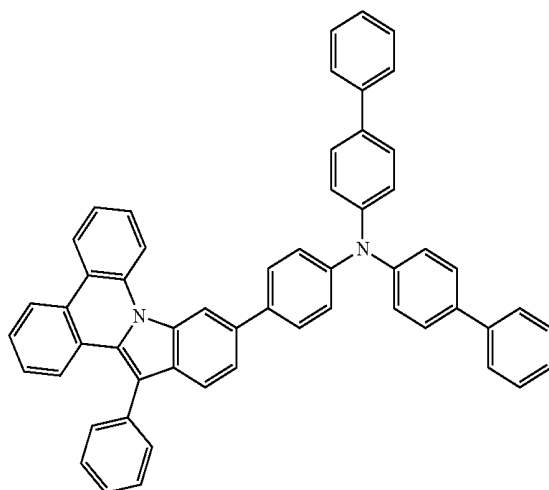
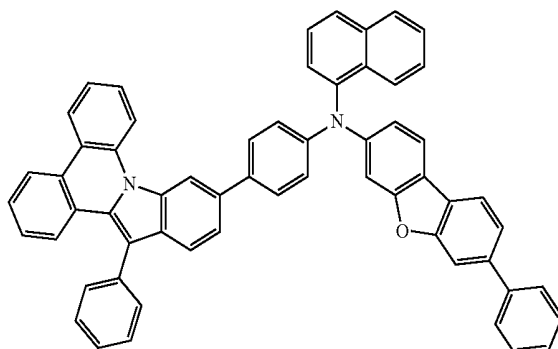
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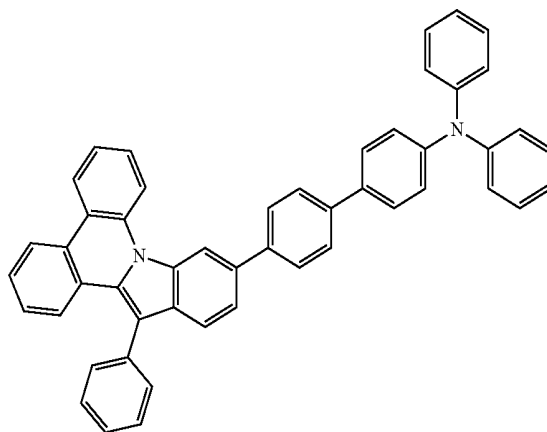
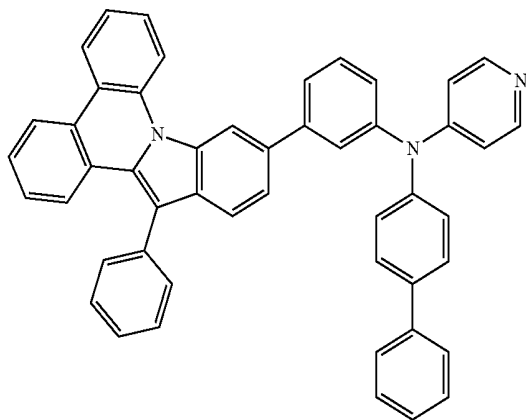
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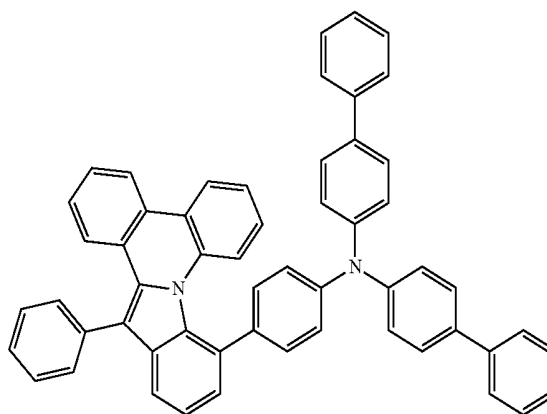
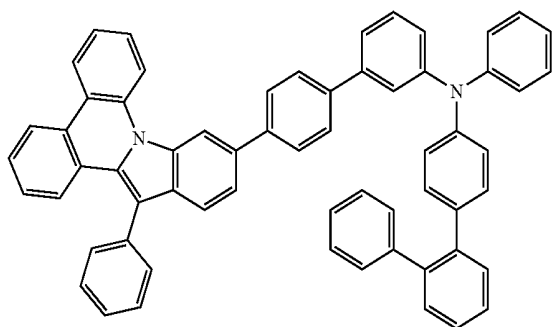
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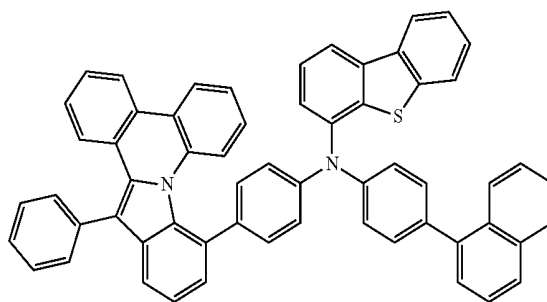
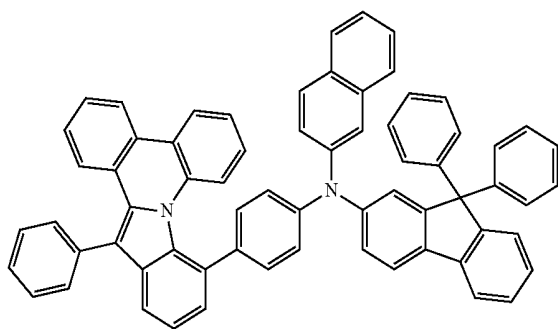
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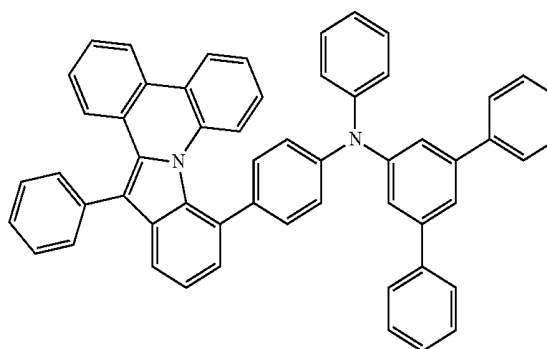
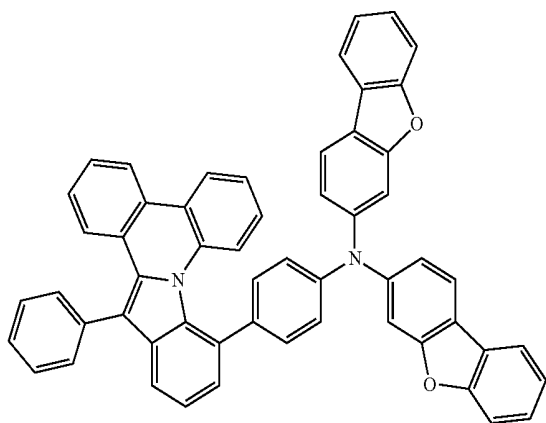
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D86



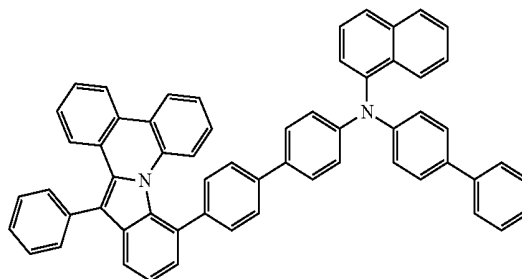
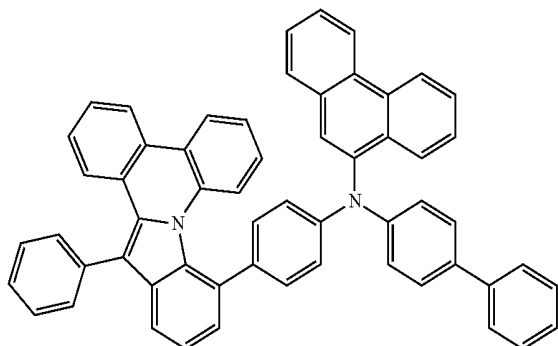
D87

D88



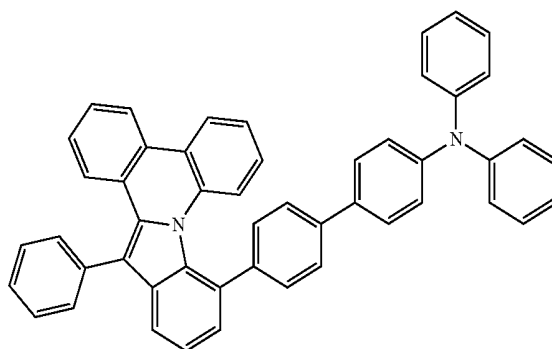
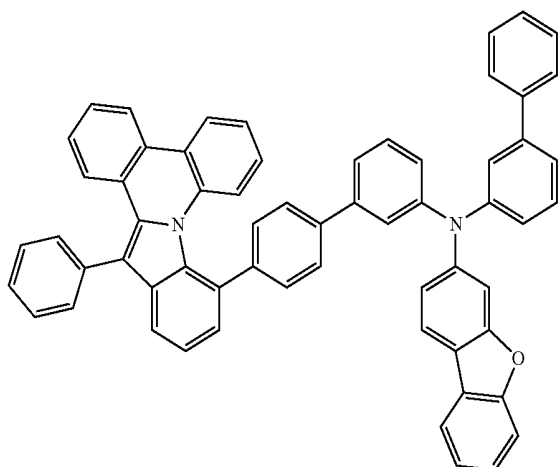
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D89

D90

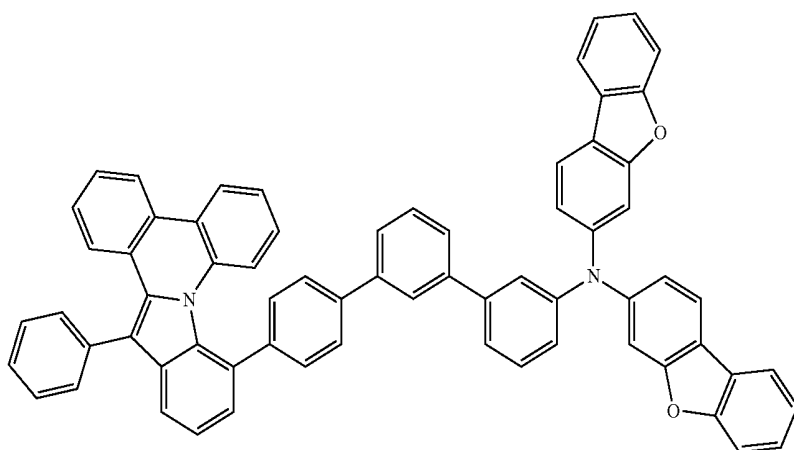


D91

D92



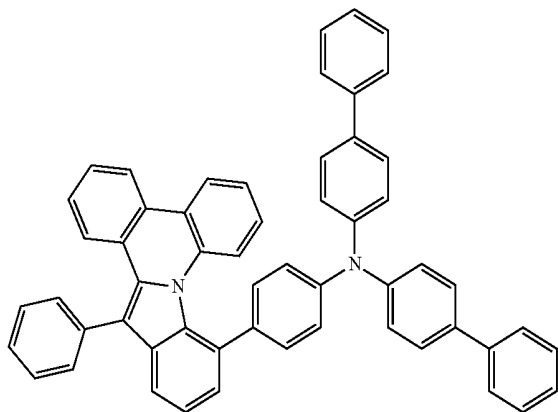
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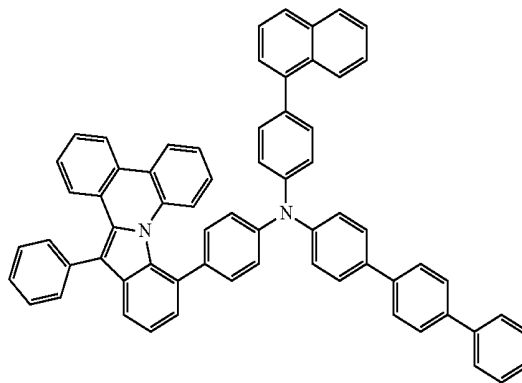
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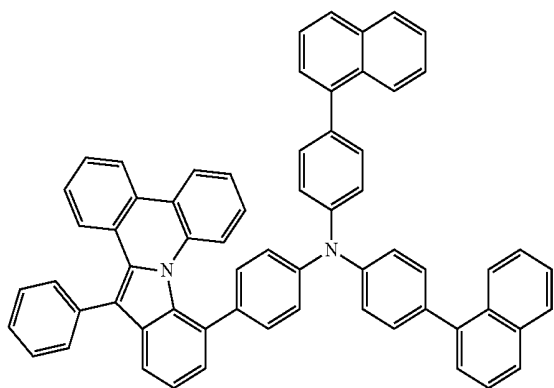
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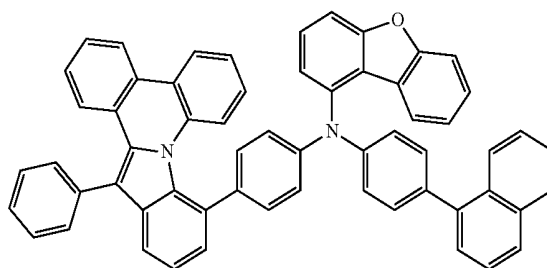
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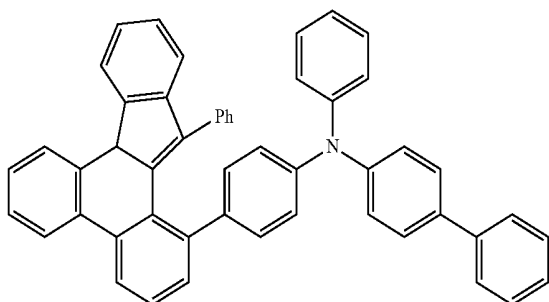
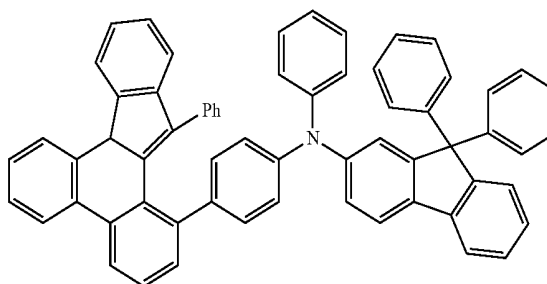
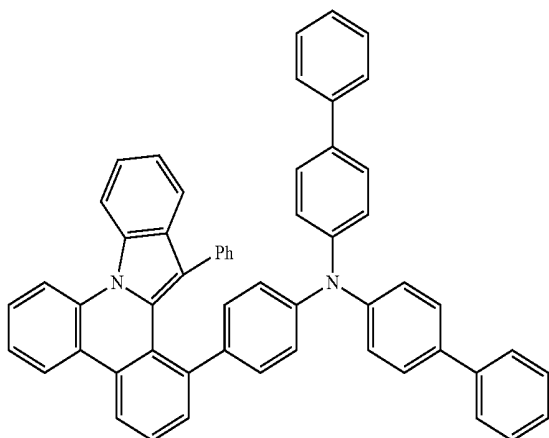
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D98



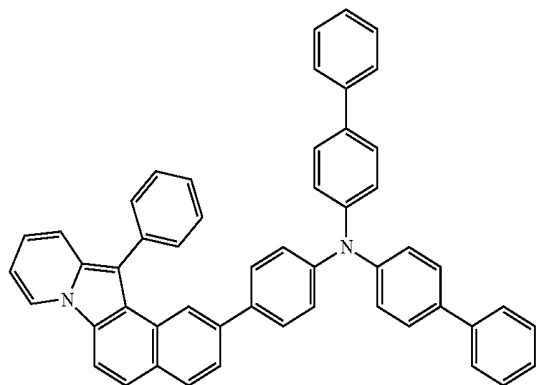
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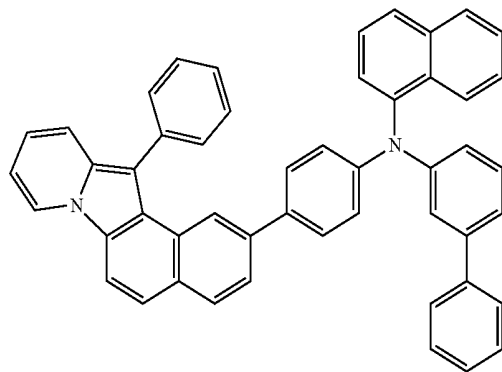
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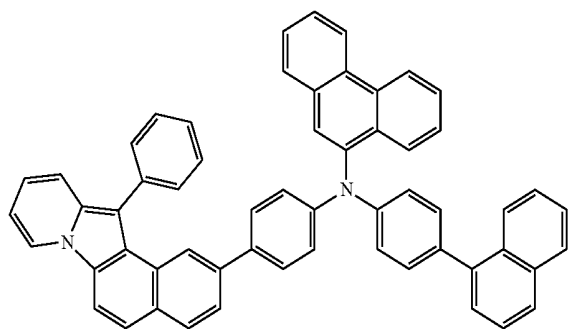
Compound Group 2



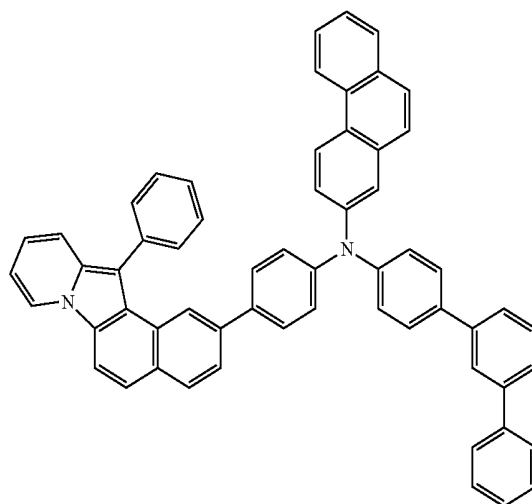
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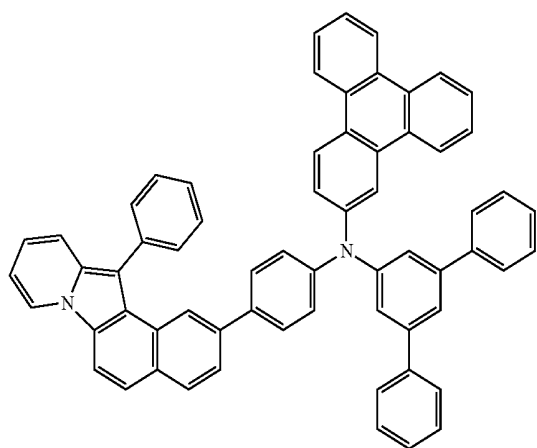
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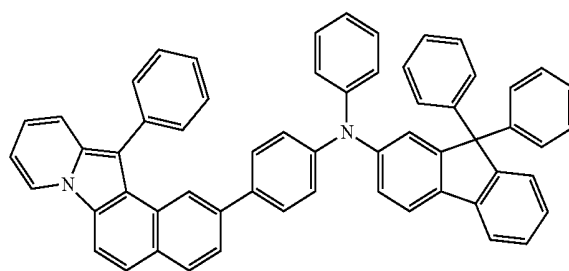
E3



E4



E5

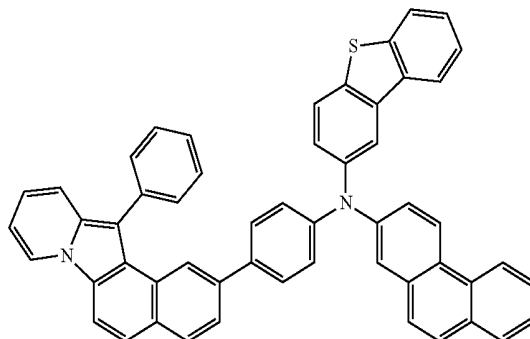
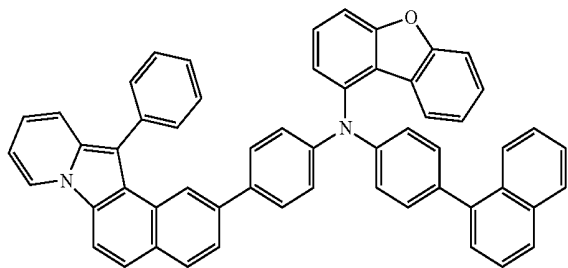


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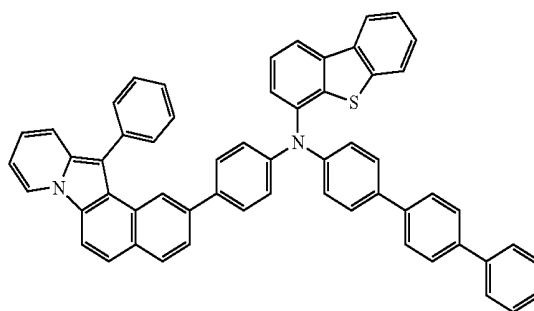
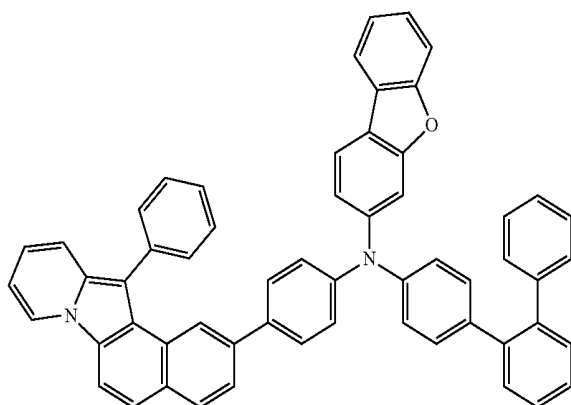
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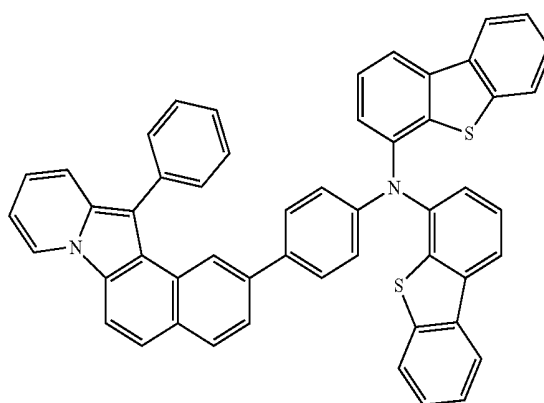
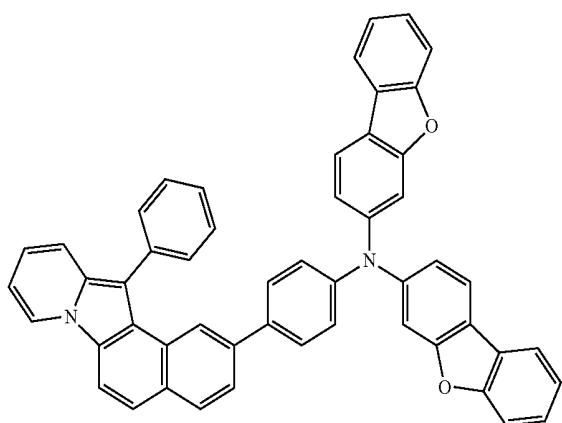
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E10



E11

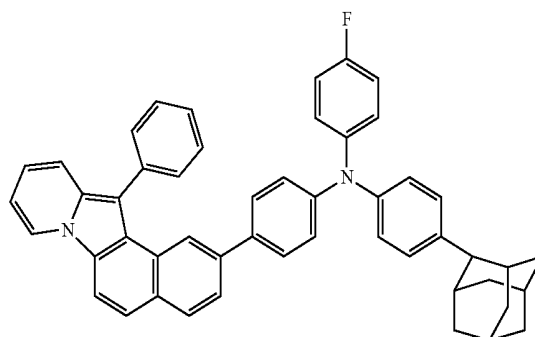
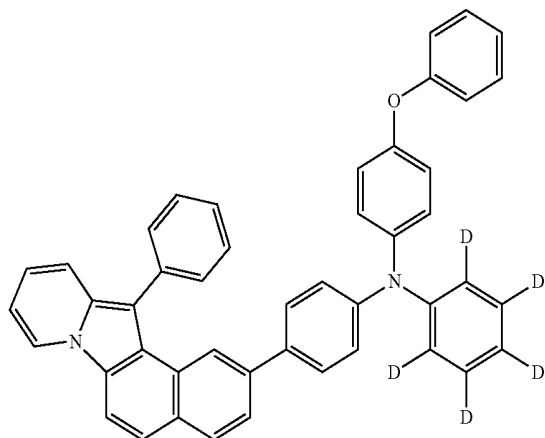
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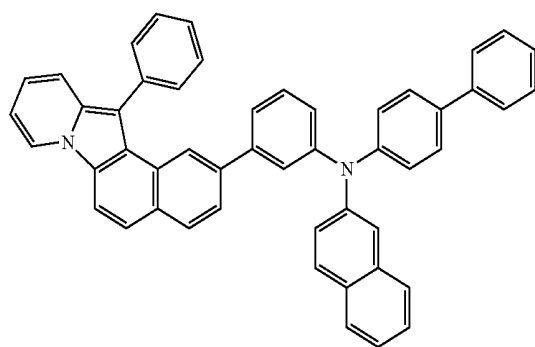
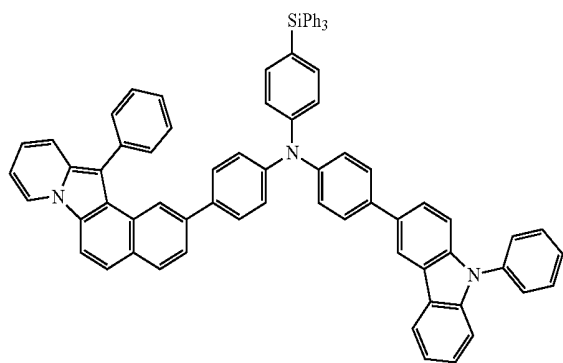
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E14



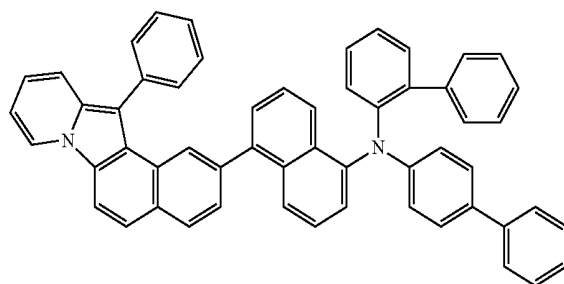
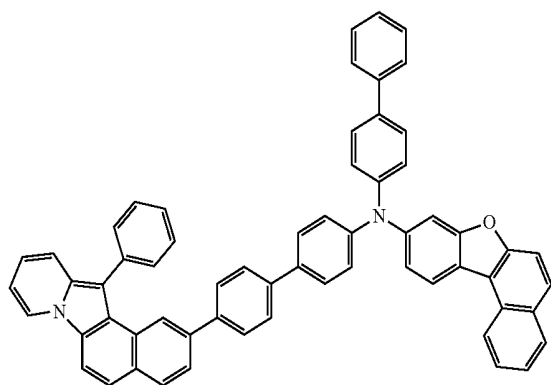
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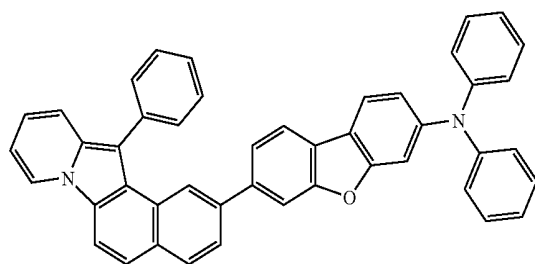
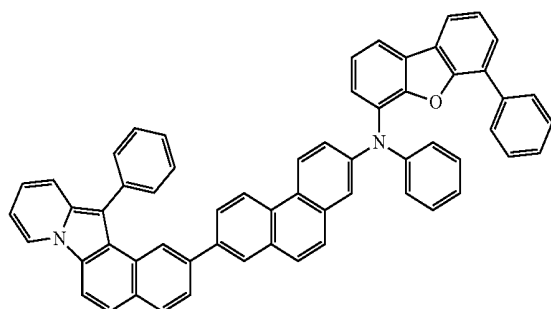
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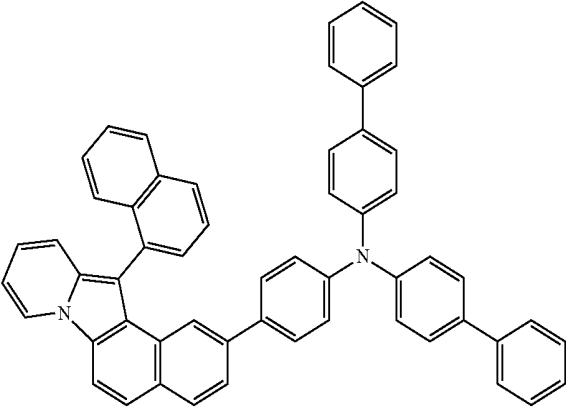
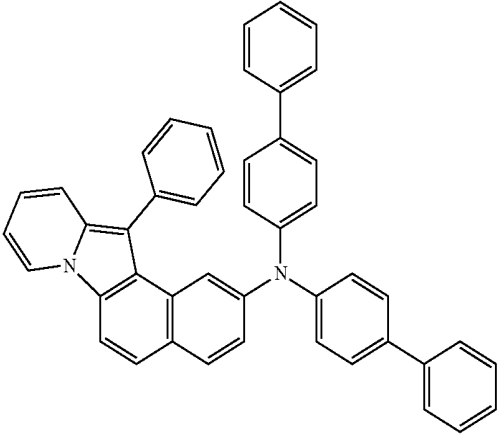
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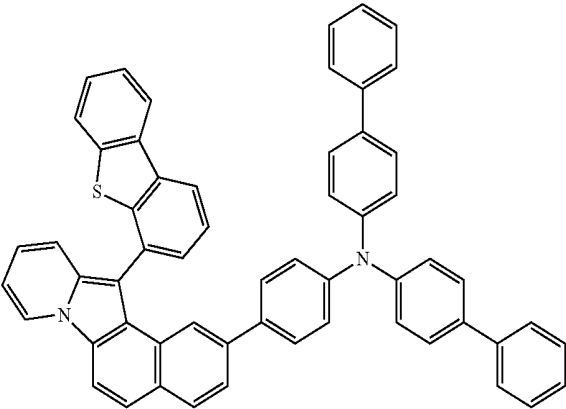
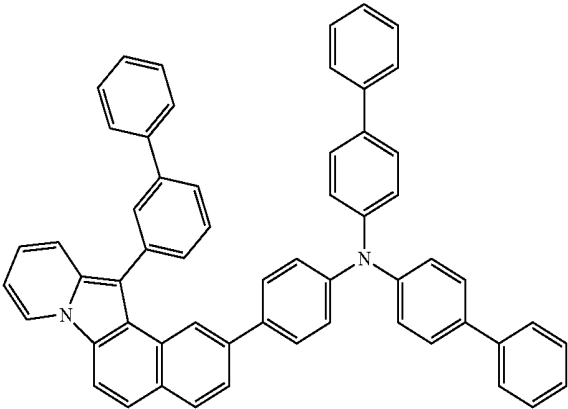
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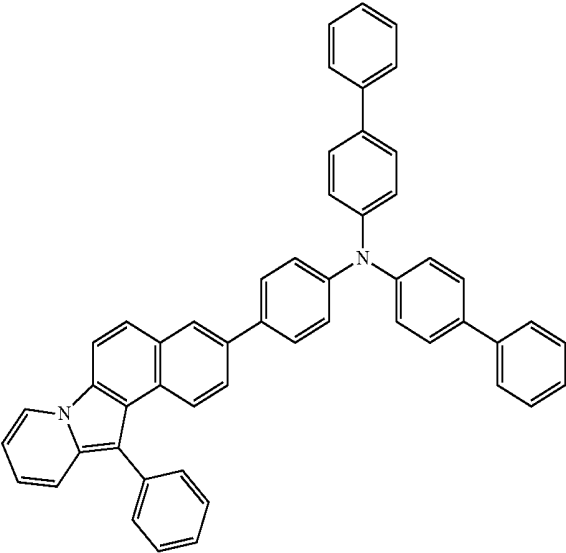
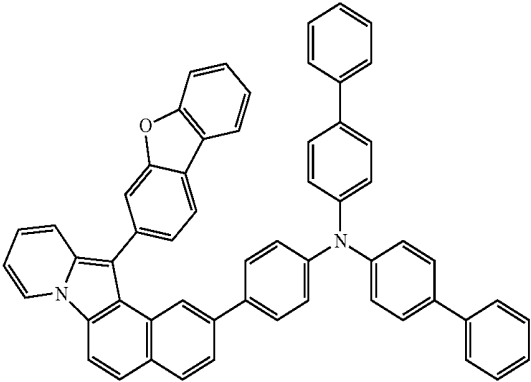
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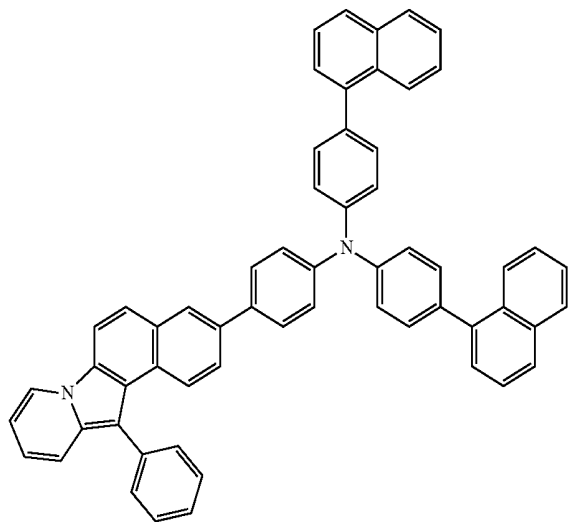
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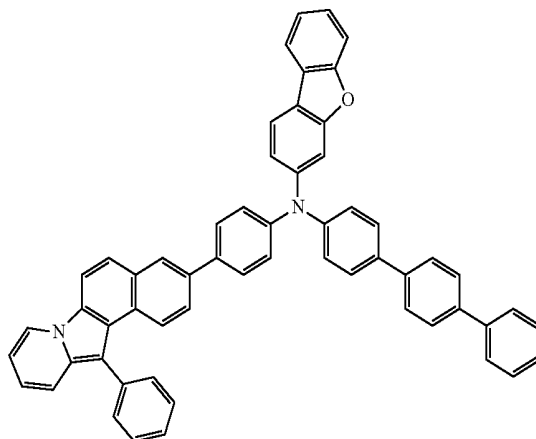


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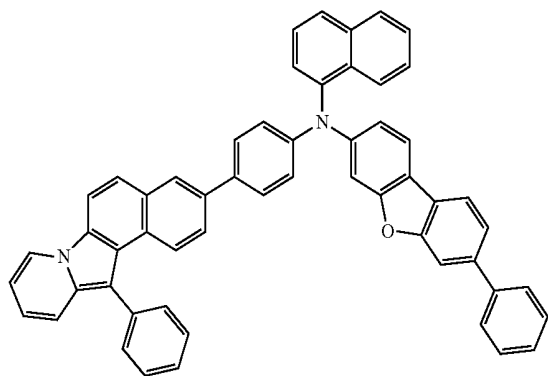
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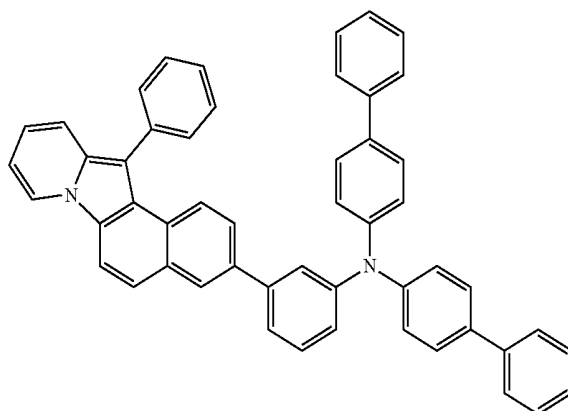
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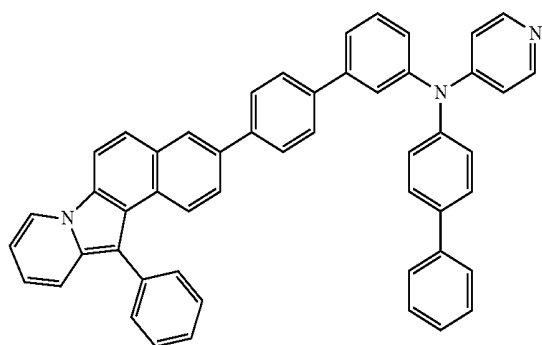
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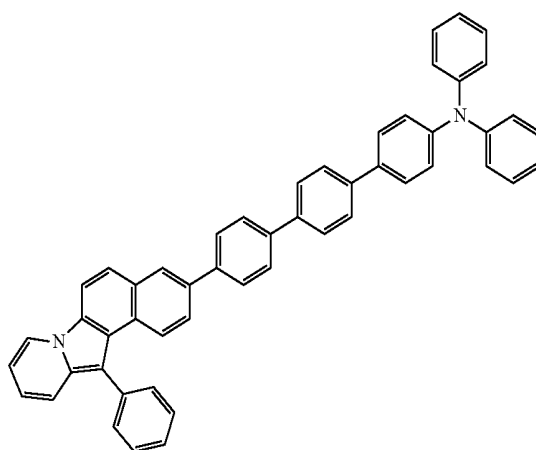
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E31

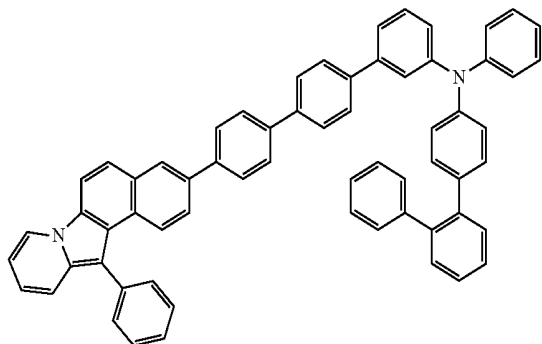


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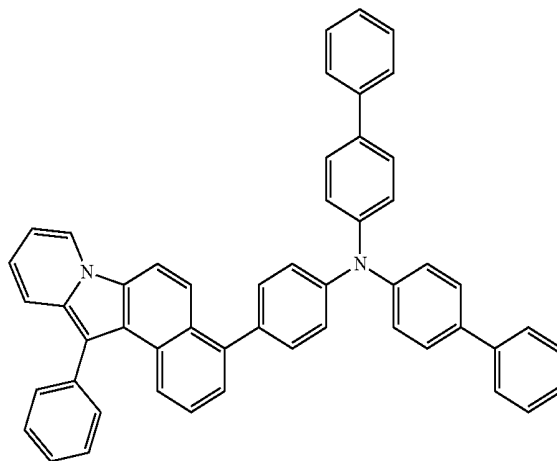


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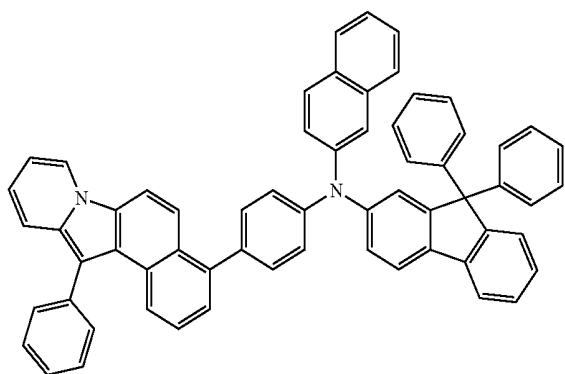
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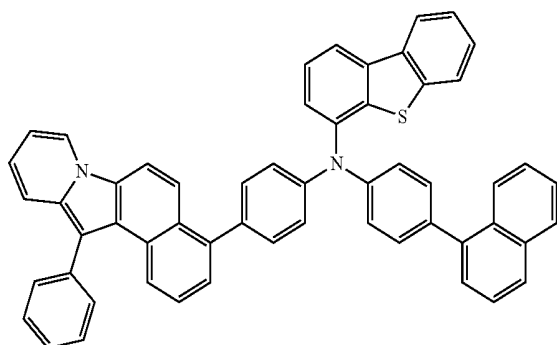
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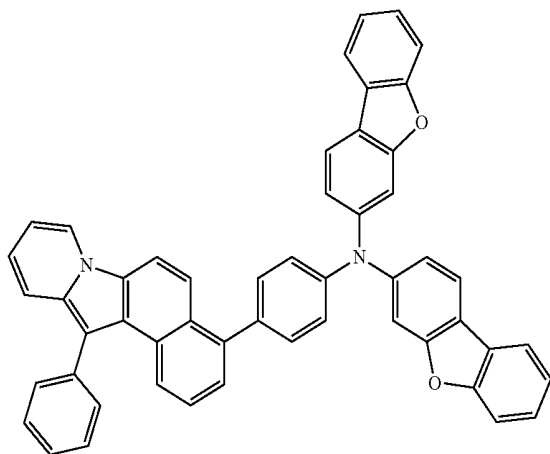
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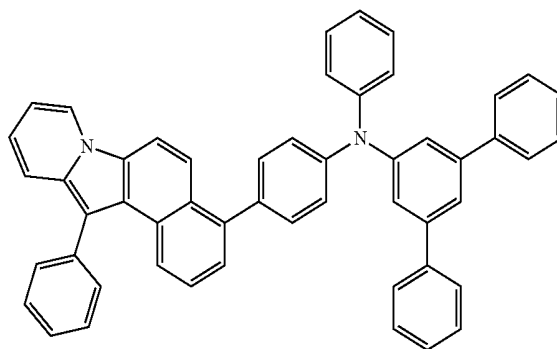
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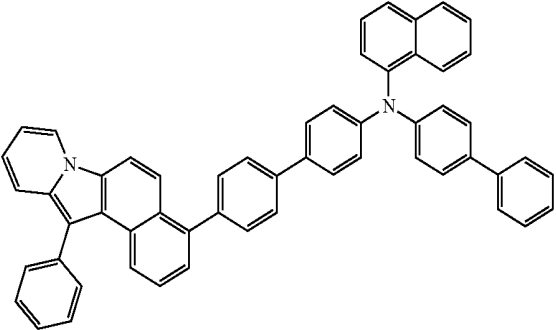
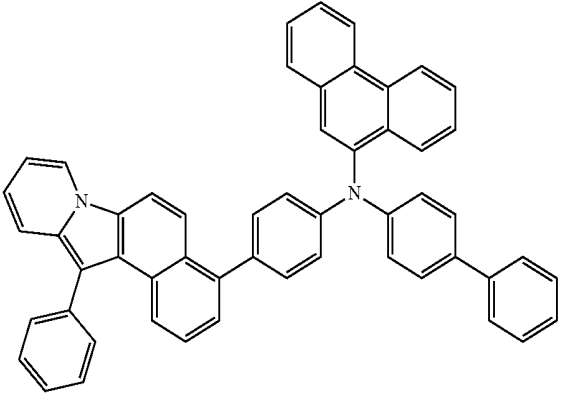


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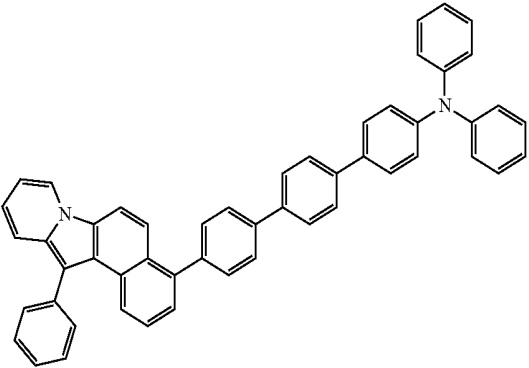
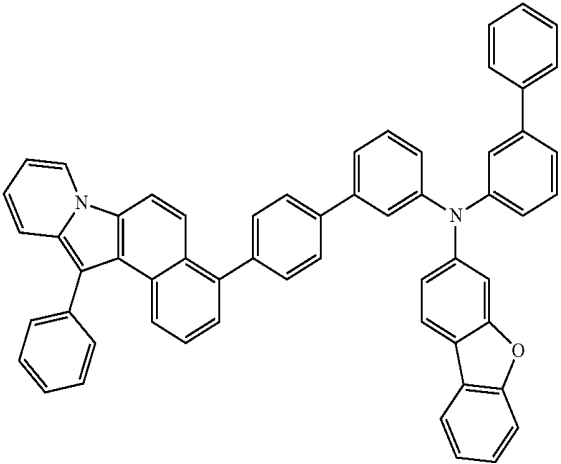
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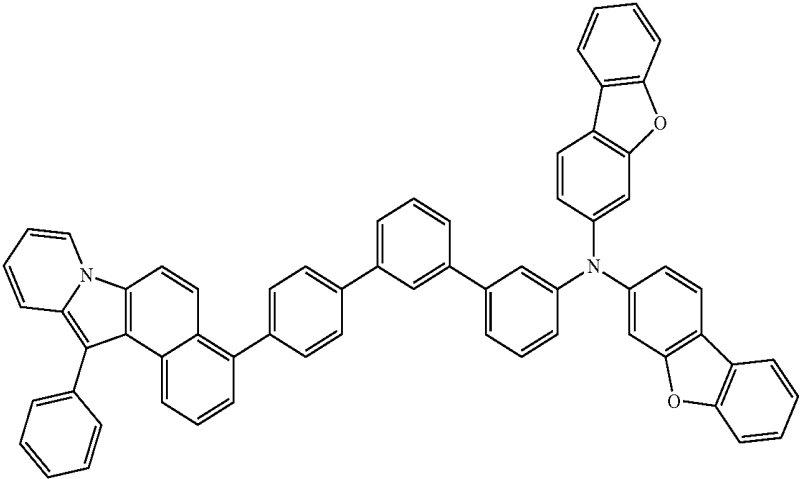


E41

E42

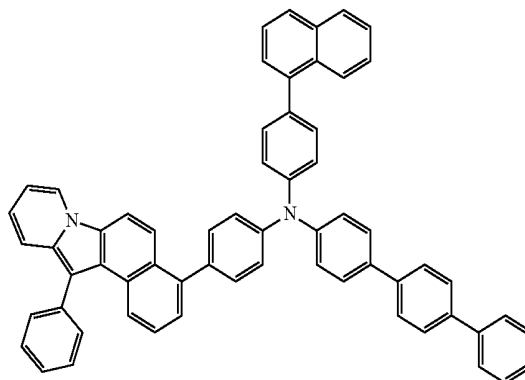
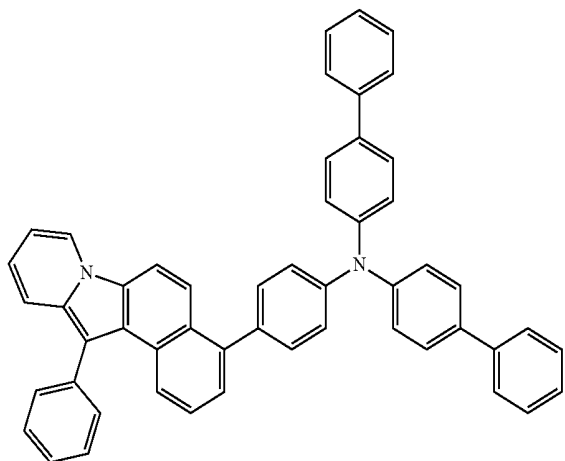


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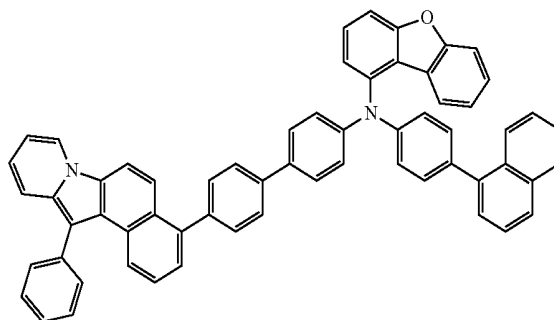
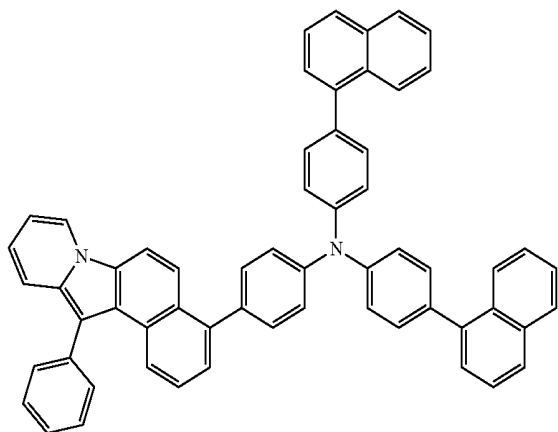
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E45

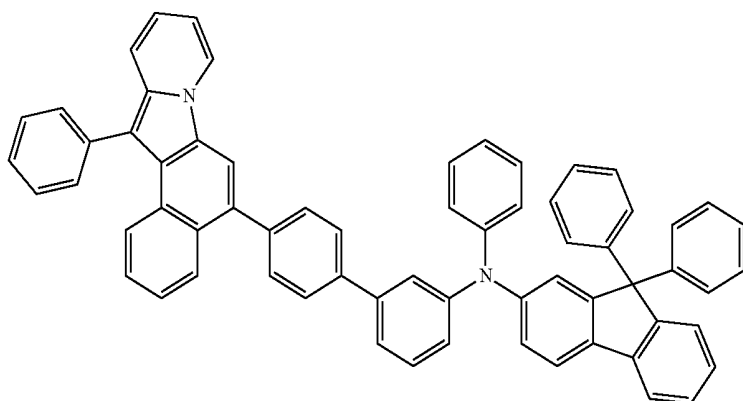


E46

E47

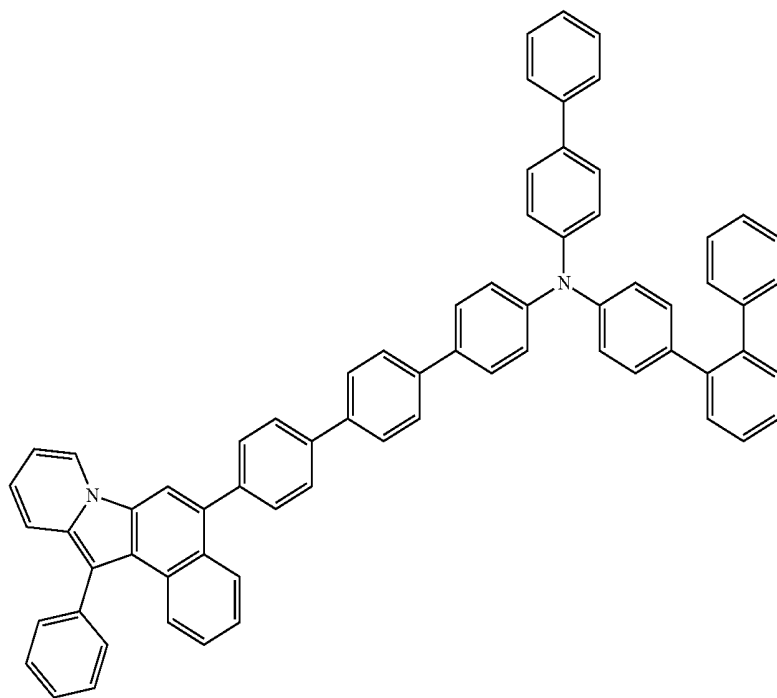


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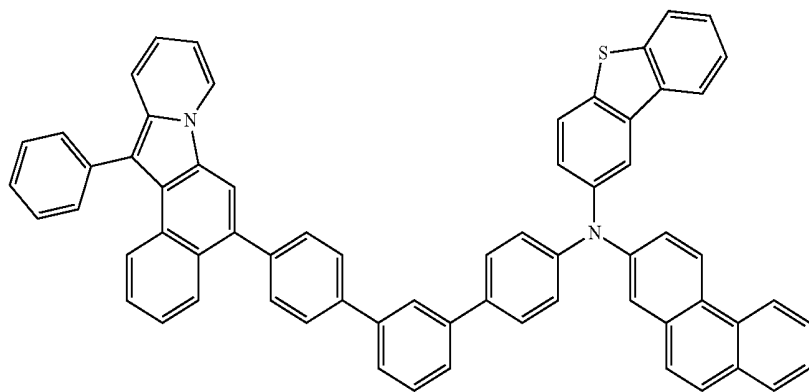


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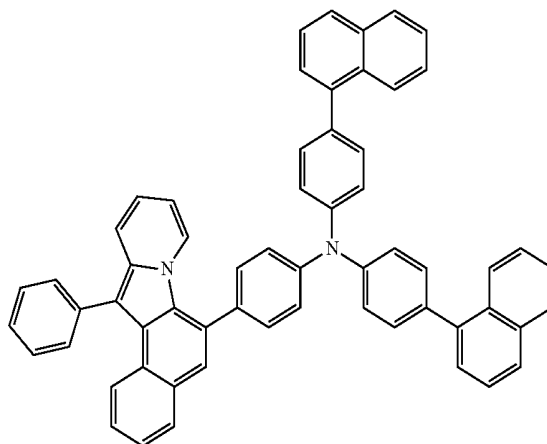
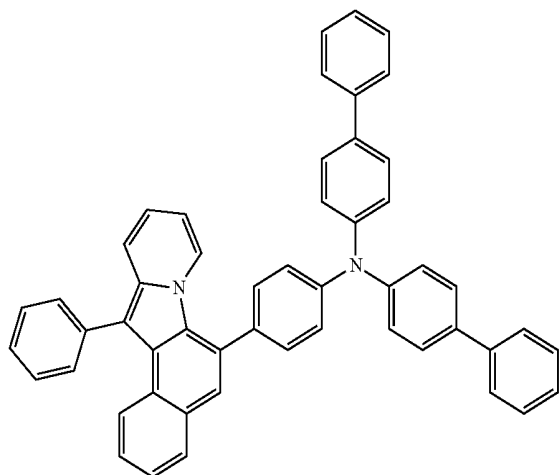


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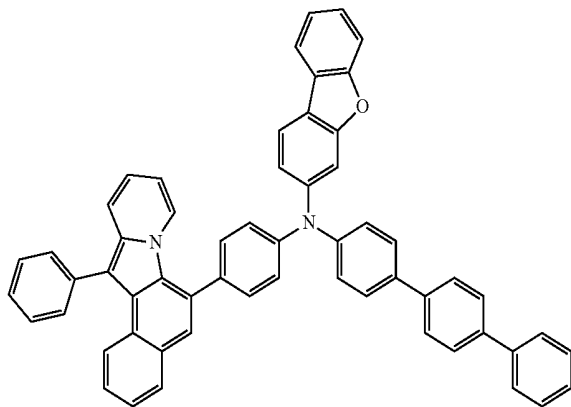
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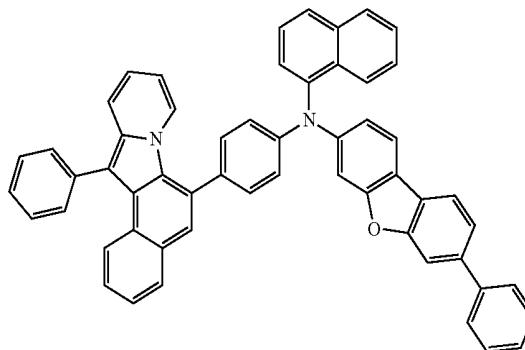


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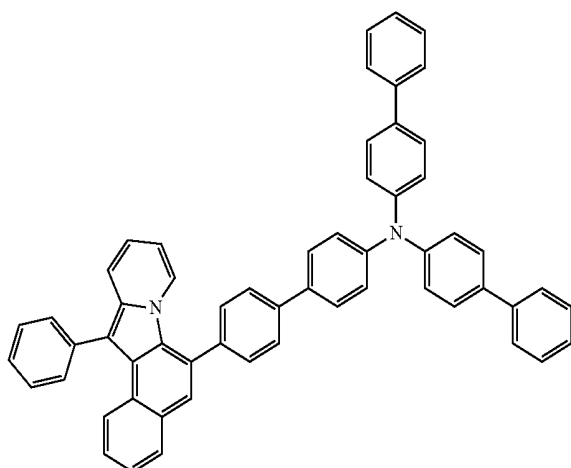
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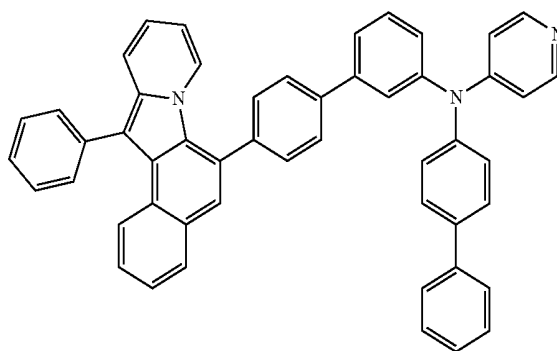
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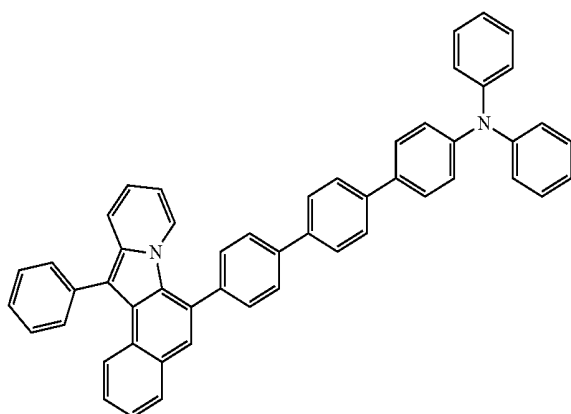
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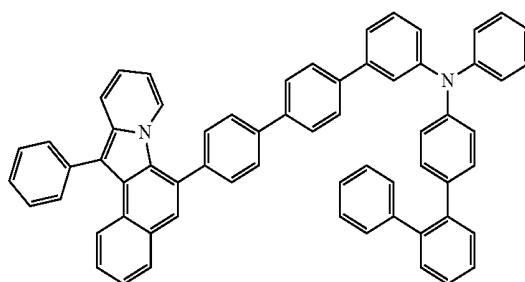
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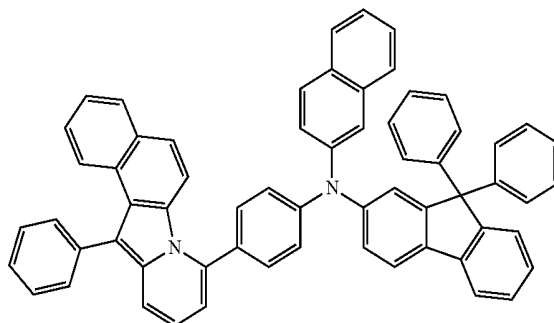
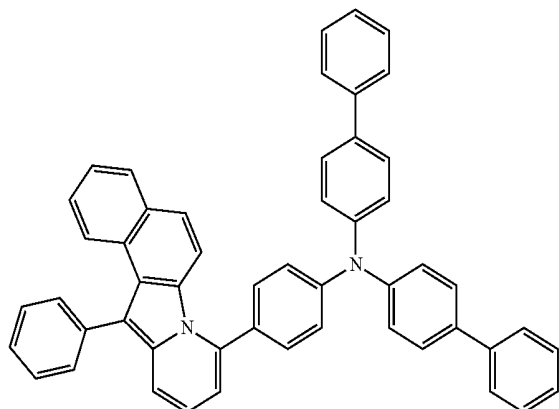


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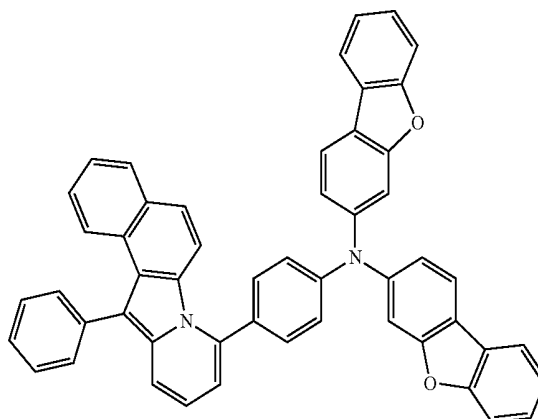
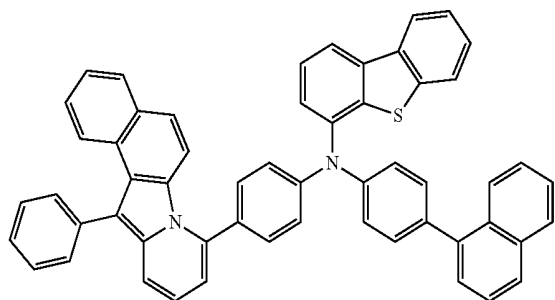
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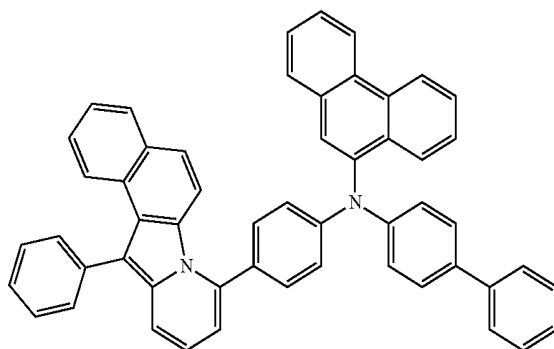
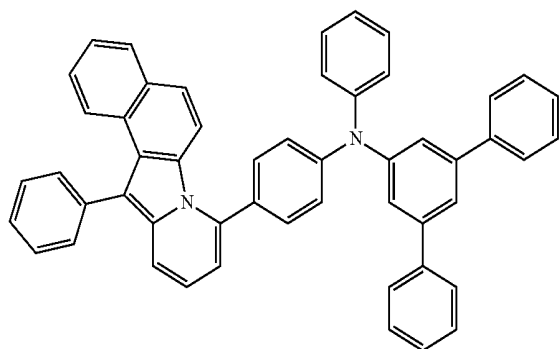
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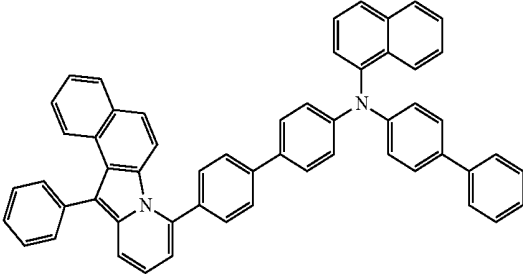


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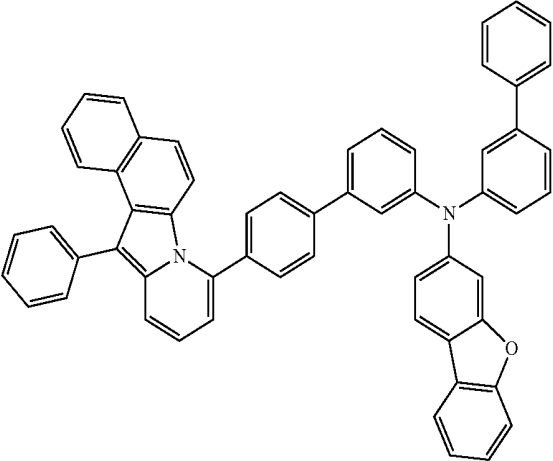
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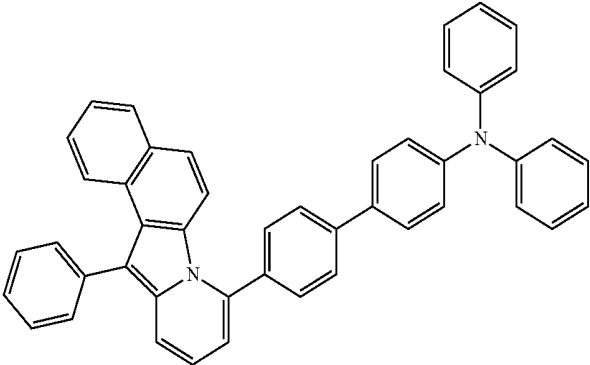
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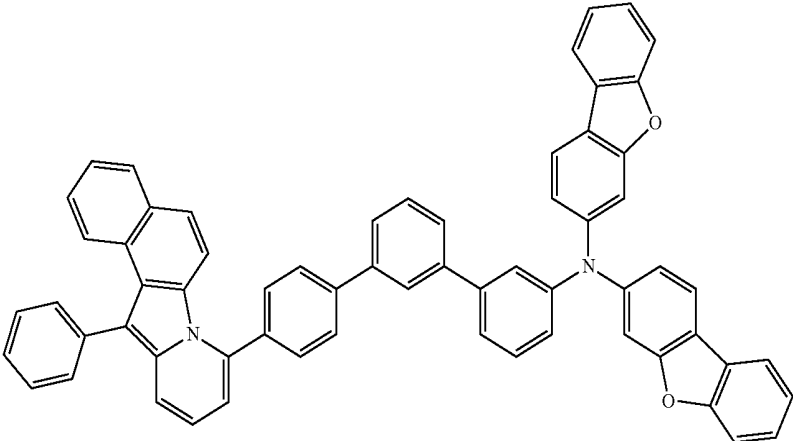
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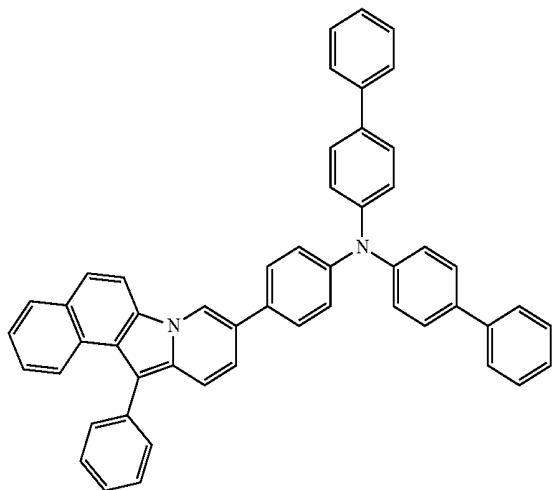


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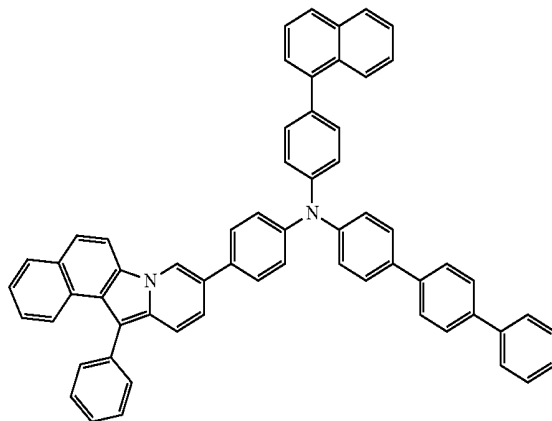


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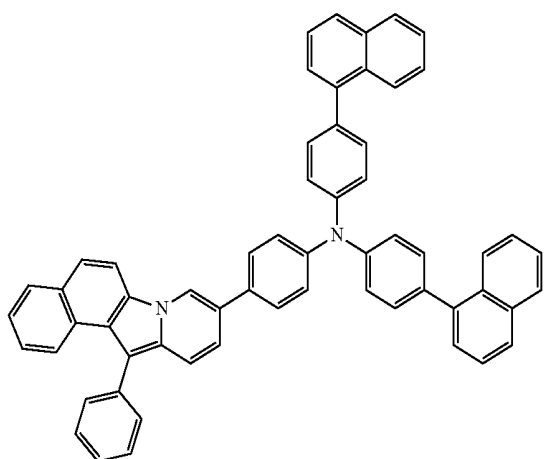
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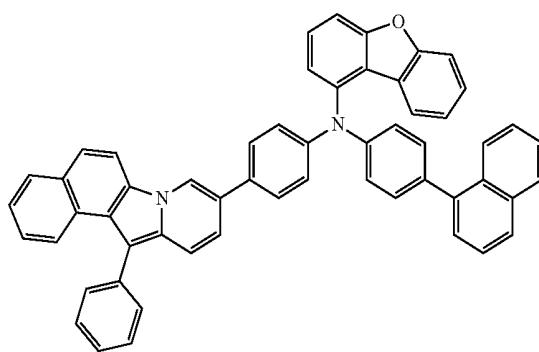
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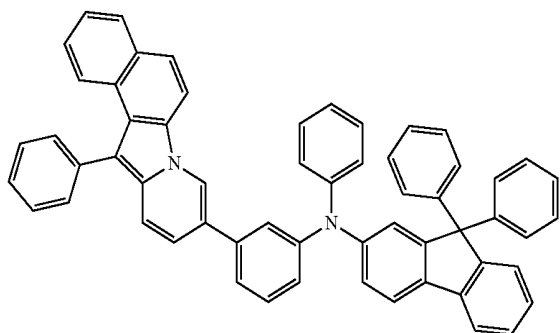
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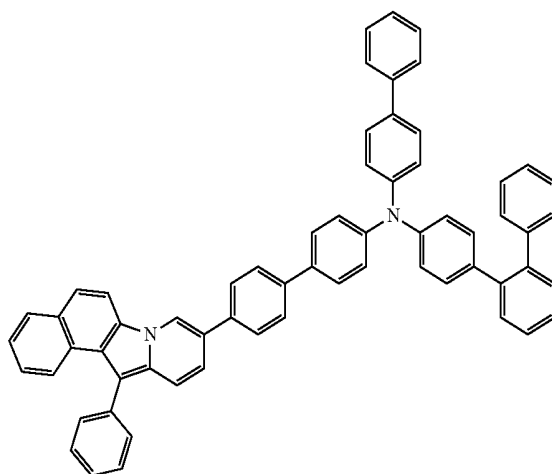
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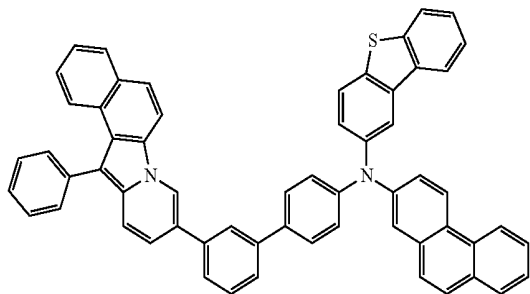


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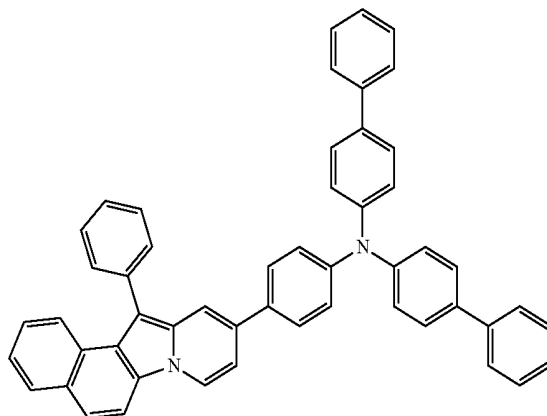


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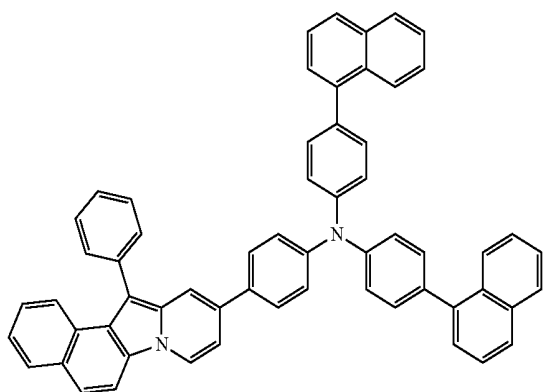
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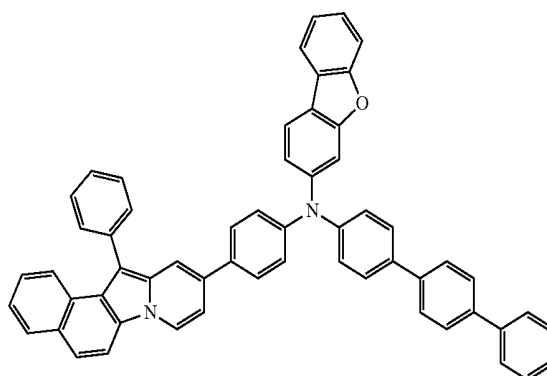
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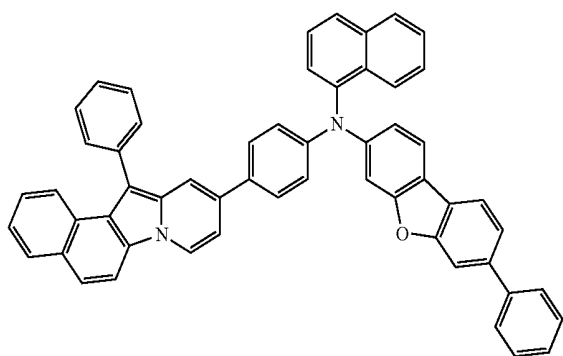
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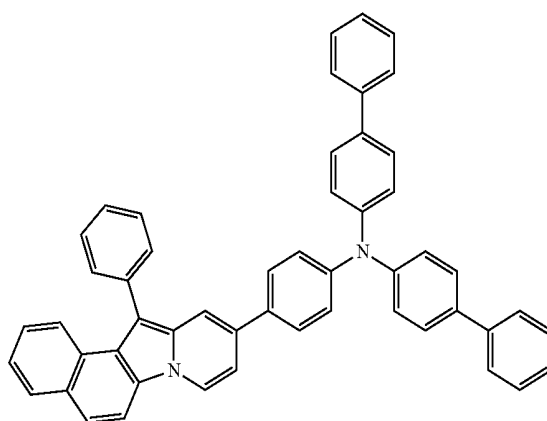
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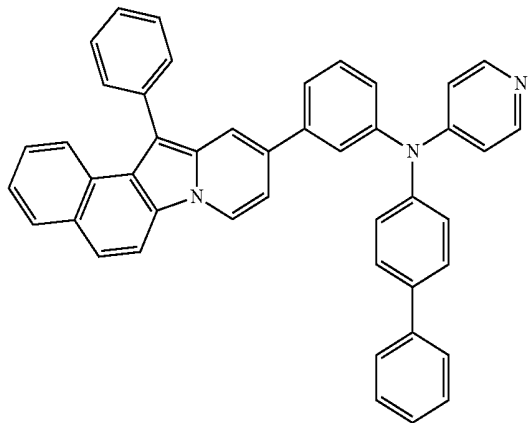


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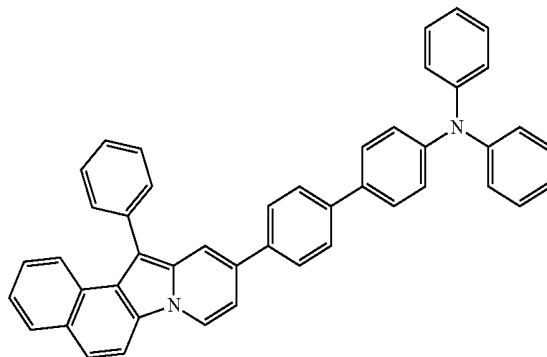


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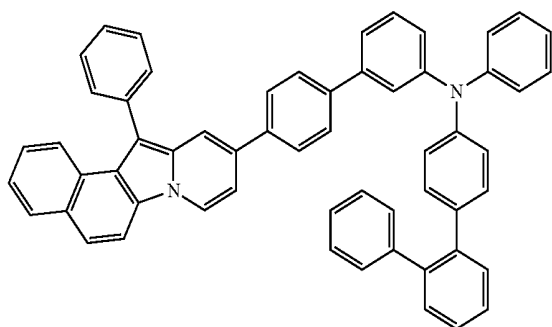
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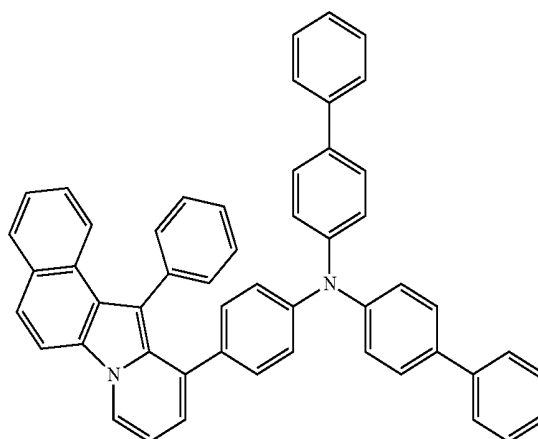
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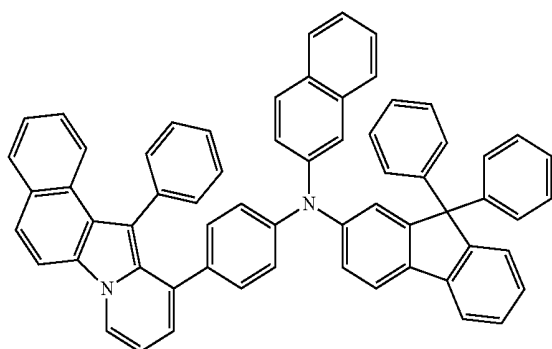
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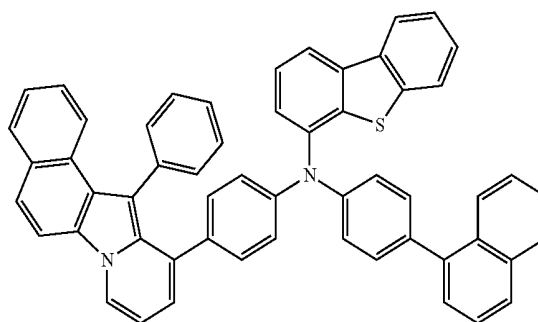
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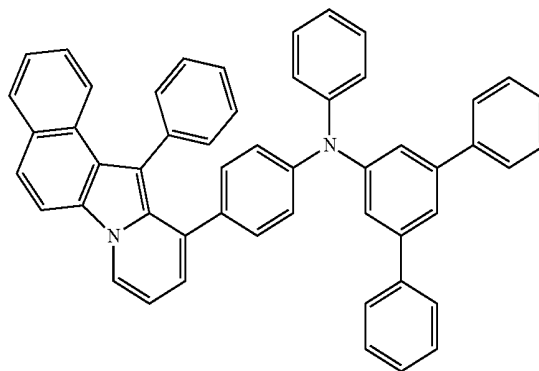
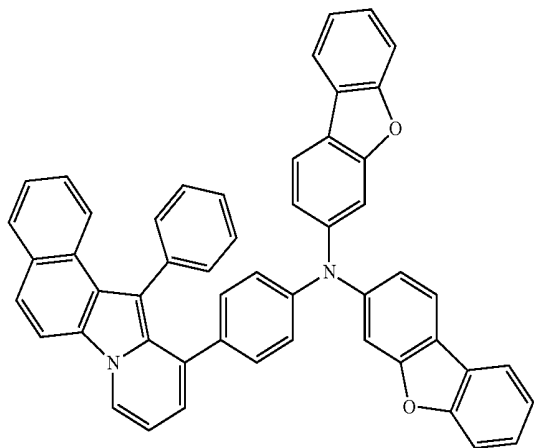
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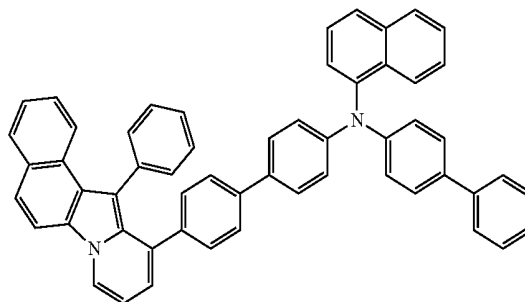
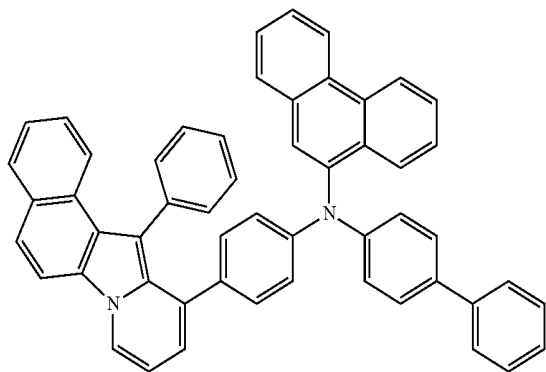
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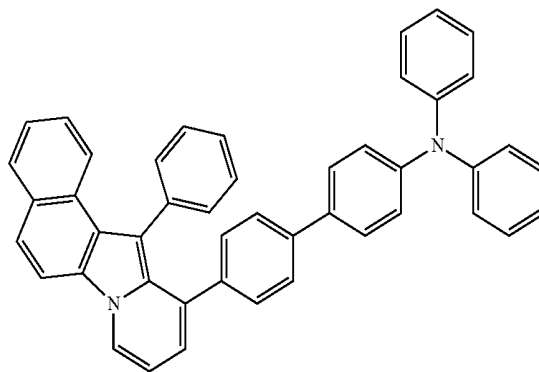
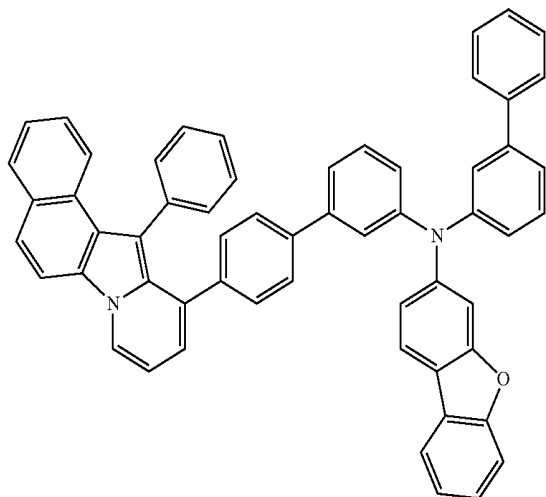
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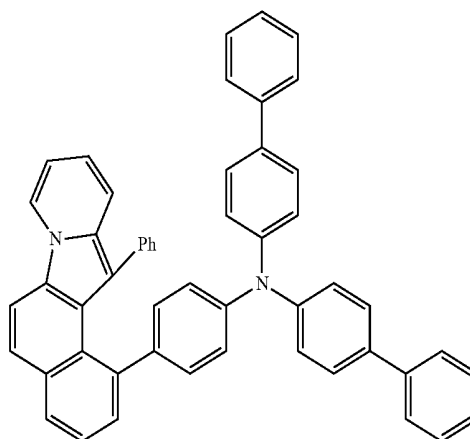
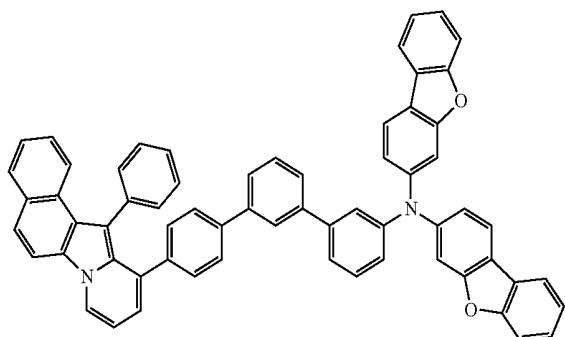
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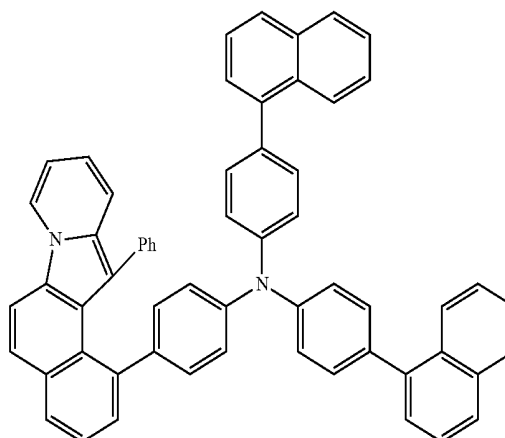
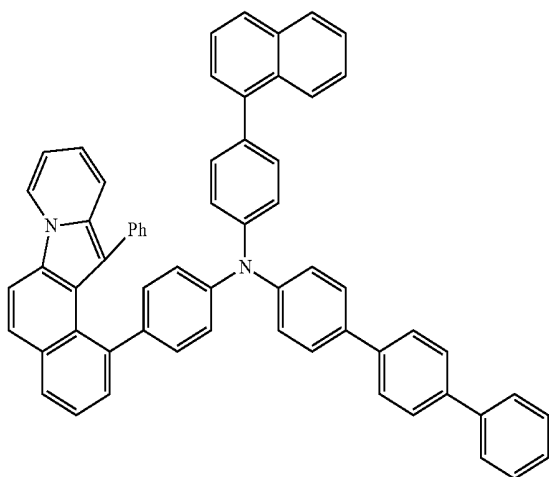
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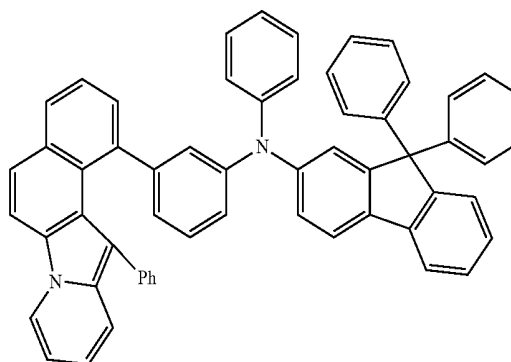
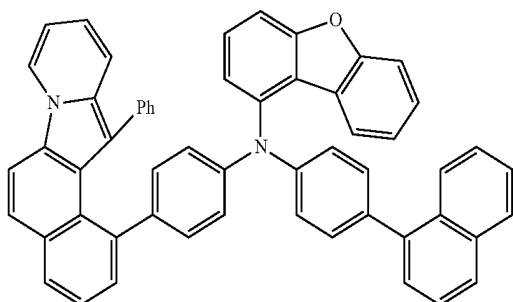
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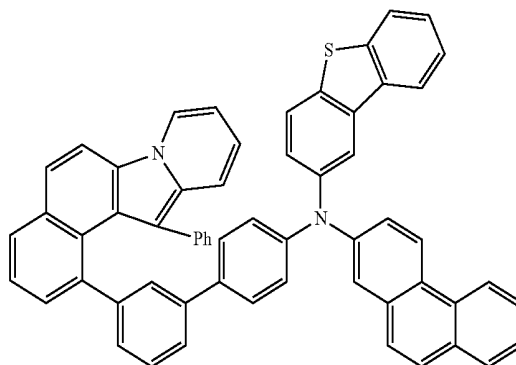
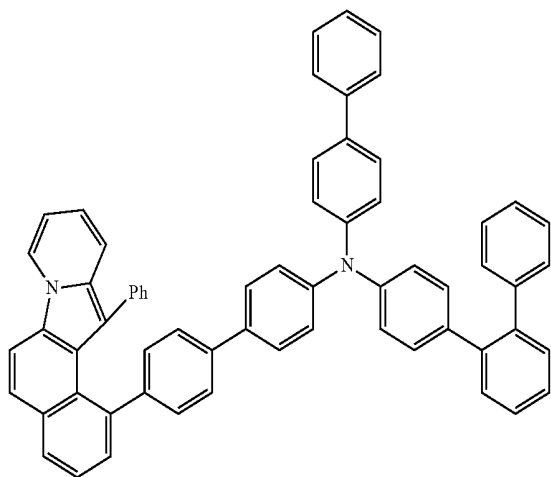
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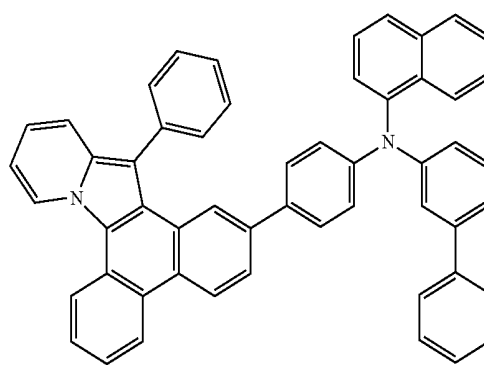
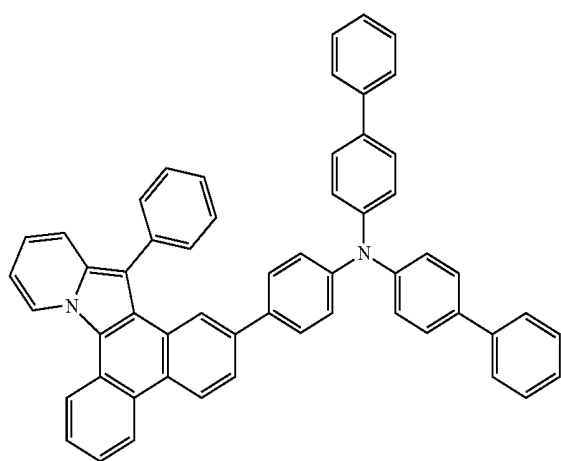
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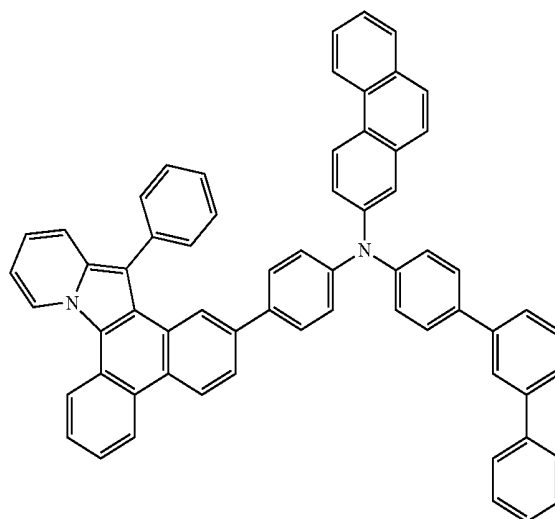
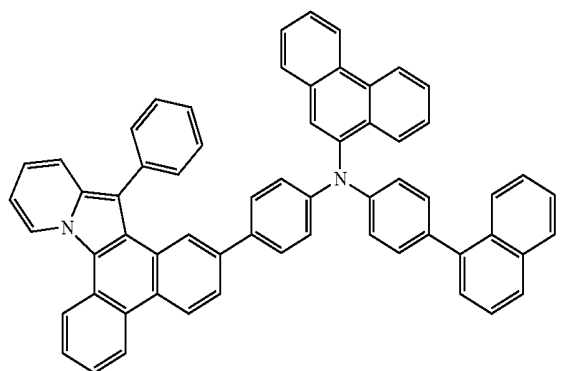
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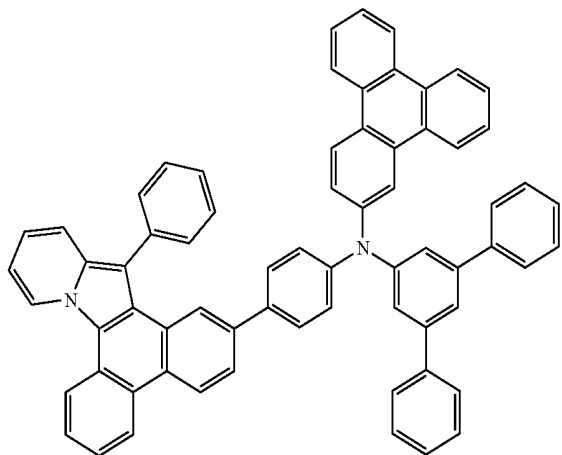
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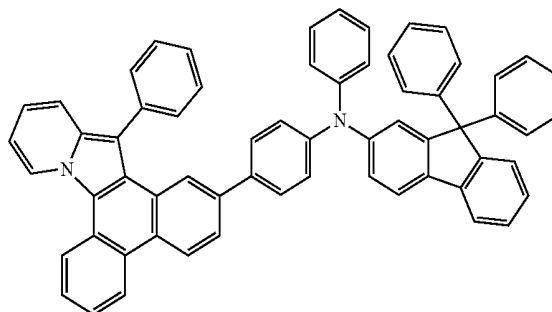


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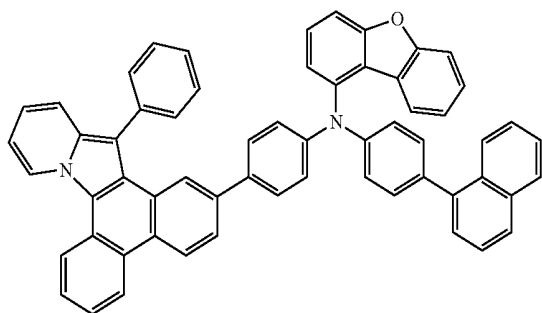
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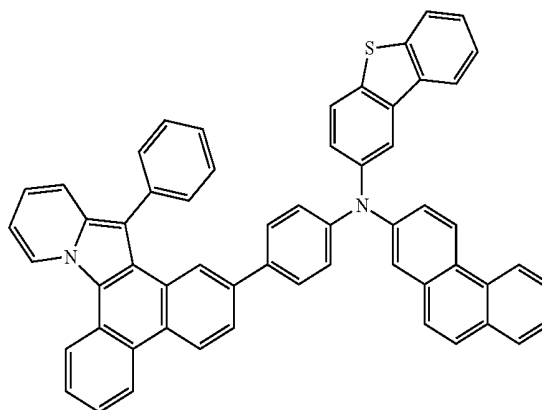
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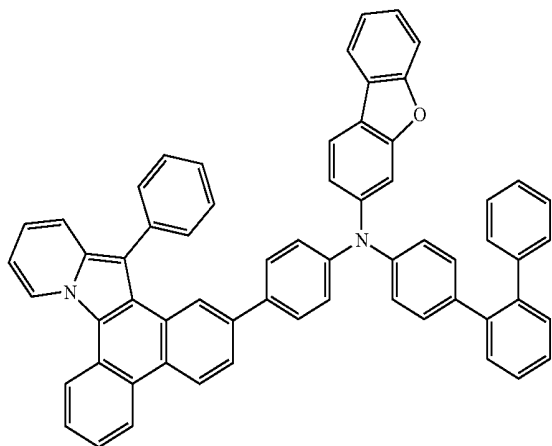
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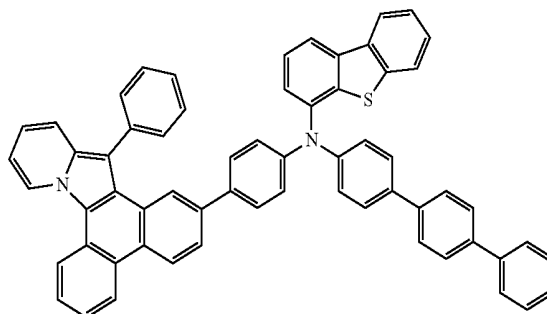
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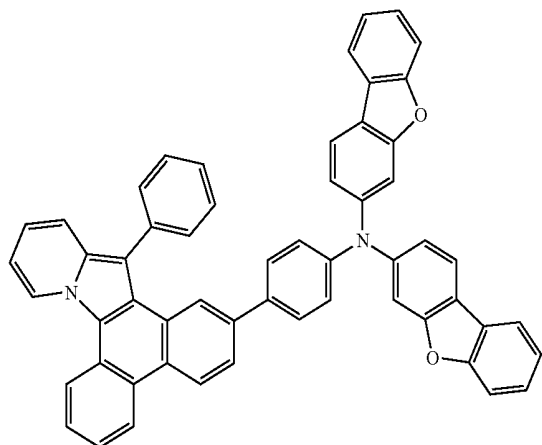


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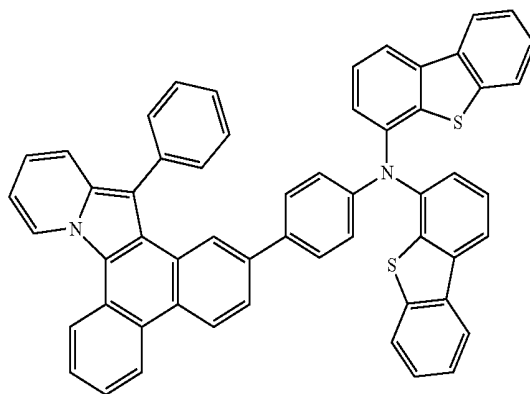


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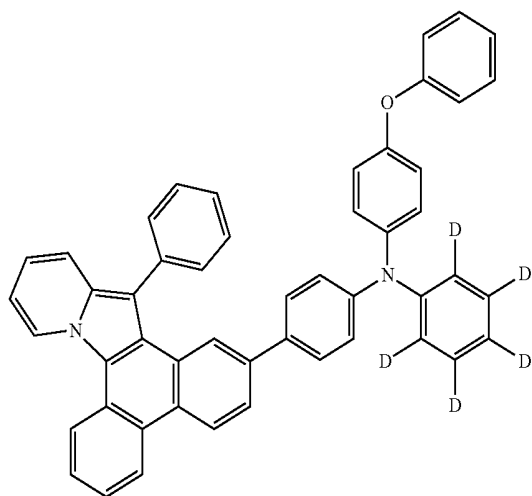
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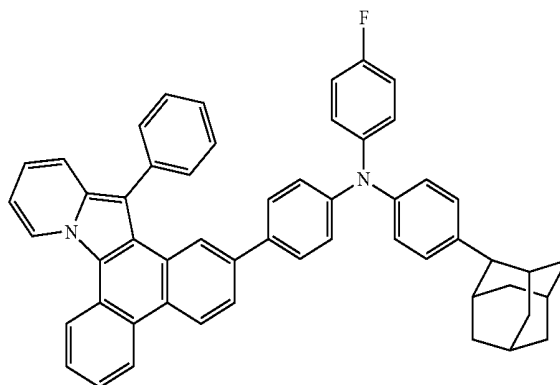
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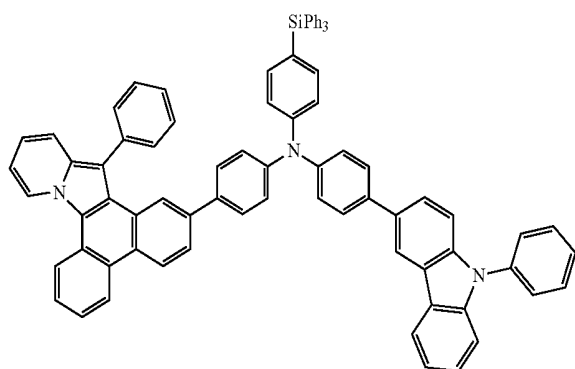
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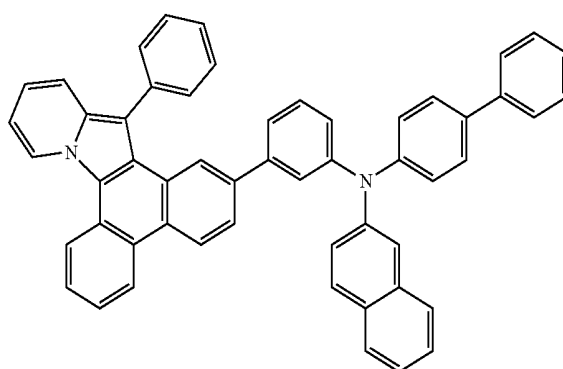
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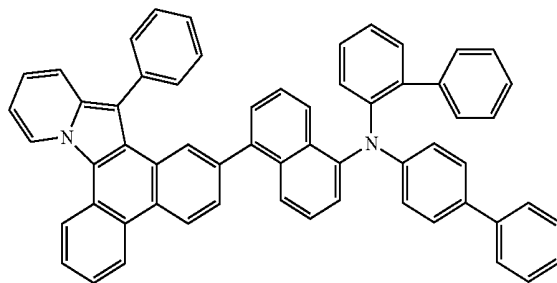
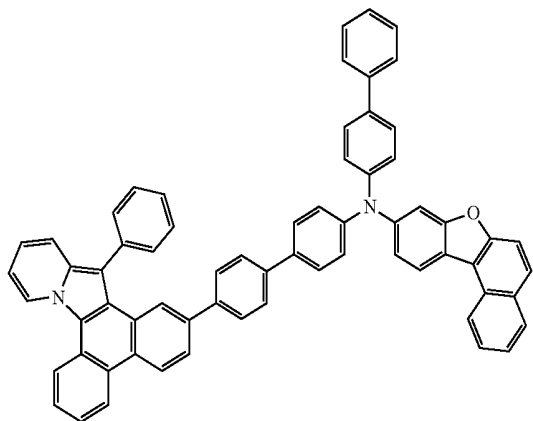
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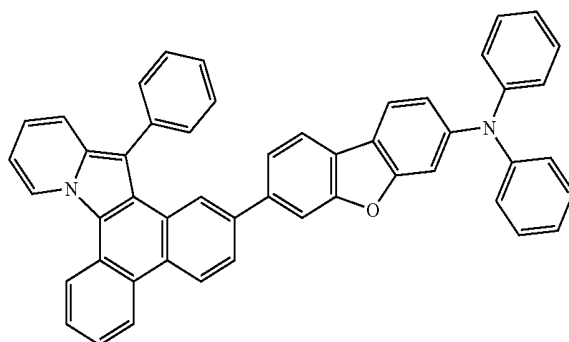
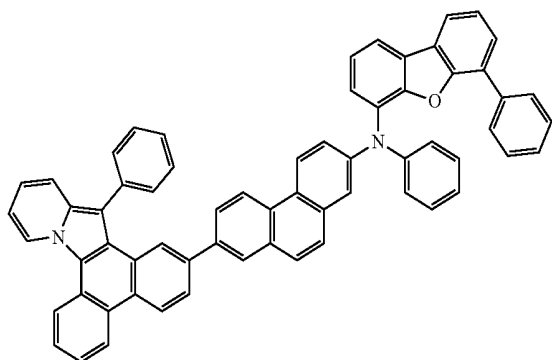
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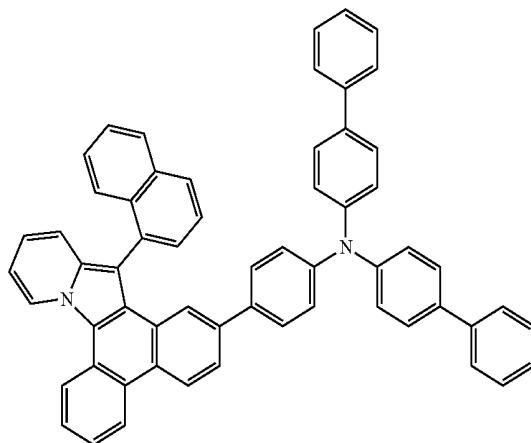
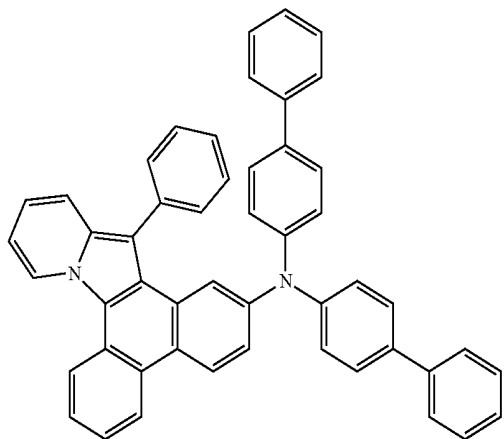
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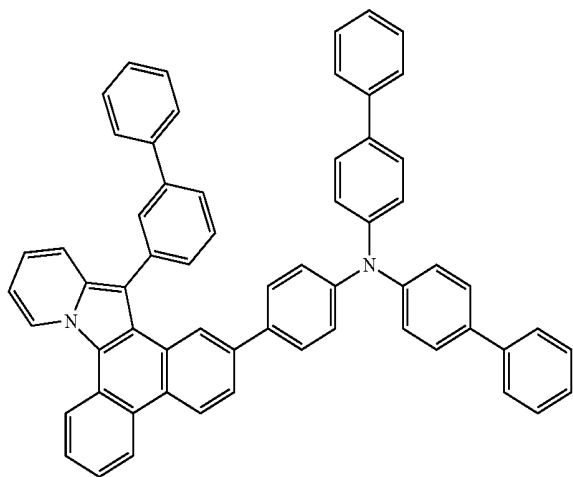
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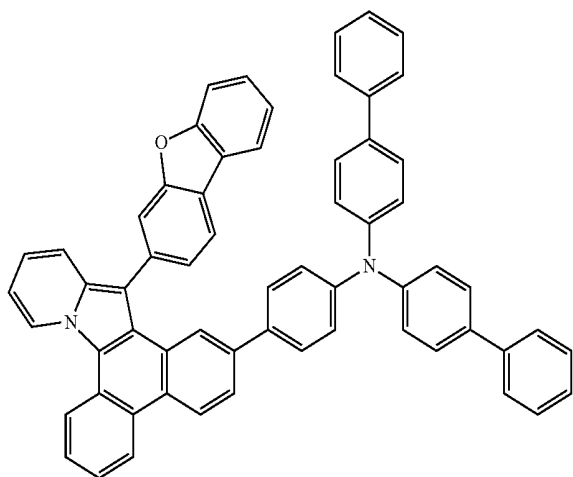
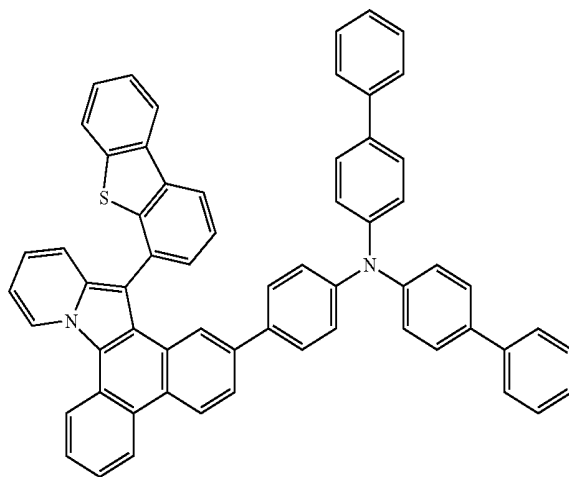
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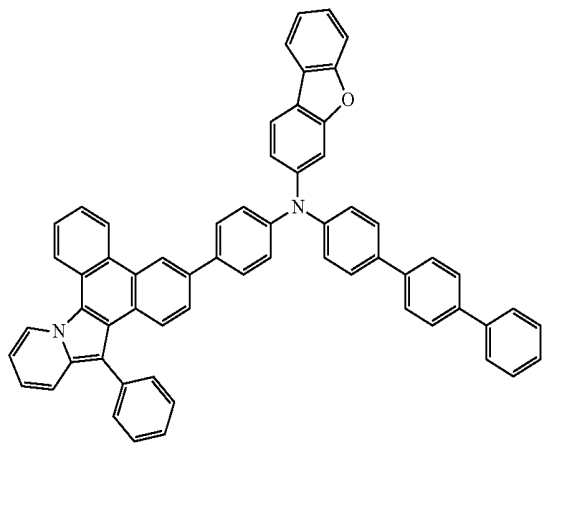
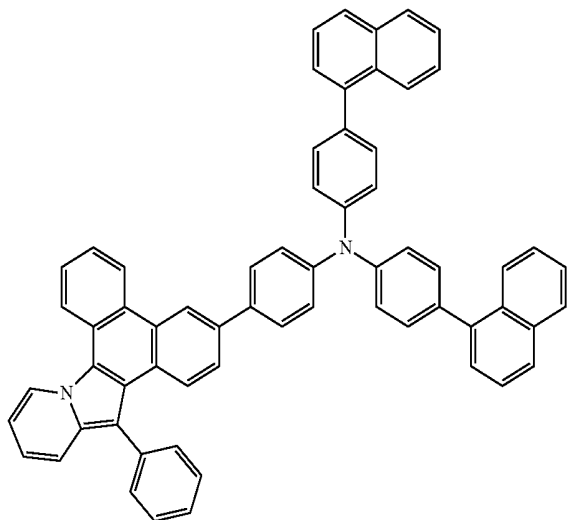
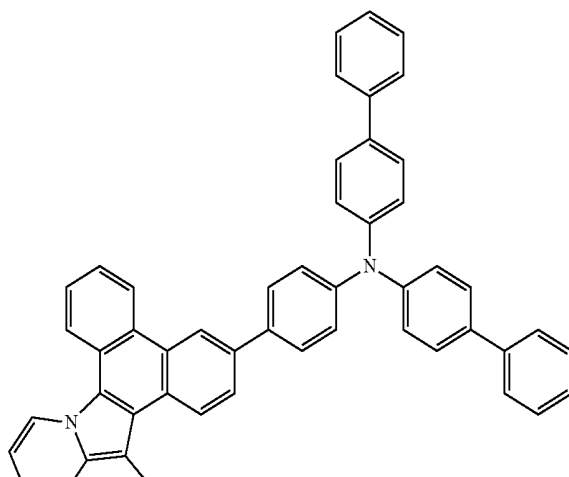
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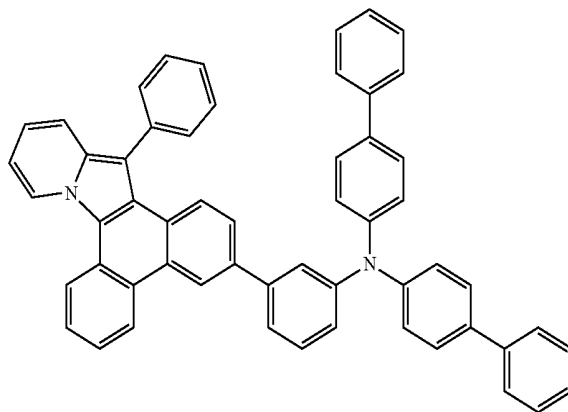
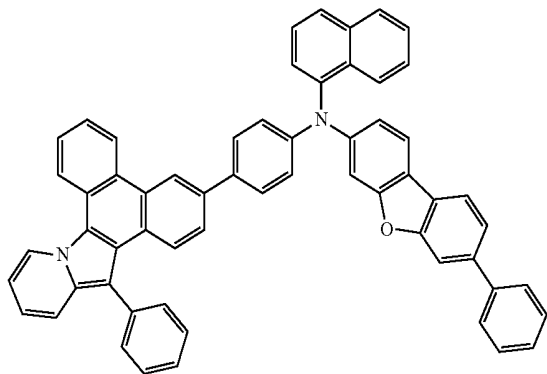
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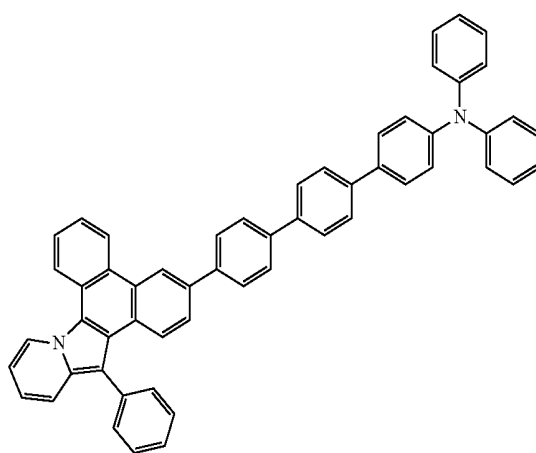
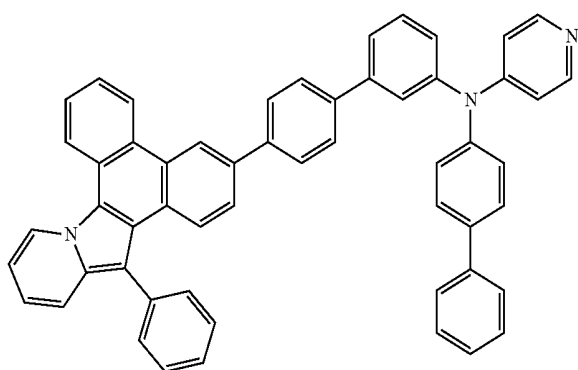
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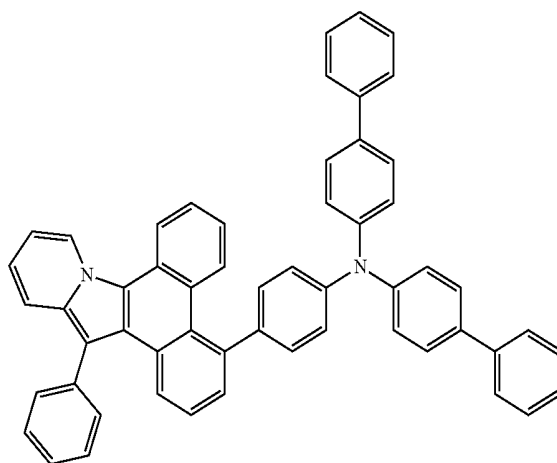
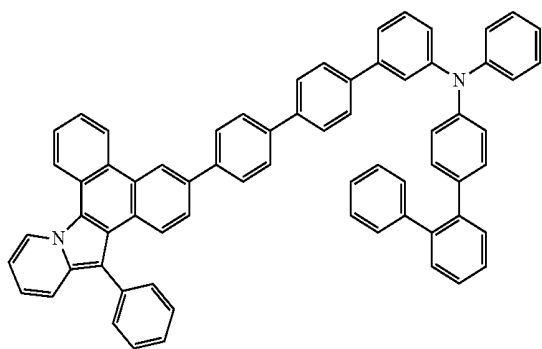
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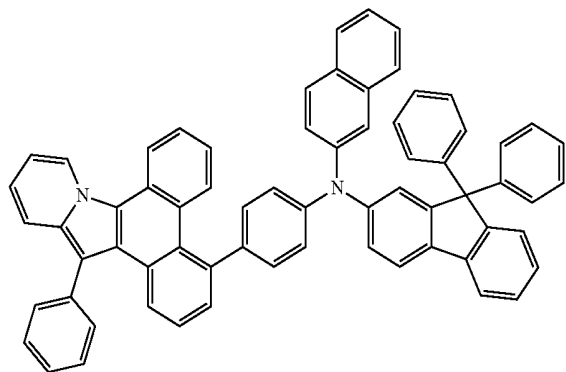
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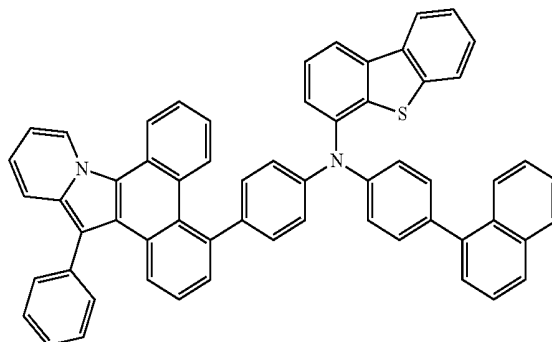


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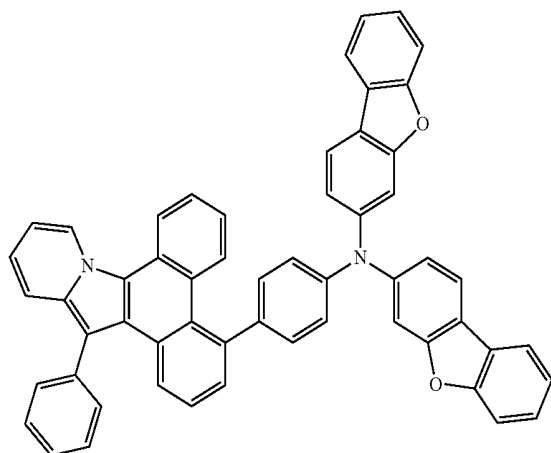
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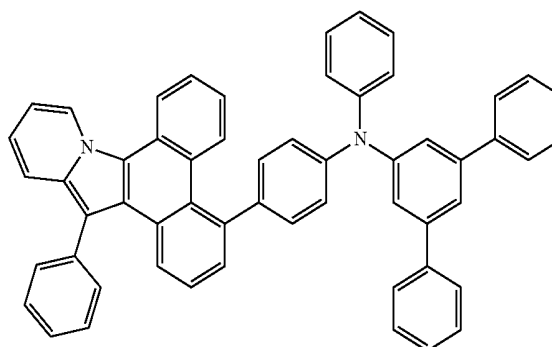
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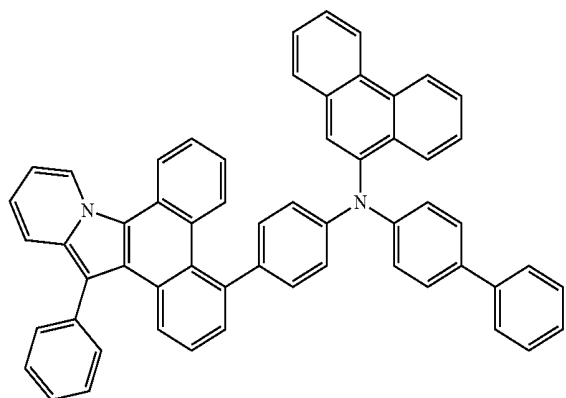
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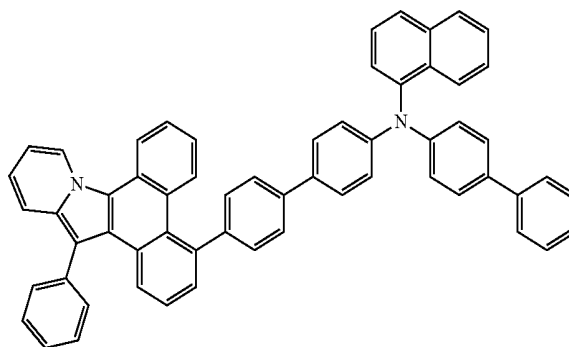
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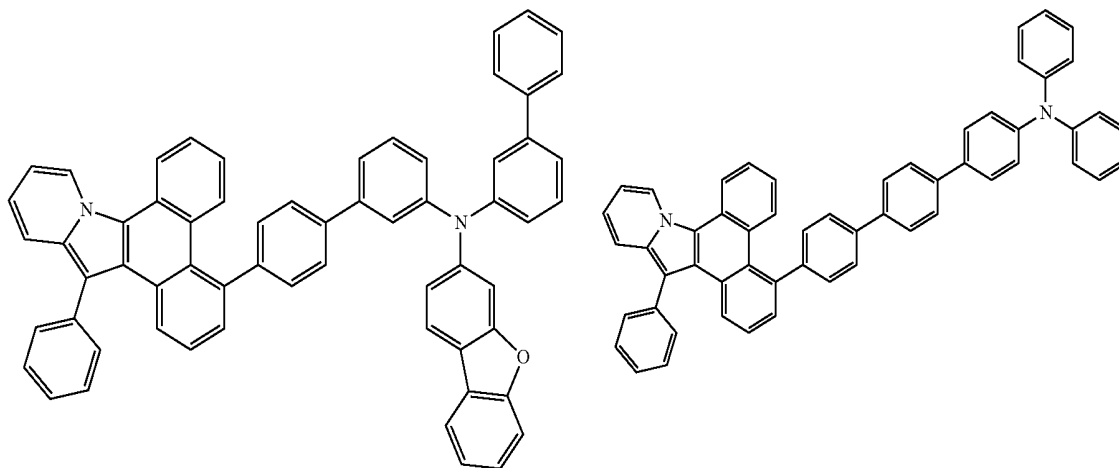


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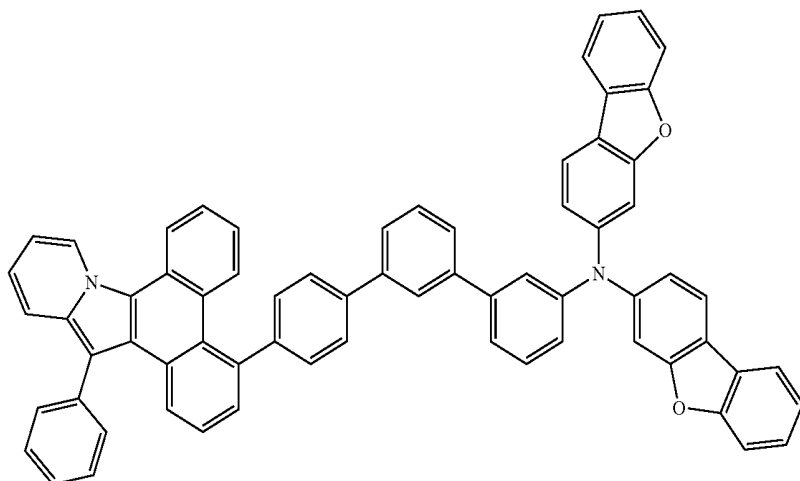


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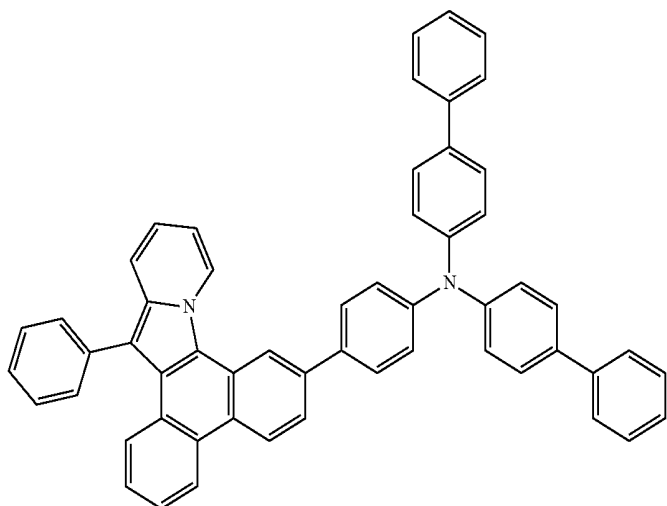
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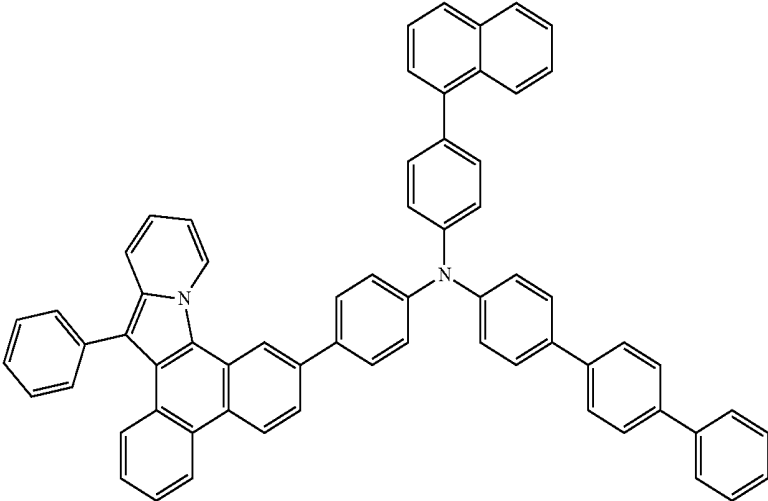


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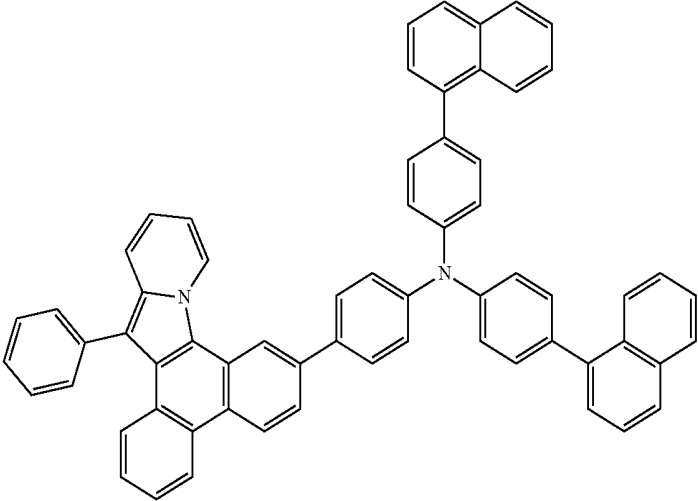


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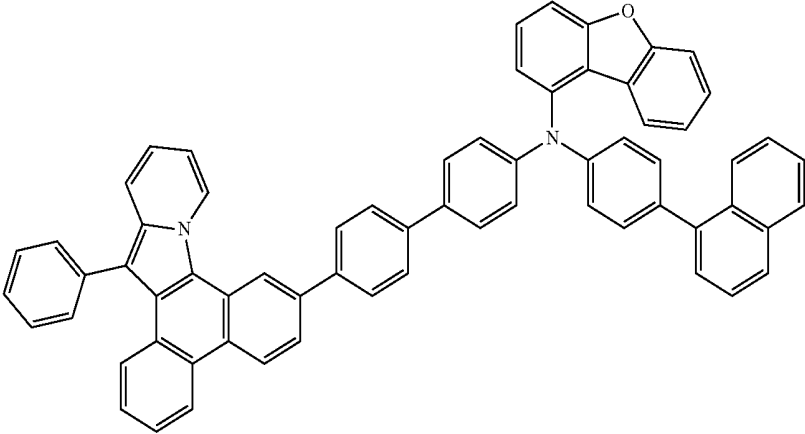
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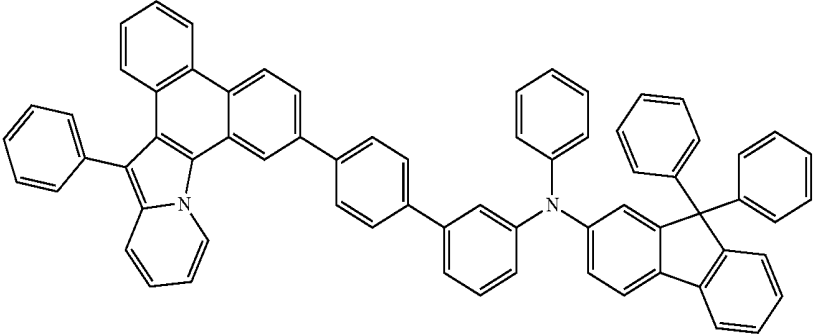


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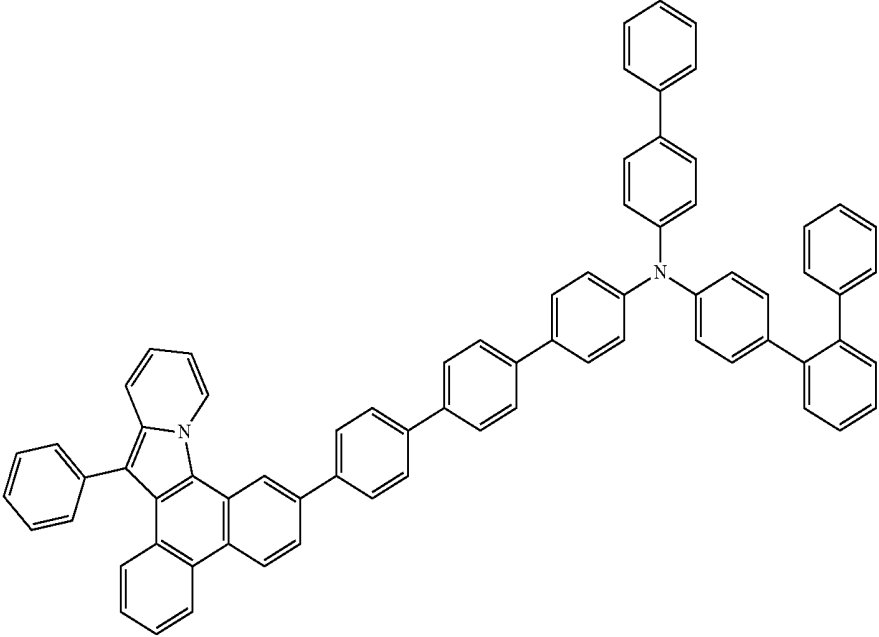


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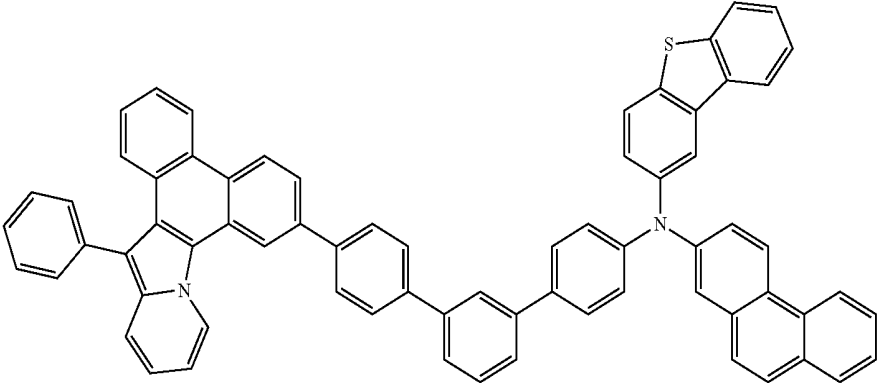
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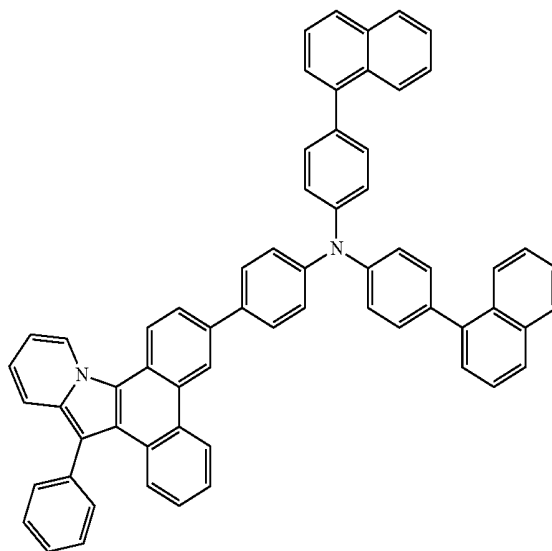
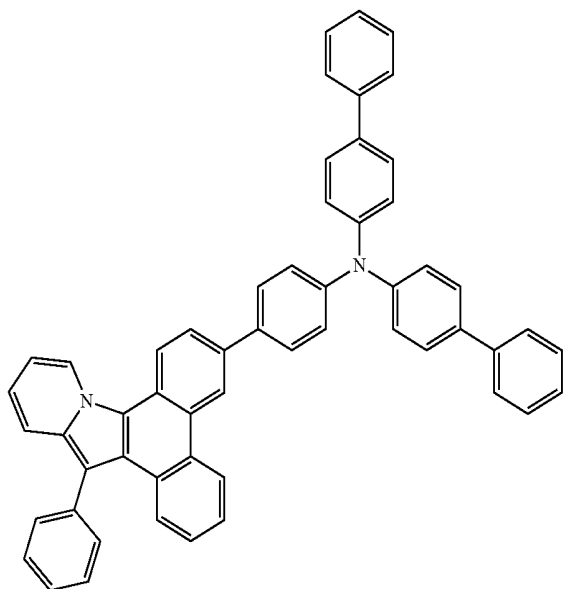


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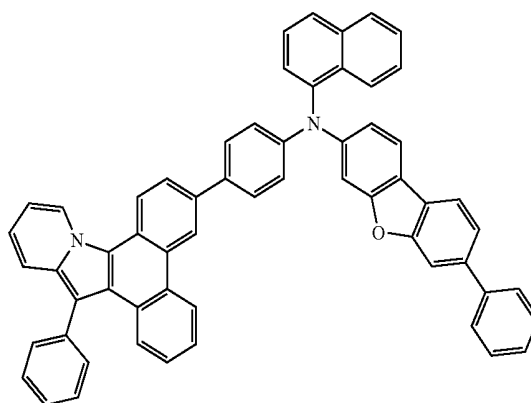
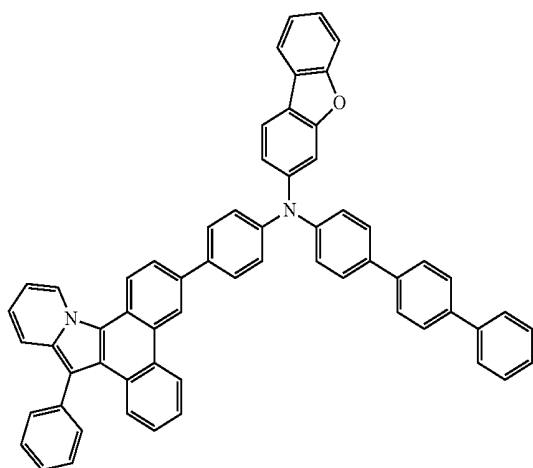
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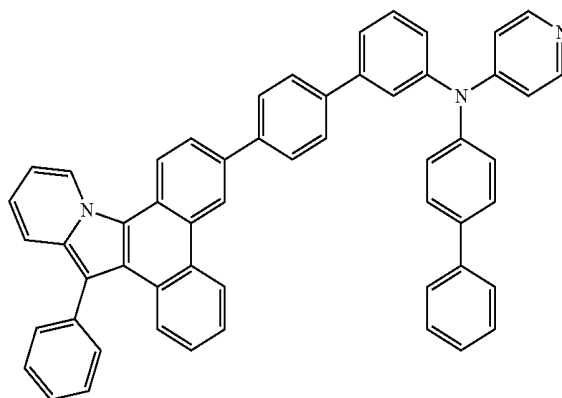
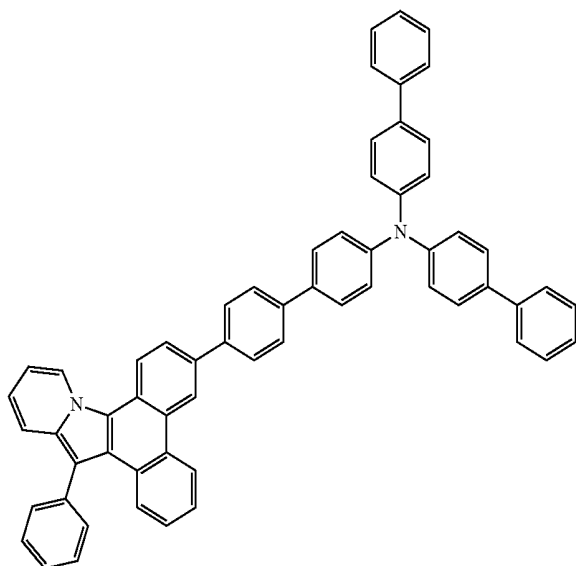
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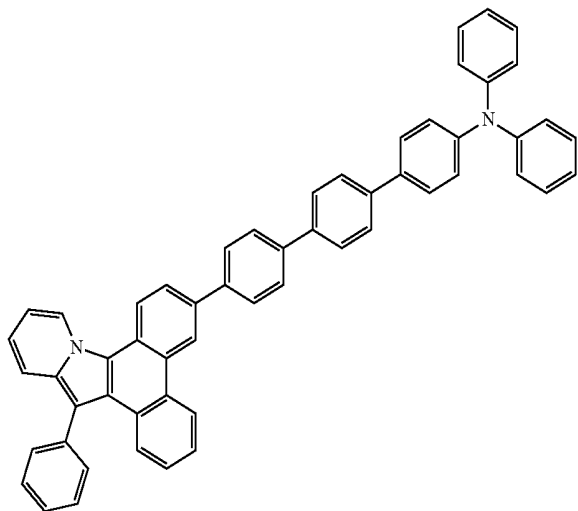
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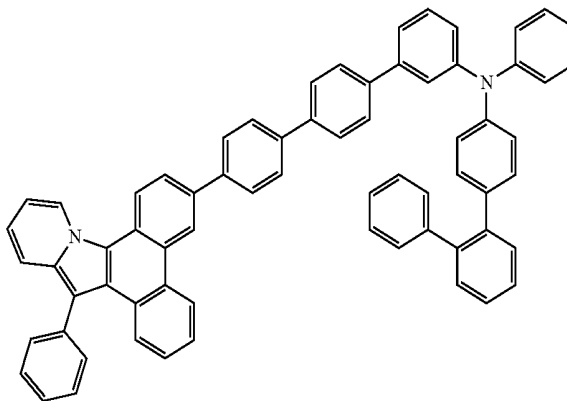


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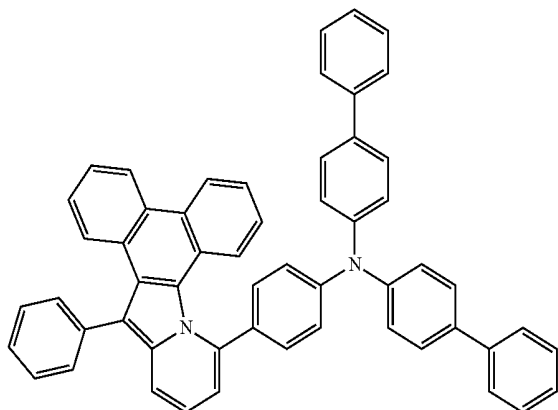
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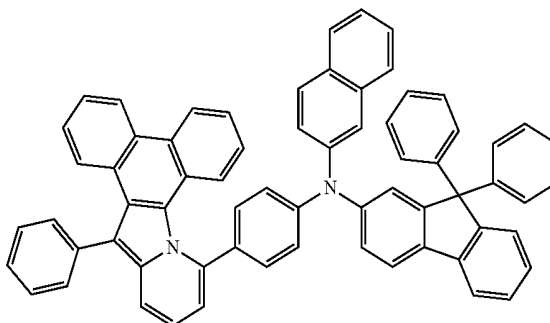
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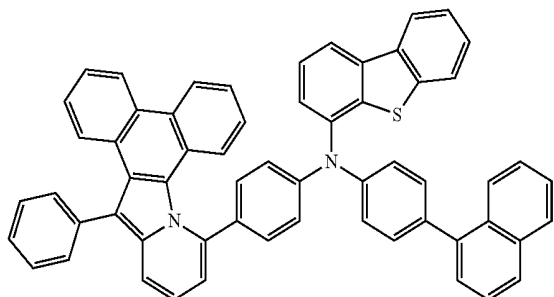
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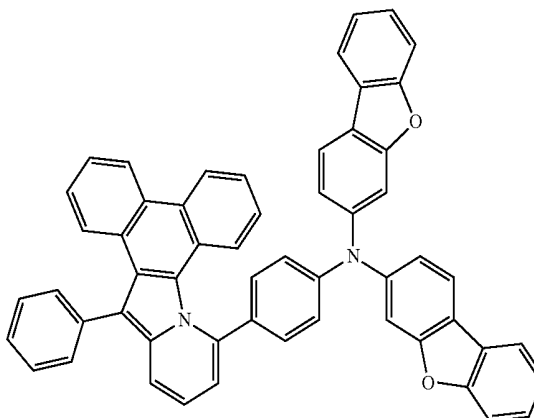
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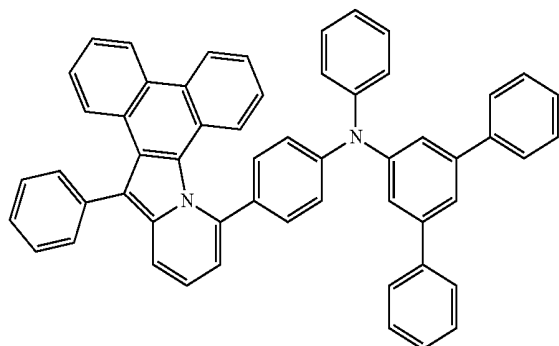


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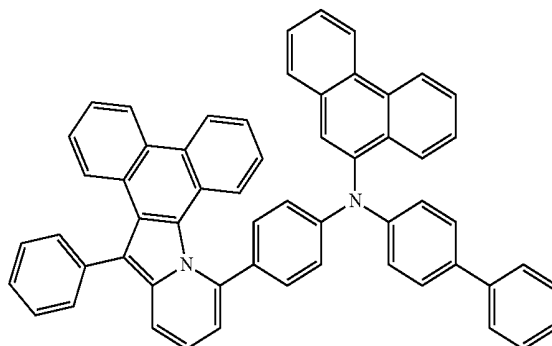


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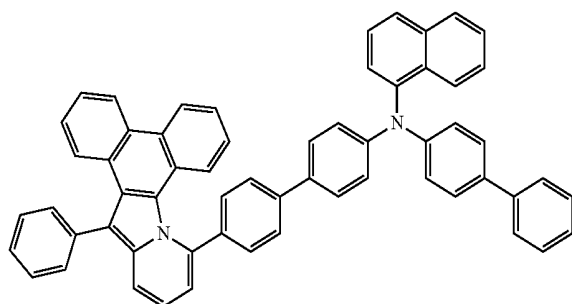
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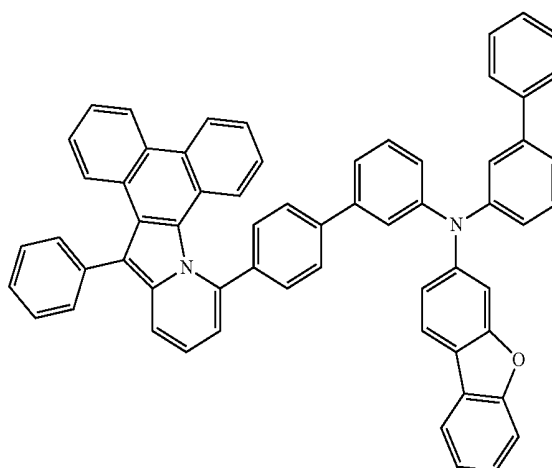
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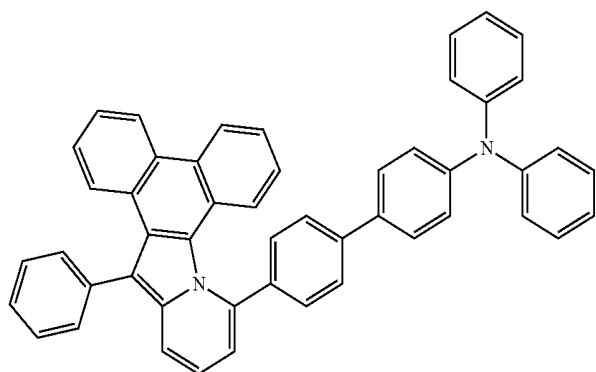
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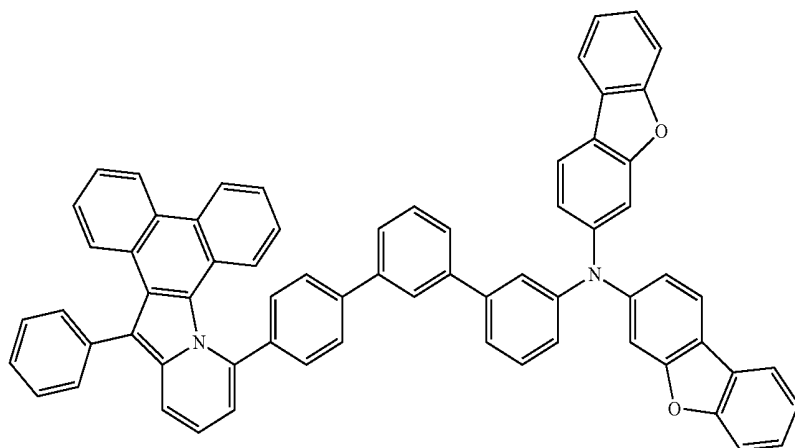


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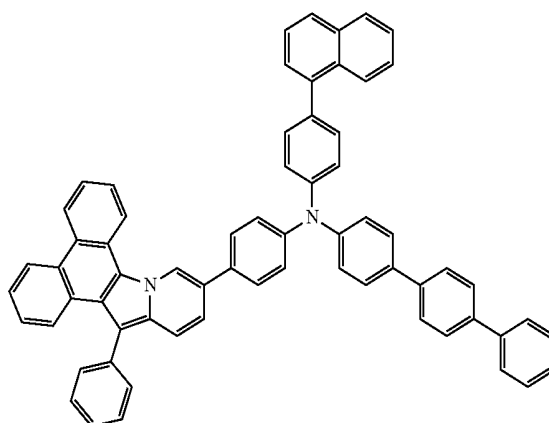
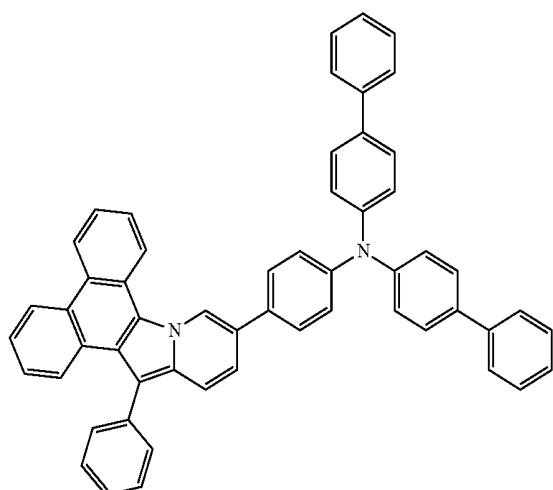
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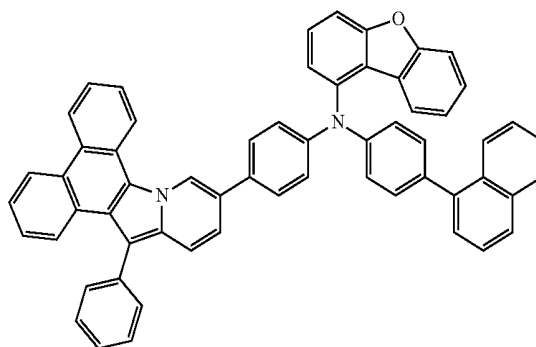
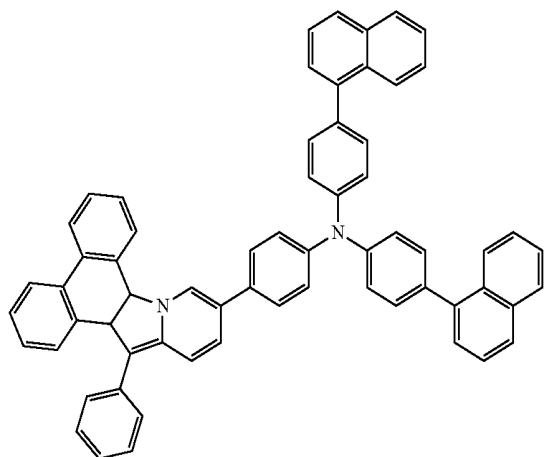
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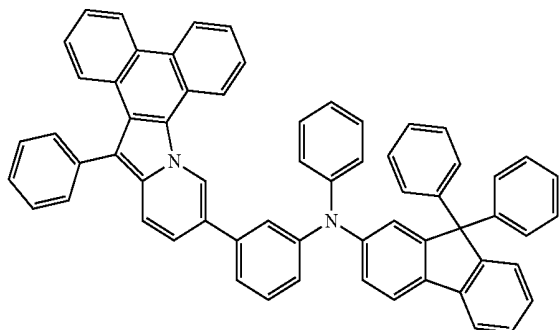
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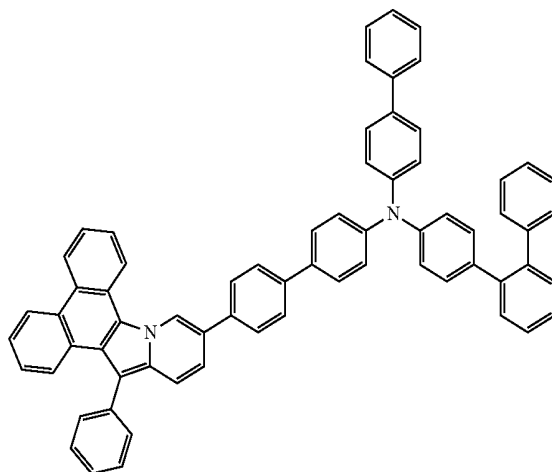


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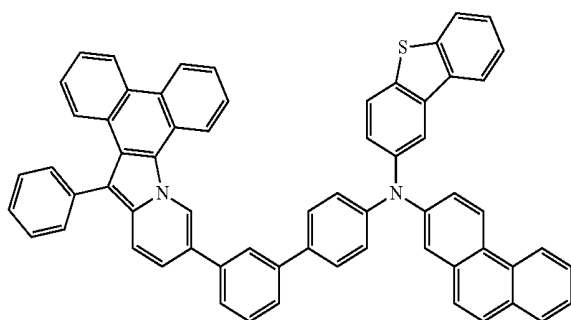
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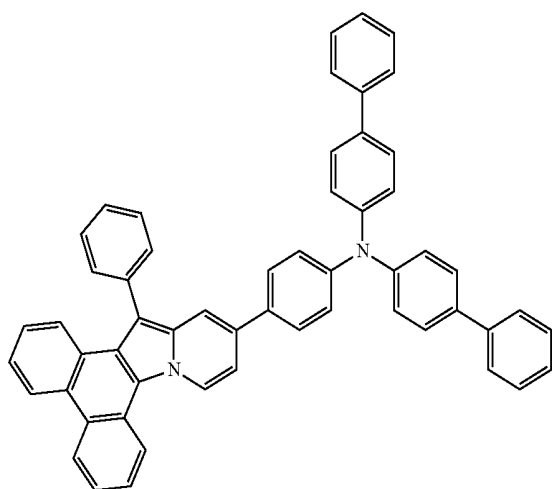
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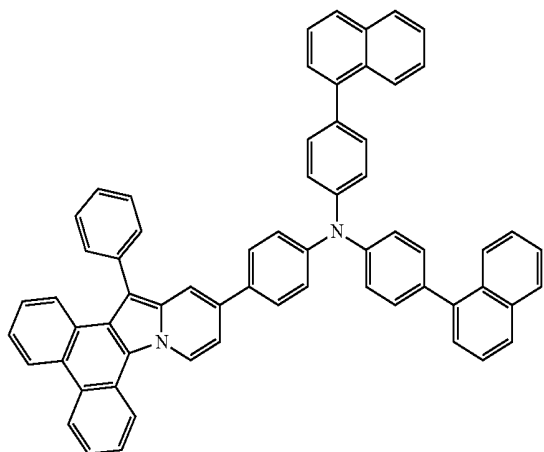
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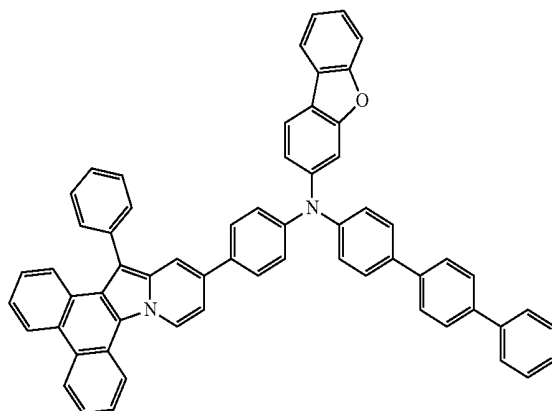
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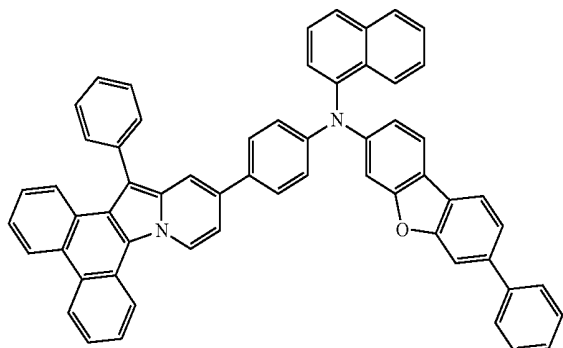


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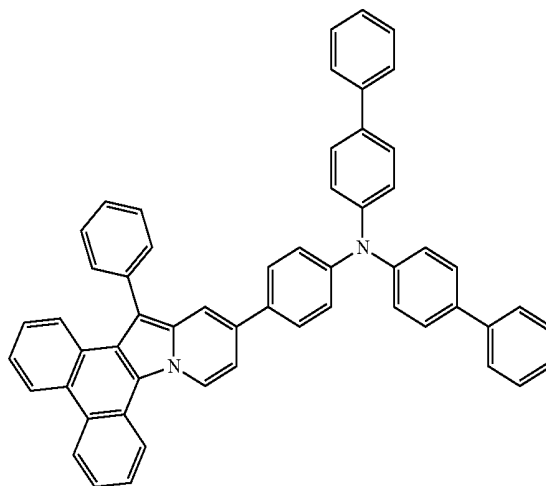


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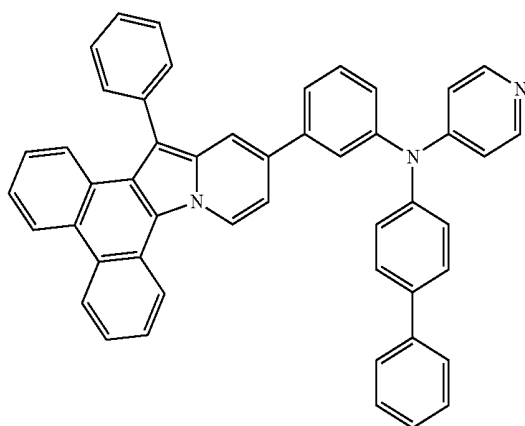
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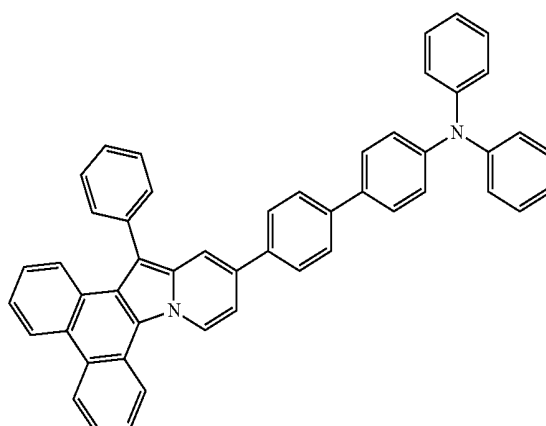
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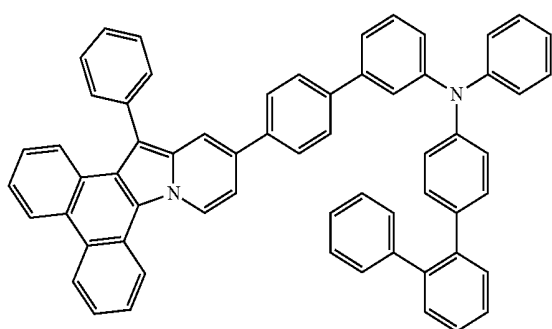
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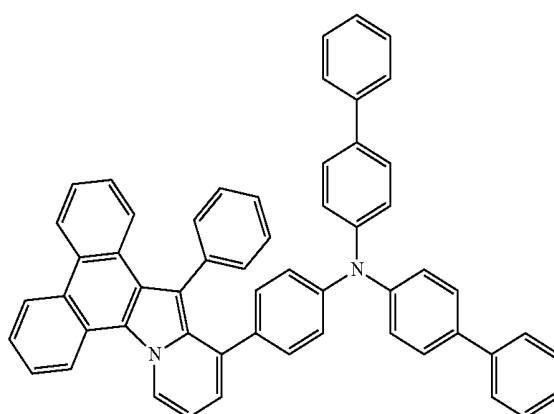
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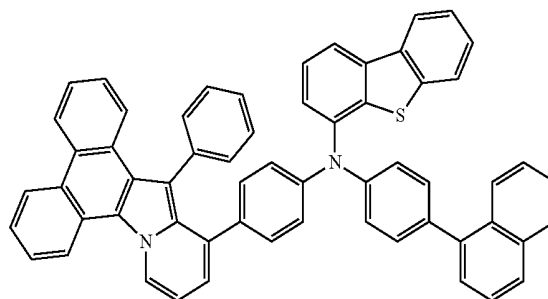
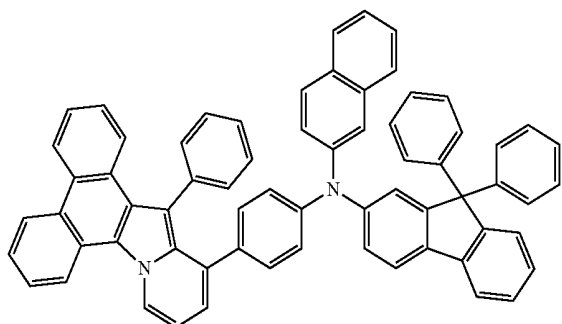


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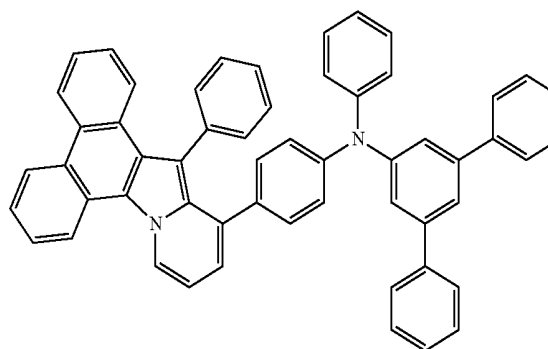
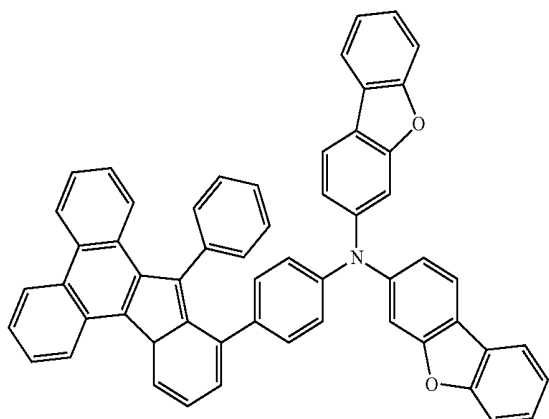
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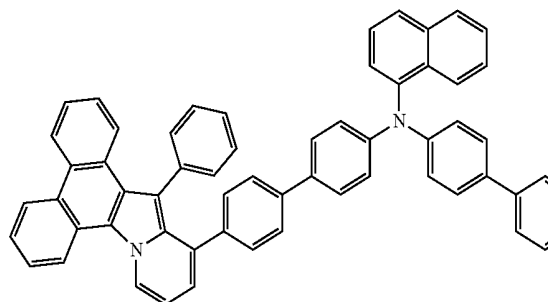
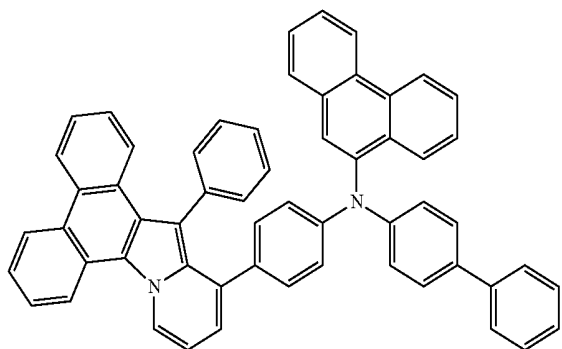
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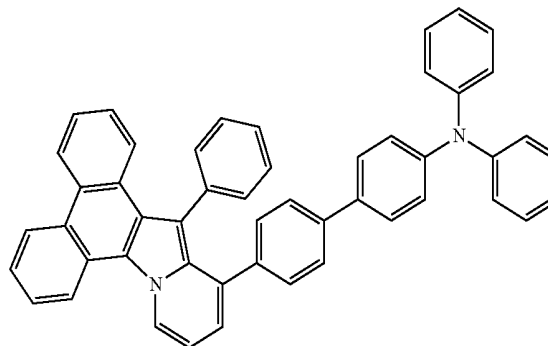
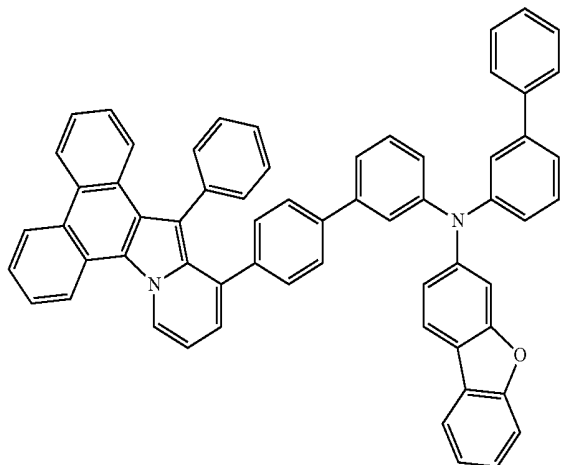
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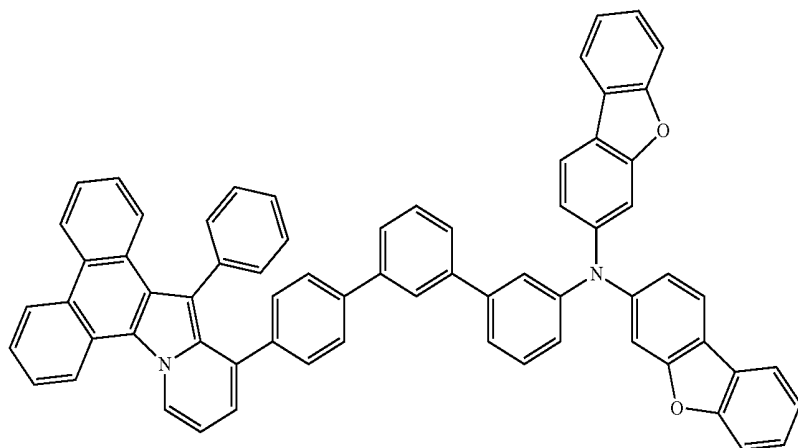
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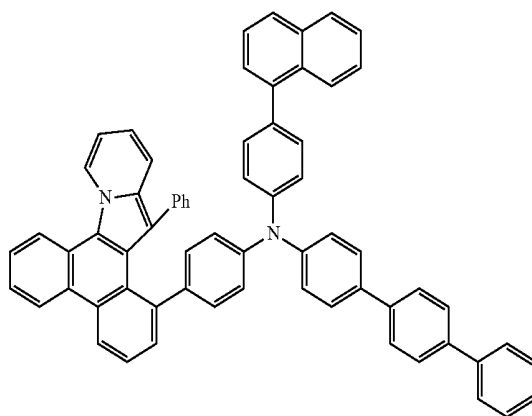
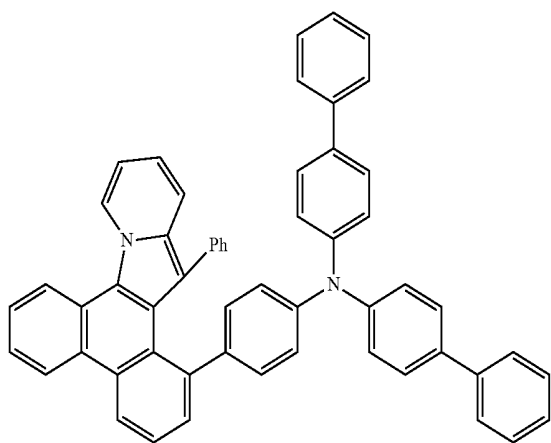
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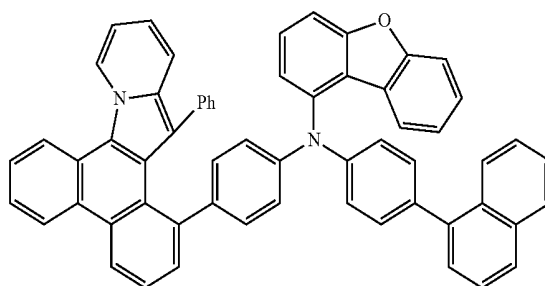
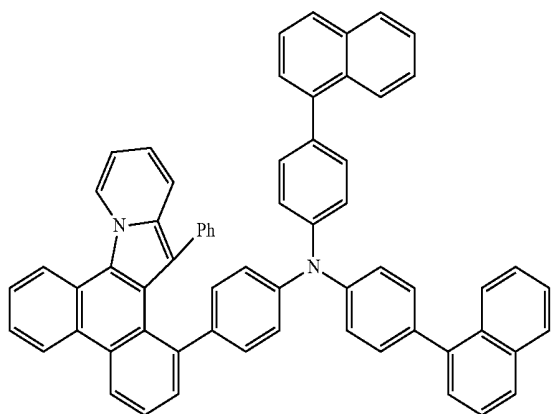
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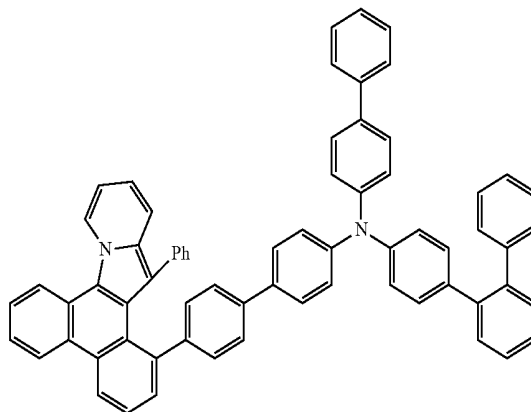
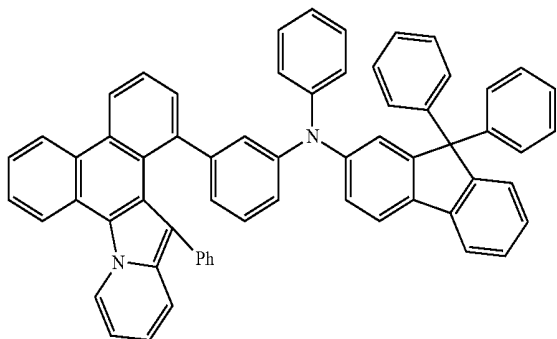
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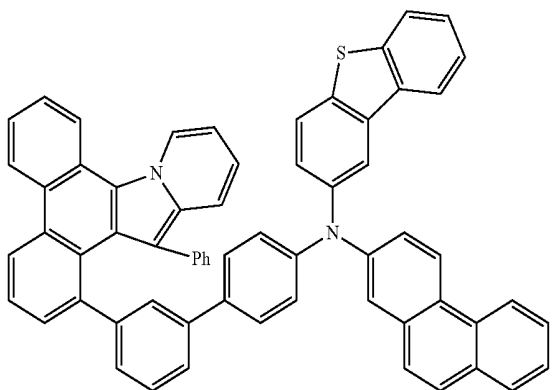


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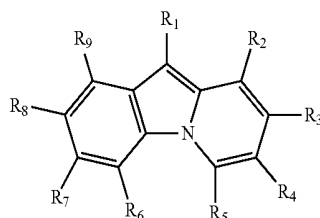
[0114] Compound A1 to Compound A97 in Compound Group 1 correspond to structures in which R_2 and R_3 are combined with each other to form a hexagonal hydrocarbon ring represented by Formula 3. Compound B1 to Compound B97 in Compound Group 1 correspond to structures in which R_3 and R_4 are combined with each other to form a hexagonal hydrocarbon ring represented by Formula 3. Compound C1 to Compound C97 in Compound Group 1 correspond to structures in which R_4 and R_5 are combined with each other to form a hexagonal hydrocarbon ring represented by Formula 3. Compound D1 to Compound D100 in Compound Group 1 correspond to structures in which R_2 and R_3 , and R_4 and R_5 are respectively combined with each other to form hexagonal hydrocarbon rings represented by Formula 3.

[0115] Compound E1 to Compound E100 in Compound Group 2 correspond to structures in which R_8 and R_9 are combined with each other to form a hexagonal hydrocarbon ring represented by Formula 3. Compound F1 to Compound F100 in Compound Group 2 correspond to structures in which R_6 and R_7 , and R_8 and R_9 are respectively combined with each other to form hexagonal hydrocarbon rings represented by Formula 3.

[0116] The amine compound according to an embodiment of the present disclosure includes a condensed ring including a pyridoindole moiety, and may be used as a material for an organic electroluminescence device showing good thermal/charge tolerance and/or excellent emission efficiency. When position R_8 in the pyridoindole moiety represented by Formula 2 is not substituted with an arylamine moiety, the

compound may have a stable molecular structure. When position R_1 in the pyridoindole moiety represented by Formula 2 is not substituted with an arylamine moiety, the efficiency and life characteristics of an organic electroluminescence device including the amine compound may be improved.

Formula 2



[0117] In the organic electroluminescence device **10** according to an embodiment of the present disclosure, as shown in FIG. 1 to FIG. 3, a hole transport region (HTR) may include one kind (species), or two or more kinds (species) of the amine compounds represented in Compound Group 1 and Compound Group 2. The hole transport region HTR may further include any suitable material available in the art, in addition to the amine compound.

[0118] The hole transport region HTR of the organic electroluminescence device **10** according to an embodiment of the present disclosure may include the amine compound according to an embodiment of the present disclosure. When

the hole transport region HTR includes a plurality of organic layers, the amine compound according to an embodiment of the present disclosure may be included in an organic layer that is adjacent to the emission layer EML.

[0119] For example, the amine compound according to an embodiment of the present disclosure may be included in the hole transport layer HTL of the hole transport region HTR. When the hole transport layer HTL includes a plurality of organic layers, the amine compound according to an embodiment of the present disclosure may be included in an organic layer that is adjacent to the emission layer EML.

[0120] For example, when the hole transport region HTR of the organic electroluminescence device **10** according to an embodiment of the present disclosure includes a hole injection layer HIL and a hole transport layer HTL, the amine compound according to an embodiment of the present disclosure may be included in the hole transport layer HTL. When the hole transport region HTR of the organic electroluminescence device according to an embodiment of the present disclosure includes a hole injection layer HIL, a hole transport layer HTL, and an electron blocking layer EBL, the amine compound according to an embodiment of the present disclosure may be included in the electron blocking layer EBL.

[0121] In the organic electroluminescence device **10** according to an embodiment of the present disclosure, if the hole transport layer HTL includes the amine compound according to an embodiment of the present disclosure, the hole injection layer HIL may include any suitable hole injection material. For example, the hole injection layer HIL may include triphenylamine-containing polyetherketone (TPAPEK), 4-isopropyl-4'-methyl diphenyliodonium tetrakis(pentafluorophenyl)borate (PPBI), N,N'-diphenyl-N,N'-bis[4-(phenyl-m-tolyl-amino)-phenyl]-phenyl-4,4'-diamine (DNTPD), a phthalocyanine compound (such as copper phthalocyanine), 4,4',4''-tris(3-methyl phenyl phenylamino) triphenylamine (m-MTDATA), N,N'-di(1-naphthyl)-N,N'-diphenylbenzidine (NPB), N,N'-bis(1-naphthyl)-N,N'-diphenyl-4,4'-diamine (α -NPD), 4,4',4''-tris(N,N'-diphenylamino) triphenylamine (TDATA), 4,4',4''-tris(N,N'-2-naphthyl phenylamino) triphenylamine (2-TNATA), polyaniline/dodecylbenzenesulfonic acid (PANI/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (PANI/CSA), polyaniline/poly(4-styrenesulfonate) (PANI/PSS), or dipyrzino[2,3-f: 2',3'-h]quinoxaline-2,3,6,7,10,11-hexacarbonitrile (HAT-CN). However, embodiments of the present disclosure are not limited thereto.

[0122] Meanwhile, the hole transport layer HTL of the organic electroluminescence device **10** according to an embodiment of the present disclosure may further include any suitable hole transport material in addition to the amine compound. For example, the hole transport layer HTL may include 1,1-bis[(di-4-tolylamino)phenyl]cyclohexane (TAPC), carbazole derivatives (such as N-phenyl carbazole and/or polyvinyl carbazole), fluorine-based derivatives, N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), triphenylamine-based derivatives (such as 4,4',4''-tris(N-carbazolyl) triphenylamine (TCTA)), N,N'-di(1-naphthalene-1-yl)-N,N'-diphenylbenzidine (NPB), 4,4'-cyclohexylidene bis[N,N-bis(4-methylphenyl)benzenamine] (TAPC), 4,4'-bis[N,N'-(3-tolyl)amino]-3,3'-dimeth-

ylbiphenyl (HMTPD), 1,3-bis(N-carbazolyl)benzene (mCP), etc. However, embodiments of the present disclosure are not limited thereto.

[0123] As described above, in the organic electroluminescence device **10** according to an embodiment of the present disclosure, the hole transport region HTR may further include at least one selected from a hole buffer layer and an electron blocking layer EBL, in addition to the hole injection layer HIL and the hole transport layer HTL. The hole buffer layer may compensate for an optical resonance distance according to the wavelength of light emitted from an emission layer EML (e.g., be used to adjust the optical resonance distance to match the wavelength of light emitted from the EML), and may thereby increase light emission efficiency. Materials that may be included in a hole transport region HTR may be included in a hole buffer layer.

[0124] When a hole transport region HTR further includes an electron blocking layer EBL between a hole transport layer HTL and an emission layer EML, the electron blocking layer EBL may play the role of preventing or reducing electron injection from an electron transport region ETR to a hole transport region HTR.

[0125] In the organic electroluminescence device **10** according to an embodiment of the present disclosure, when the hole transport region HTR includes an electron blocking layer EBL, the electron blocking layer EBL may include the amine compound according to an embodiment of the present disclosure. The electron blocking layer EBL may include any suitable material available in the art in addition to the amine compound. The electron blocking layer EBL may include, for example, carbazole derivatives (such as N-phenylcarbazole and/or polyvinyl carbazole), fluorine-based derivatives, N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), triphenylamine-based derivatives (such as 4,4',4''-tris(N-carbazolyl) triphenylamine (TCTA)), N,N'-di(naphthalene-1-yl)-N,N'-diphenylbenzidine (NPB), 4,4'-cyclohexylidene bis[N,N-bis(4-methylphenyl)benzenamine] (TAPC), 4,4'-bis[N,N'-(3-tolyl)amino]-3,3'-dimethylbiphenyl (HMTPD), mCP, etc.

[0126] For example, in the organic electroluminescence device **10** according to an embodiment of the present disclosure, if the hole transport region HTR is a single layer, the hole transport region HTR may include the amine compound according to an embodiment of the present disclosure. In this case, the hole transport region HTR may further include any suitable hole injection material and/or hole transport material.

[0127] In some embodiments, in the organic electroluminescence device **10** according to an embodiment of the present disclosure, when the hole transport region HTR includes a plurality of layers, at least one layer among the plurality of layers included in the hole transport region HTR may include the amine compound according to an embodiment of the present disclosure. For example, the layer adjacent to the emission layer EML among the plurality of layers included in the hole transport region HTR may include the amine compound according to an embodiment of the present disclosure. Meanwhile, the layer(s) not including the amine compound according to an embodiment of the present disclosure may include any suitable hole injection material and/or hole transport material. In some embodiments, the layer including the amine compound according to

an embodiment of the present disclosure may further include any suitable hole injection material and/or hole transport material.

[0128] The thickness of the hole transport region HTR may be about 100 Å to about 10,000 Å, for example, about 100 Å to about 5,000 Å. The thickness of the hole injection region HIL may be, for example, about 30 Å to about 1,000 Å, and the thickness of the hole transport layer HTL may be about 30 Å to about 1,000 Å. For example, the thickness of the electron blocking layer EBL may be about 10 Å to about 1,000 Å. When the thicknesses of the hole transport region HTR, the hole injection layer HIL, the hole transport layer HTL, and the electron blocking layer EBL satisfy the above-described ranges, satisfactory hole transport properties may be achieved without a substantial increase in driving voltage.

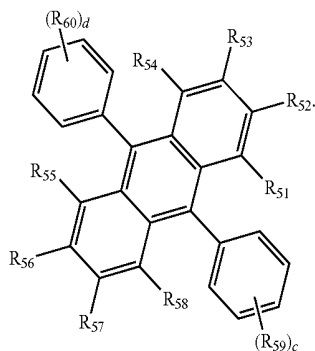
[0129] In some embodiments, the hole transport region HTR may further include a charge generating material in addition to the above-described materials to increase conductivity. The charge generating material may be dispersed uniformly (e.g., substantially uniformly) or non-uniformly in the hole transport region HTR. The charge generating material may be, for example, a p-dopant. The p-dopant may be a quinone derivative, metal oxide, or cyano group-containing compound, without limitation. For example, non-limiting examples of the p-dopant include quinone derivatives (such as tetracyanoquinodimethane (TCNQ) and/or 2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane (F4-TCNQ)), and metal oxides (such as tungsten oxide and/or molybdenum oxide), without limitation.

[0130] The emission layer EML is on the hole transport region HTR. The thickness of the emission layer EML may be, for example, about 100 Å to about 300 Å. The emission layer EML may have a single layer structure formed using a single material, a single layer structure formed using a plurality of different materials, or a multilayer structure having a plurality of layers formed using a plurality of different materials.

[0131] The emission layer EML may be to emit at least one selected from red, green, blue, white, yellow, and cyan light. The emission layer EML may include a fluorescence-emitting material and/or a phosphorescence-emitting material.

[0132] In the organic electroluminescence device 10 according to an embodiment of the present disclosure, the emission layer EML may include anthracene derivatives, pyrene derivatives, fluoranthene derivatives, fluoranthene derivatives, chrysene derivatives, dihydrobenzanthracene derivatives, and/or triphenylene derivatives. For example, the emission layer EML may include an anthracene derivative and/or a pyrene derivative.

[0133] In some embodiments, the emission layer EML may include an anthracene derivative represented by Formula 4:

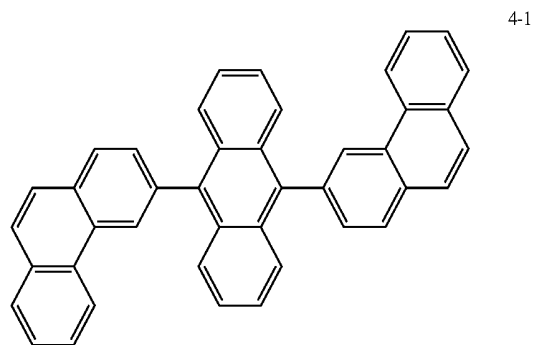


Formula 4

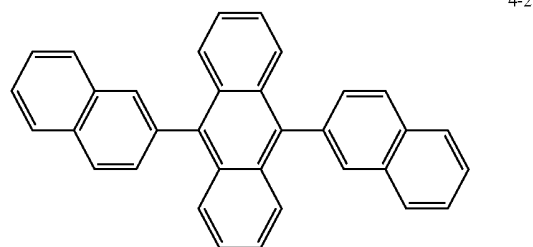
[0134] In Formula 4, R_{51} to R_{60} may each independently be a hydrogen atom, a deuterium atom, a halogen atom, a substituted or unsubstituted silyl group, a substituted or unsubstituted alkyl group of 1 to 10 carbon atoms, a substituted or unsubstituted aryl group of 6 to 30 carbon atoms for forming a ring, or a substituted or unsubstituted heteroaryl group of 2 to 30 carbon atoms for forming a ring, or may be combined with an adjacent group to form a ring. In some embodiments, R_{51} to R_{60} may be combined with an adjacent group to form a saturated hydrocarbon ring or an unsaturated hydrocarbon ring.

[0135] In Formula 4, “c” and “d” may each independently be an integer of 0 to 5.

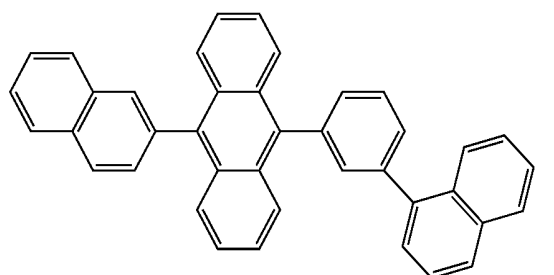
[0136] In some embodiments, the anthracene derivative represented by Formula 4 may be further represented by one of Formula 4-1 to Formula 4-6:



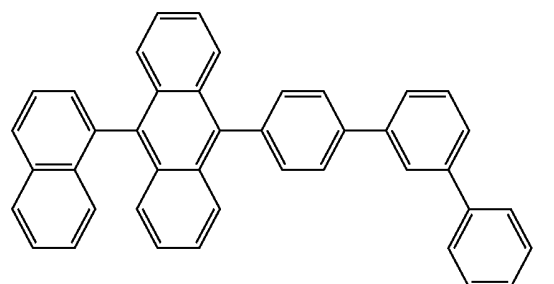
4-1



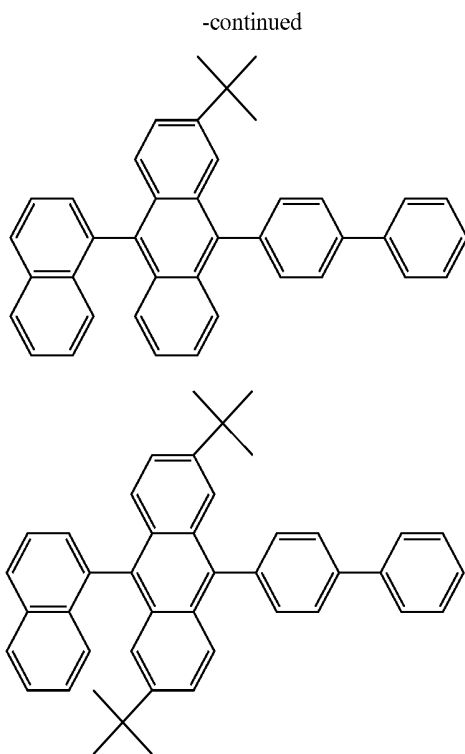
4-2



4-3



4-4



[0137] In the organic electroluminescence device **10** according to an embodiment of the present disclosure, as shown in FIG. 1 to FIG. 3, the emission layer EML may include a host and a dopant, and the emission layer EML may include the compound represented by Formula 4 as a host material.

[0138] The emission layer EML may further include any suitable material in the art as a host material. For example, at least one selected from bis[2-(diphenylphosphino)phenyl] ether oxide (DPEPO), 4,4'-bis(carbazol-9-yl)biphenyl (CBP), 1,3-bis(carbazol-9-yl)benzene (mCP), 2,8-bis(diphenylphosphoryl)dibenzo[b,d]furan (PPF), 4,4',4''-tris(carbazol-9-yl)-triphenylamine (TcTa), 1,3,5-tris(N-phenylbenzimidazole-2-yl)benzene (TPBi), tris(8-hydroxyquinolino)aluminum (Alq₃), 4,4'-bis(N-carbazolyl)-1,1'-biphenyl (CBP), poly(N-vinylcarbazole) (PVK), 9,10-di(naphthalen-2-yl)anthracene (ADN), 4,4',4''-tris(carbazol-9-yl)-triphenylamine (TCTA), 1,3,5-tris(N-phenylbenzimidazole-2-yl)benzene (TPBi), 3-tert-butyl-9,10-di(naphth-2-yl)anthracene (TBADN), distyrylarylene (DSA), 4,4'-bis(9-carbazolyl)-2,2'-dimethyl-biphenyl (CDBP), 2-methyl-9,10-bis(naphthalen-2-yl)anthracene (MADN), bis[2-(diphenylphosphino)phenyl]ether oxide (DPEPO), hexaphenyl cyclotriphosphazene (CP1), 1,4-bis(triphenylsilyl)benzene (UGH2), hexaphenylcyclotrisiloxane (DPSiO₃), octaphenylcyclotetrasiloxane (DPSiO₄), and 2,8-bis(diphenylphosphoryl)dibenzofuran (PPF), etc. may be used as the host material. However, embodiments of the present disclosure are not limited thereto.

[0139] In some embodiments, the emission layer EML may include any suitable dopant material, for example, styryl derivatives (such as 1,4-bis[2-(3-N-ethylcarbazolyl)vinyl]benzene (BCzVB), 4-(di-p-tolylamino)-4'-[(di-p-tolylamino)styryl]stilbene (DPAVB), and N-(4-((E)-2-(6-((E)-4-(diphenylamino)styryl)naphthalen-2-Avinyl)phenyl)-N-phenylbenzenamine (N-BDAVB)), perylene and

derivatives thereof (such as, 2,5,8,11-tetra-t-butylperylene (TBP)), pyrene and derivatives thereof (such as, 1,1-dipyrene, 1,4-dipyrenylbenzene, and/or 1,4-bis(N,N-diphenylamino)pyrene), etc.

[0140] In some embodiments, when the emission layer EML is to emit red light, the emission layer EML may further include a fluorescence material including tris(dibenzoylmethanato)phenanthroline europium (PBD:Eu(DBM)₃ (Phen)) and/or perylene. If the emission layer EML is to emit red light, the dopant included in the emission layer EML may be selected from, for example, a metal complex or organometallic complex (such as bis(1-phenylisoquinoline)acetylacetonate iridium (PIQIr(acac)), bis(1-phenylquinoline)acetylacetonate iridium (PQIr(acac)), tris(1-phenylquinoline)iridium (PQIr), and octaethylporphyrin platinum (PtOEP)), rubrene and derivatives thereof, and 4-dicyanomethylene-2-(p-dimethylaminostyryl)-6-methyl-4H-pyran (DCM) and derivatives thereof.

[0141] In some embodiments, when the emission layer EML is to emit green light, the emission layer EML may further include a fluorescence material including tris(8-hydroxyquinolino)aluminum (Alq₃). If the emission layer EML is to emit green light, the dopant included in the emission layer EML may be selected from, for example, a metal complex or organometallic complex (such as fac-tris(2-phenylpyridine)iridium (Ir(ppy)₃)), and coumarin and derivatives thereof.

[0142] In some embodiments, when the emission layer EML is to emit blue light, the emission layer EML may further include a fluorescence material including, for example, one selected from the group consisting of spiro-DPVBi, spiro-6P, distyryl-benzene (DSB), distyryl-arylene (DSA), a polyfluorene (PFO)-based polymer, and a poly(p-phenylene vinylene) (PPV)-based polymer. If the emission layer EML is to emit blue light, the dopant included in the emission layer EML may be selected from a metal complex or organometallic complex (such as (4,6-F2ppy)₂Irpic), and perylene and derivatives thereof.

[0143] In some embodiments, the emission layer EML of the organic electroluminescence device **10** according to an embodiment of the present disclosure may be to emit blue light and/or green light. The emission layer EML may emit blue light at a wavelength of about 450 nm to about 480 nm and/or green light at a wavelength of about 490 nm to about 560 nm.

[0144] In the organic electroluminescence device **10** according to an embodiment of the present disclosure, the electron transport region ETR is provided on the emission layer EML. The electron transport region ETR may include at least one selected from a hole blocking layer HBL, an electron transport layer ETL, and an electron injection layer EIL. However, embodiments of the present disclosure are not limited thereto.

[0145] The electron transport region ETR may have a single layer formed using a single material, a single layer formed using a plurality of different materials, or a multi-layer structure having a plurality of layers formed using a plurality of different materials.

[0146] In some embodiments, for example, the electron transport region ETR may have a single layer structure including an electron injection layer EIL or an electron transport layer ETL, or a single layer structure formed using both of an electron injection material and an electron transport material. In some embodiments, the electron transport

region ETR may have a single layer structure composed of a plurality of different materials, or a multi-layer structure laminated on the emission layer EML of electron transport layer ETL/electron injection layer EIL, or hole blocking layer HBL/electron transport layer ETL/electron injection layer EIL, without limitation. The thickness of the electron transport region ETR may be, for example, about 100 Å to about 1,500 Å.

[0147] The electron transport region ETR may be formed using any suitable method (such as a vacuum deposition method, a spin coating method, a cast method, a Langmuir-Blodgett (LB) method, an inkjet printing method, a laser printing method, and/or a laser induced thermal imaging (LITI) method).

[0148] In some embodiments, when the electron transport region ETR includes an electron transport layer ETL, the electron transport region ETR may include, for example, tris(8-hydroxyquinolino)aluminum (Alq3), 1,3,5-tri(3-pyridyl)-phen-3-yl]benzene, 2,4,6-tris(3'-(pyridin-3-yl)biphenyl-3-yl)-1,3,5-triazine, 2-(4-(N-phenylbenzimidazolyl-1-ylphenyl)-9,10-dinaphthylanthracene, 1,3,5-tri(1-phenyl-1H-benzo[d]imidazol-2-yl)benzene (TPBi), 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP), 4,7-diphenyl-1,10-phenanthroline (Bphen), 3-(4-biphenyl)-4-phenyl-5-tert-butylphenyl-1,2,4-triazole (TAZ), 4-(naphthalen-1-yl)-3,5-diphenyl-4H-1,2,4-triazole (NTAZ), 2-(4-biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (tBu-PBD), bis(2-methyl-8-quinolino-N1,O8)-(1,1'-biphenyl-4-olato)aluminum (BALq), beryllium bis(benzoquinolin-10-olate) (Bebq2), 9,10-di(naphthalene-2-yl)anthracene (ADN), or a mixture thereof, without limitation.

[0149] In some embodiments, when the electron transport region ETR includes the electron transport layer ETL, the thickness of the electron transport layer ETL may be about 100 Å to about 1,000 Å, for example, about 150 Å to about 500 Å. When the thickness of the electron transport layer ETL satisfies the above-described range, satisfactory electron transport properties may be obtained without a substantial increase in driving voltage.

[0150] In some embodiments, when the electron transport region ETR includes the electron injection layer EIL, the electron transport region ETR may include, for example, LiF, 8-hydroxyquinolino-lithium (LiQ), Li₂O, BaO, NaCl, CsF, a lanthanide metal (such as Yb), and/or a metal halide (such as RbCl, RbI, and/or KI). However, embodiments of the present disclosure are not limited thereto. The electron injection layer EIL may be formed using a mixture of an electron transport material and an insulating organo metal salt. The organo metal salt may have an energy band gap of about 4 eV or more. The organo metal salt may include, for example, metal acetates, metal benzoates, metal acetoacetates, metal acetylacetonates, and/or metal stearates.

[0151] In some embodiments, when the electron transport region ETR includes the electron injection layer EIL, the thickness of the electron injection layer EIL may be about 1 Å to about 100 Å, or about 3 Å to about 90 Å. When the thickness of the electron injection layer EIL satisfies the above described range, suitable electron injection properties may be obtained without inducing a substantial increase in driving voltage.

[0152] The electron transport region ETR may include a hole blocking layer HBL as described above. The hole blocking layer HBL may include, for example, at least one selected from 2,9-dimethyl-4,7-diphenyl-1,10-phenanthro-

line (BCP) and 4,7-diphenyl-1,10-phenanthroline (Bphen). However, embodiments of the present disclosure are not limited thereto.

[0153] The second electrode EL2 is on the electron transport region ETR. The second electrode EL2 may be conductive. The second electrode EL2 may be formed using a metal alloy and/or a conductive compound. The second electrode EL2 may be a cathode. The second electrode EL2 may be a transmissive electrode, a transfective electrode, or a reflective electrode. When the second electrode EL2 is a transmissive electrode, the second electrode EL2 may include a transparent metal oxide, for example, ITO, IZO, ZnO, ITZO, etc.

[0154] When the second electrode EL2 is a transfective electrode or a reflective electrode, the second electrode EL2 may include Ag, Mg, Cu, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, Li, Ca, LiF/Ca, LiF/Al, Mo, Ti, a compound thereof, or a mixture thereof (for example, a mixture of Ag and Mg). The second electrode EL2 may have a multilayered structure including a reflective layer or a transfective layer formed using the above-described materials, and a transparent conductive layer formed using ITO, IZO, ZnO, ITZO, etc.

[0155] In some embodiments, the second electrode EL2 may be connected with an auxiliary electrode. When the second electrode EL2 is connected with the auxiliary electrode, the resistance of the second electrode EL2 may decrease.

[0156] In the organic electroluminescence device 10, upon application of a voltage across the first electrode EL1 and second electrode EL2, holes injected from the first electrode EL1 may move via the hole transport region HTR to the emission layer EML, and electrons injected from the second electrode EL2 may move via the electron transport region ETR to the emission layer EML. The electrons and the holes may recombine in the emission layer EML to produce excitons, and the excitons may emit light upon transition from an excited state to the ground state.

[0157] In some embodiments, when the organic electroluminescence device 10 is a top emission device, the first electrode EL1 may be a reflective electrode and the second electrode EL2 may be a transmissive electrode or a transfective electrode. In some embodiments, when the organic electroluminescence device 10 is a bottom emission device, the first electrode EL1 may be a transmissive electrode or a transfective electrode and the second electrode EL2 may be a reflective electrode.

[0158] The amine compound according to an embodiment of the present disclosure may be included in the organic electroluminescence device 10 according to an embodiment of the present disclosure. The organic electroluminescence device 10 according to an embodiment of the present disclosure may include the amine compound in at least one organic layer between the first electrode EL1 and the second electrode EL2, or in a capping layer on the second electrode EL2.

[0159] In some embodiments, the organic electroluminescence device 10 according to an embodiment of the present disclosure may include the amine compound in at least one organic layer between the first electrode EL1 and the second electrode EL2, and excellent emission efficiency and high reliability may be achieved. For example, the organic electroluminescence device 10 according to an embodiment of the present disclosure may include the amine compound in

a hole transport region HTR and may show high emission efficiency and/or improved life characteristics.

[0160] For example, when the organic electroluminescence device according to an embodiment of the present disclosure includes the amine compound according to an embodiment of the present disclosure in an organic layer adjacent to the emission layer, the hole transport region may maintain high hole transport capacity while restraining the movement of electrons, thereby enabling improved emission efficiency.

[0161] When an amine compound including both a pyridoindole moiety and an arylamine moiety (e.g., simultaneously) is included in a hole transport region, the amine compound may have excellent reliability, and the organic electroluminescence device according to an embodiment of the present disclosure may thus show excellent life characteristics. In some embodiments, the nitrogen atom included in the pyridoindole moiety may improve the hole transport capacity of the entire amine compound structure, and the probability of recombination of holes and electrons in the emission layer of an organic electroluminescence device may be increased. Accordingly, the amine compound according to an embodiment of the present disclosure may enable improved emission efficiency.

[0162] Hereinafter, an amine compound according to embodiments of the present disclosure and an organic electroluminescence device including the amine compound according to an embodiment of the present disclosure will be explained in more detail with reference to example embodiments and comparative embodiments. The following embodiments are provided only as illustrations to assist the understanding of the present disclosure, and the scope of embodiments of the present disclosure is not limited thereto.

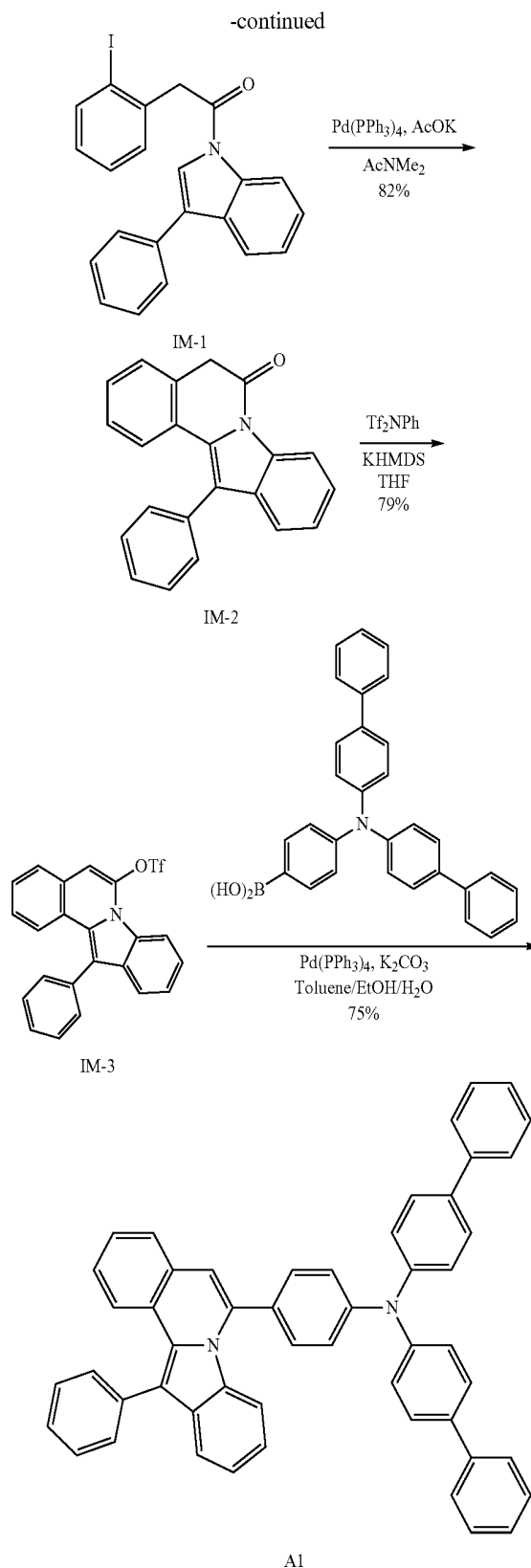
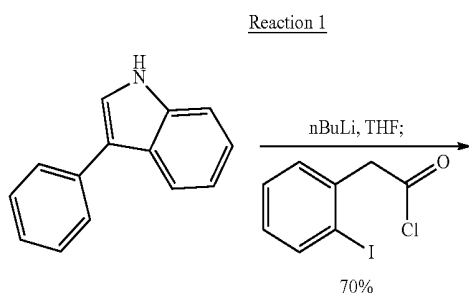
Examples

1. Synthesis of Amine Compound

[0163] Suitable synthetic methods for the amine compound according to embodiments of the present disclosure will be explained with reference to Compound A1, Compound A28, Compound A57, Compound B36, Compound B46, Compound C47, Compound C87, Compound D47, Compound D60, Compound D74, Compound E6, Compound E25, Compound E55, Compound E73, Compound E89, Compound F21, Compound F63, and Compound F82 in Compound Group 1. The synthetic methods are provided as example embodiments, and synthetic methods of an amine compound according to an embodiment of the present disclosure are not limited thereto.

Synthesis of Compound A1

[0164] Amine Compound A1 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 1:



Synthesis of Intermediate IM-1

[0165] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 20.00 g (103.5 mmol) of 3-phenyl-1H-indole and

345 mL (0.3 M) of THF were added while stirring at a temperature of about -78°C ., and 72 mL (1.1 eq) of a $n\text{BuLi}/n\text{-hexane}$ solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature conditions, a THF solution (28.5 mL, 1 mol/L) of 31.94 g (1.1 eq, 113.8 mmol) of 2-(2-iodophenyl)acetyl chloride was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-1 (31.68 g, yield 70%). As measured by FAB-MS, mass number $m/z=437$ was observed as a molecular ion peak and Intermediate IM-1 was identified.

Synthesis of Intermediate IM-2

[0166] Under an argon atmosphere, to a three-neck, 500 mL flask, 25.00 g (57.2 mmol) of Intermediate IM-1, 8.42 g (1.5 eq, 85.8 mmol) of potassium acetate, 3.30 g (0.05 eq, 2.9 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 228 mL (0.25 M) of N,N -dimethylacetamide were added in order, and stirred while heating at about 80°C .. After securing the disappearance of raw materials, the reaction solution was air cooled to room temperature, water was added to the reaction solution, and extraction with toluene was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-2 (14.50 g, yield 82%). As measured by FAB-MS, mass number $m/z=309$ was observed as a molecular ion peak and Intermediate IM-2 was identified.

Synthesis of Intermediate IM-3

[0167] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (32.3 mmol) of IM-2 and 108 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 35.6 mL (1.1 eq) of a KHMDs/THF solution of 1.0 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (10.0 mL, 1 mol/L) of 13.86 g (1.2 eq, 38.8 mmol) of N,N' -bis(trifluoromethanesulfonyl)aniline was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After that, 10% NaOH aqueous solution was added thereto, and the reaction solution was extracted with AcOEt . The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained, i.e., Intermediate IM-3 (11.27 g, yield 79%) was used without further purification in the subsequent reaction. As measured

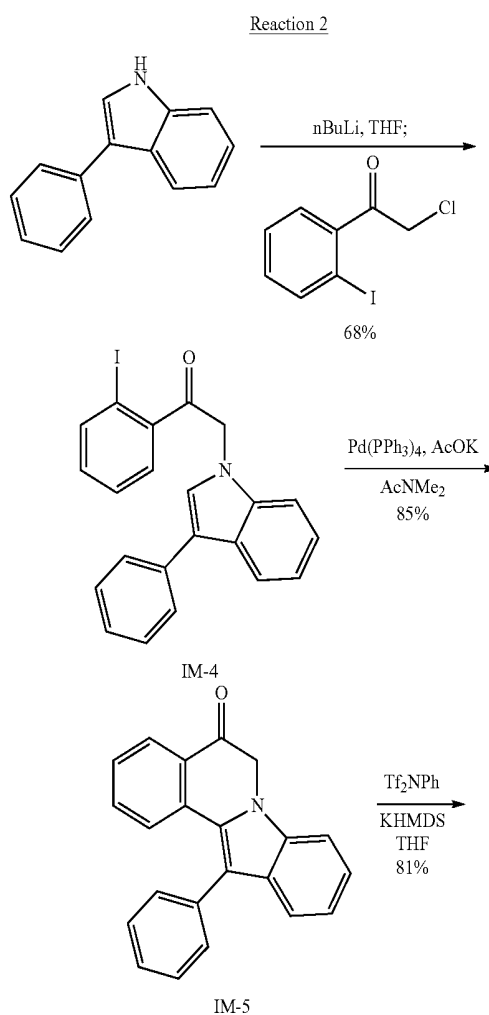
by FAB-MS, mass number $m/z=441$ was observed as a molecular ion peak and Intermediate IM-3 was identified.

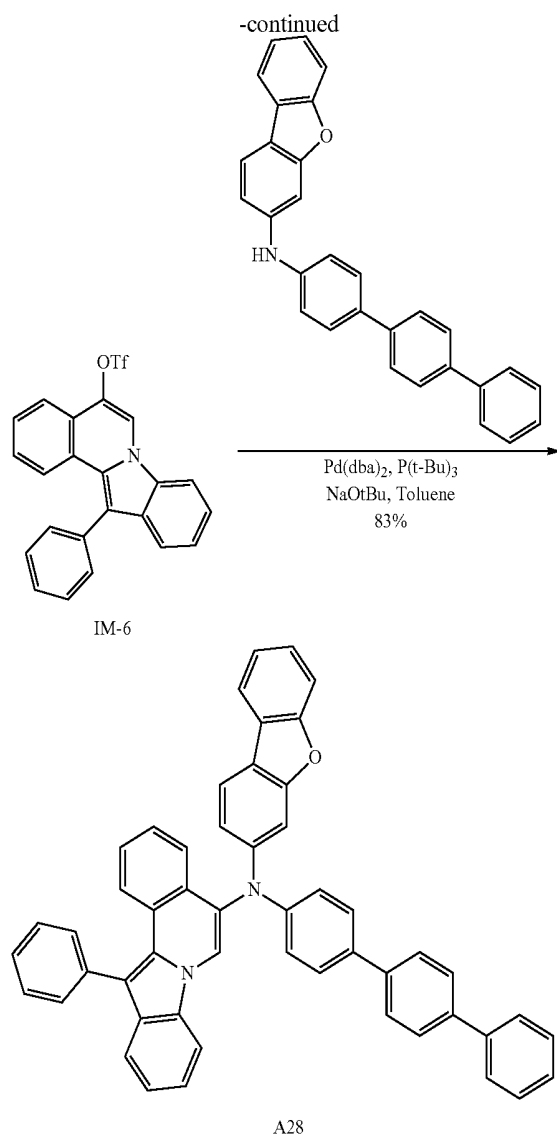
Synthesis of Compound A1

[0168] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (22.7 mmol) of Intermediate IM-3, 11.00 g (1.1 eq, 24.9 mmol) of 4-{di[(1,1'-biphenyl)-4-yl]amino}phenylboronic acid, 9.39 g (3.0 eq, 68.0 mmol) of K_2CO_3 , 1.31 g (0.05 eq, 1.1 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 159 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating to about 80°C .. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound A1 (11.70 g, yield 75%) as a white solid. As measured by FAB-MS, mass number $m/z=688$ was observed as a molecular ion peak and Compound A1 was identified.

Synthesis of Compound A28

[0169] Amine Compound A28 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 2:





Synthesis of Intermediate IM-4

[0170] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 20.00 g (103.5 mmol) of 3-phenyl-1H-indole and 345 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 72 mL (1.1 eq) of a *n*BuLi/*n*-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (28.5 mL, 1 mol/L) of 31.94 g (1.1 eq, 113.8 mmol) of 2-chloro-1-(2-iodophenyl)ethanone was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and stirring was additionally performed for about 2 hours. After securing the disappearance of raw materials, the reaction solution was cooled with water and extraction with toluene was performed. Then, the aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to

obtain Intermediate IM-4 (30.77 g, yield 68%). As measured by FAB-MS, mass number $m/z=437$ was observed as a molecular ion peak and Intermediate IM-4 was identified.

Synthesis of Intermediate IM-5

[0171] Under an argon atmosphere, to a three-neck, 500 mL flask, 25.00 g (57.2 mmol) of Intermediate IM-4, 8.42 g (1.5 eq, 85.8 mmol) of potassium acetate, 3.30 g (0.05 eq, 2.9 mmol) of $\text{Pd(PPh}_3)_4$, and 228 mL (0.25 M) of *N,N*-dimethylacetamide were added in order, and stirred while heating at about 80°C . After securing the disappearance of raw materials, the reaction solution was air cooled to room temperature, water was added to the reaction solution, and extraction with toluene was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-5 (15.03 g, yield 85%). As measured by FAB-MS, mass number $m/z=309$ was observed as a molecular ion peak and Intermediate IM-5 was identified.

Synthesis of Intermediate IM-6

[0172] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (32.3 mmol) of IM-5 and 108 mL (0.3 M) of THF were added, and 35.6 mL (1.1 eq) of a KHMDS/THF solution of 1.0 mol/L was added dropwise thereto while stirring at about -78°C . After stirring for about 1 hour at the same temperature, a THF solution (10.0 mL, 1 mol/L) of 13.86 g (1.2 eq, 38.8 mmol) of *N,N'*-bis(trifluoromethanesulfonyl)aniline was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After that, 10% NaOH aqueous solution was added thereto, and the reaction solution was extracted with AcOEt. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and an organic layer was concentrated, and the crude product thus obtained, i.e., Intermediate IM-6 (11.56 g, yield 81%) was used without further purification in the subsequent reaction. As measured by FAB-MS, mass number $m/z=441$ was observed as a molecular ion peak and Intermediate IM-6 was identified.

Synthesis of Compound A28

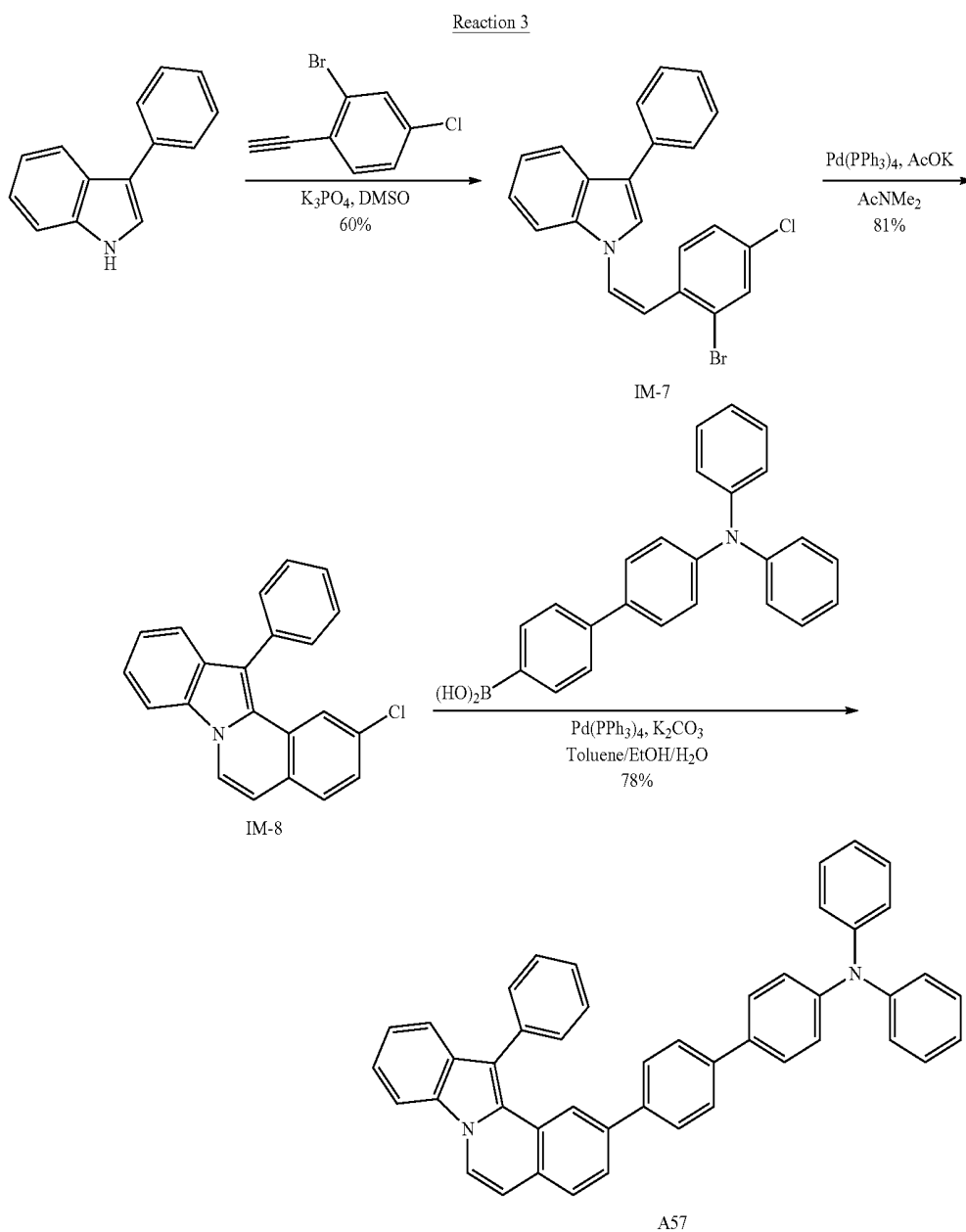
[0173] Under an argon atmosphere, to a three-neck, 200 mL flask, 10.00 g (18.5 mmol) of Intermediate IM-6, 0.39 g (0.03 eq, 0.7 mmol) of Pd(dba)_2 , 4.35 g (2.0 eq, 45.3 mmol) of *n*BuLi, 113 mL of toluene, 10.25 g (1.1 eq, 24.9 mmol) of *N*-[(1,1':4',1''-terphenyl)-4-yl]dibenzofuran-3-amine, and 0.46 g (0.1 eq, 2.3 mmol) of $t\text{Bu}_3\text{P}$ were added in order, followed by refluxing while heating and stirring. The reaction solution was air cooled to room temperature. Water was added to the reaction solution and the organic layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected and washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using

a mixture of hexane and toluene as a developing solution) to obtain Compound A28 (13.22 g, yield 83%) as a white solid. As measured by FAB-MS, mass number $m/z=702$ was observed as a molecular ion peak and Compound A28 was identified.

Synthesis of Compound A57

[0174] Amine Compound A57 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 3:

(0.2 M) of DMSO were added in order and heated to 120° C. while stirring. After securing the disappearance of raw materials, the reaction solution was air cooled to room temperature, water was added to the reaction solution, and extraction with toluene was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column



Synthesis of Intermediate IM-7

[0175] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (77.6 mmol) of 3-phenyl-1H-indole, 25.09 g (1.5 eq, 116.4 mmol) of 1-bromo-5-chloro-2-ethynylbenzene, 32.97 g (2.0 eq, 155.2 mmol) of K_3PO_4 , and 215 mL

chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-7 (19.03 g, yield 60%). As measured by FAB-MS, mass number $m/z=408$ was observed as a molecular ion peak and Intermediate IM-7 was identified.

Synthesis of Intermediate IM-8

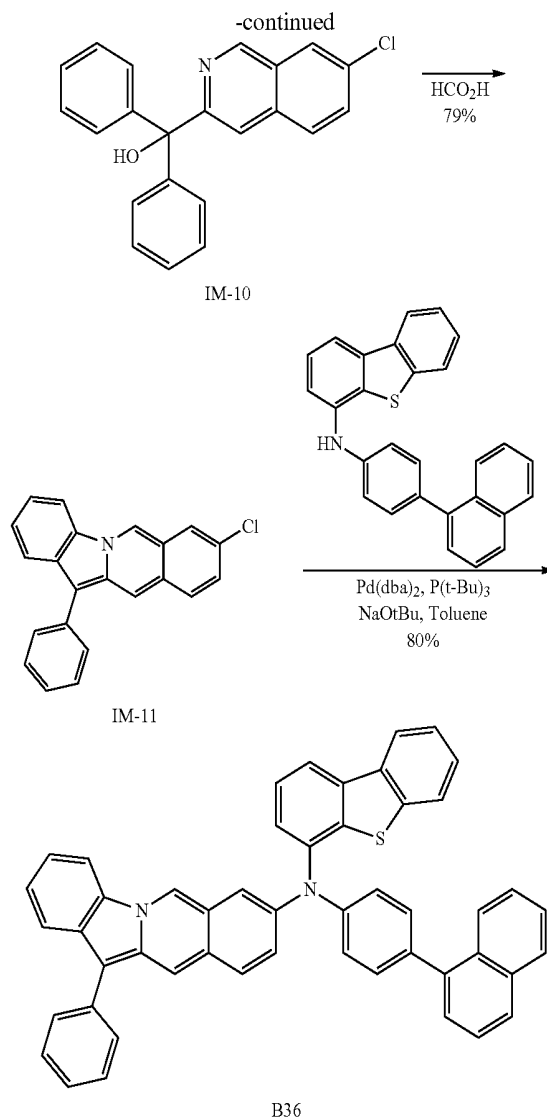
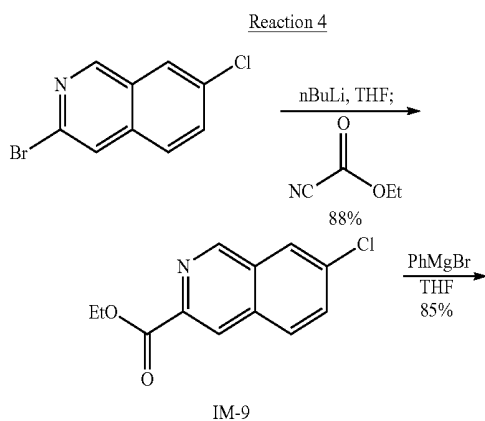
[0176] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (36.7 mmol) of Intermediate IM-7, 5.40 g (1.5 eq, 55.0 mmol) of potassium acetate, 2.12 g (0.05 eq, 1.8 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 146 mL (0.25 M) of *N,N*-dimethylacetamide were added in order, and stirred while heating to about 80° C. After securing the disappearance of raw materials, the reaction solution was air cooled to room temperature, water was added to the reaction solution, and extraction with toluene was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-8 (9.74 g, yield 81%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-8 was identified.

Synthesis of Compound A57

[0177] Under an argon atmosphere, to a three-neck, 500 mL flask, 8.00 g (24.4 mmol) of Intermediate IM-8, 9.80 g (1.1 eq, 26.8 mmol) of [4'-(diphenylamino)-1(1,1'-biphenyl)-4-yl]boronic acid, 10.12 g (3.0 eq, 73.2 mmol) of K_2CO_3 , 1.41 g (0.05 eq, 1.2 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 170 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. The reaction solution was air cooled to room temperature and extraction with toluene was performed. The aqueous layer was removed and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound A57 (11.66 g, yield 78%) as a white solid. As measured by FAB-MS, mass number $m/z=612$ was observed as a molecular ion peak and Compound A57 was identified.

Synthesis of Compound B36

[0178] Amine Compound B36 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 4:



Synthesis of Intermediate IM-9

[0179] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (82.5 mmol) of 3-bromo-7-chloroisoquinoline and 275 mL (0.3 M) of THF were added and while stirring at about -78° C., 56.7 mL (1.1 eq) of a *n*BuLi/*n*-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (23 mL, 1 mol/L) of 8.99 g (1.1 eq, 90.7 mmol) of ethyl cyanofornate was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and stirring was additionally performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extraction with toluene was performed. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-9 (17.10 g, yield 88%). As measured

by FAB-MS, mass number $m/z=235$ was observed as a molecular ion peak and Intermediate IM-9 was identified.

Synthesis of Intermediate IM-10

[0180] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (63.6 mmol) of Intermediate IM-9 and 213 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 159 mL (2.5 eq) of a PhMgBr/THF solution of 1.0 mol/L was added dropwise thereto. The stirring was performed at the same temperature for about 1 hour, and the temperature was elevated to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-10 (18.71 g, yield 85%). As measured by FAB-MS, mass number $m/z=345$ was observed as a molecular ion peak and Intermediate IM-10 was identified.

Synthesis of Intermediate IM-11

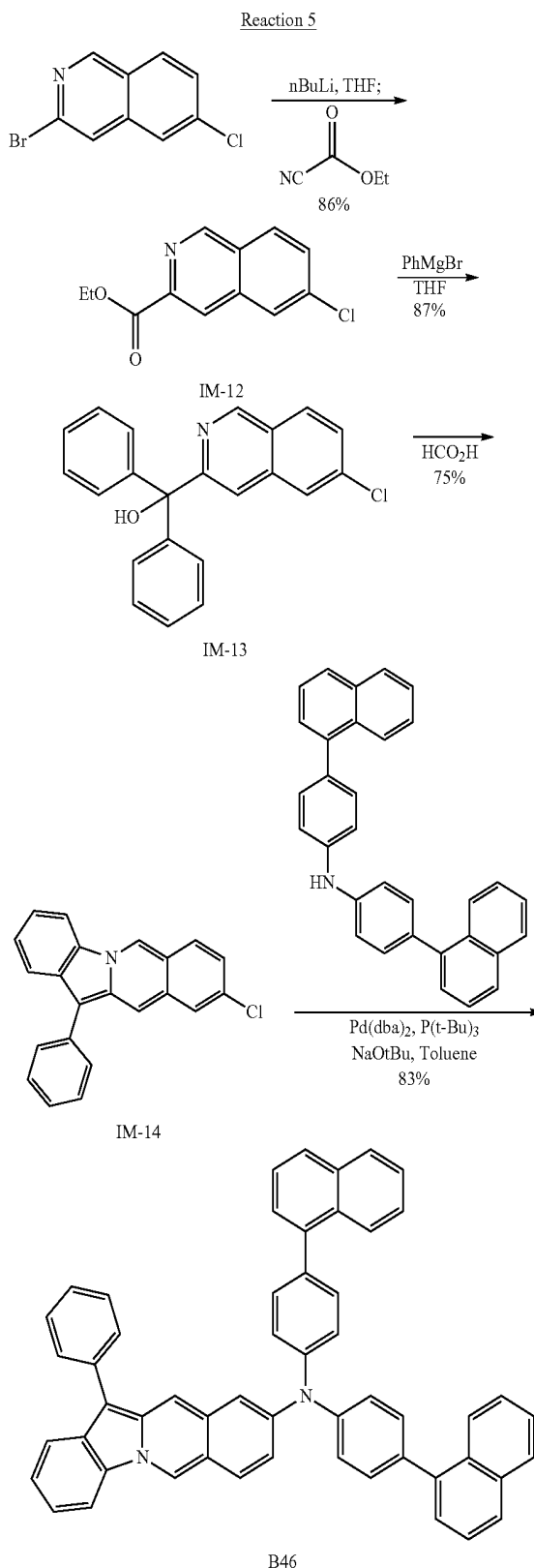
[0181] Under an argon atmosphere, to a three-neck, 300 mL flask, 15.00 g (43.4 mmol) of IM-10 and 145 mL (0.3 M) of formic acid were added, followed by heating and stirring at about 120°C . The reaction solution was air cooled to room temperature, further cooled with water, and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-11 (11.23 g, yield 79%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-11 was identified.

Synthesis of Compound B36

[0182] Under an argon atmosphere, to a three-neck, 200 mL flask, 5.00 g (15.3 mmol) of Intermediate IM-11, 0.26 g (0.03 eq, 0.5 mmol) of $\text{Pd}(\text{dba})_2$, 2.93 g (2.0 eq, 30.5 mmol) of NaOtBu , 76 mL of toluene, 6.74 g (1.1 eq, 16.8 mmol) of *N*-[4-(naphthalen-1-yl)phenyl]dibenzothiophene-4-amine, and 0.31 g (0.1 eq, 1.5 mmol) of $t\text{Bu}_3\text{P}$ were added in order, followed by refluxing while heating and stirring. The reaction solution was air cooled to room temperature. Water was added to the reaction solution and the organic layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected, washed with a saturated saline solution, and dried over MgSO_4 . MgSO_4 was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound B36 (8.45 g, yield 80%) as a white solid. As measured by FAB-MS, mass number $m/z=692$ was observed as a molecular ion peak and Compound B36 was identified.

Synthesis of Compound B46

[0183] Amine Compound B46 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 5:



Synthesis of Intermediate IM-12

[0184] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (82.5 mmol) of 3-bromo-7-chloroisoquinoline and 275 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 56.7 mL (1.1 eq) of a nBuLi/n-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (23 mL, 1 mol/L) of 8.99 g (1.1 eq, 90.7 mmol) of ethyl cyanofornate was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-12 (16.72 g, yield 86%). As measured by FAB-MS, mass number $m/z=235$ was observed as a molecular ion peak and Intermediate IM-12 was identified.

Synthesis of Intermediate IM-13

[0185] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (63.6 mmol) of Intermediate IM-12, and 213 mL (0.3 M) of THF were added and while stirring at about -78°C ., 159 mL (2.5 eq) of a PhMgBr/THF solution of 1.0 mol/L was added dropwise thereto. The stirring was performed at the same temperature for about 1 hour, the temperature was elevated to room temperature, and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-13 (19.15 g, yield 87%). As measured by FAB-MS, mass number $m/z=345$ was observed as a molecular ion peak and Intermediate IM-13 was identified.

Synthesis of Intermediate IM-14

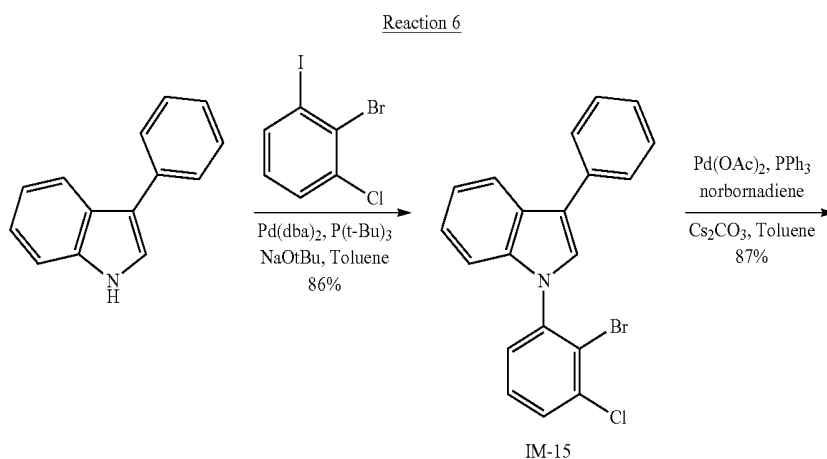
[0186] Under an argon atmosphere, to a three-neck, 300 mL flask, 15.00 g (43.4 mmol) of IM-13 and 145 mL (0.3 M) of formic acid were added, followed by heating and stirring at about 120°C . The reaction solution was air cooled to room temperature, further cooled with water, and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-14 (10.66 g, yield 75%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-14 was identified.

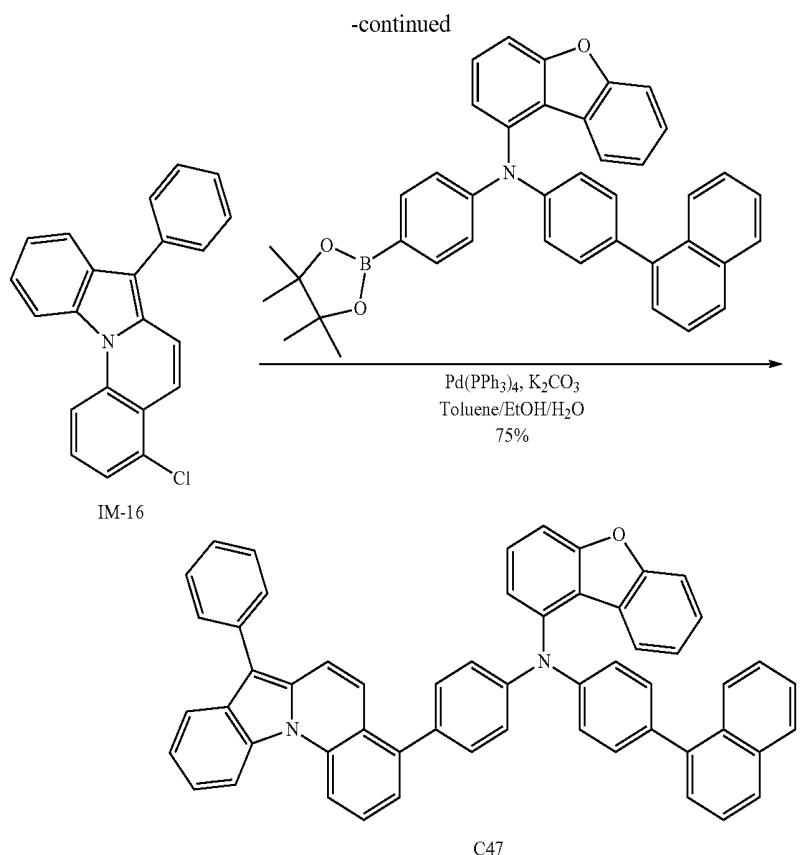
Synthesis of Compound B46

[0187] Under an argon atmosphere, to a three-neck, 200 mL flask, 5.00 g (15.3 mmol) of Intermediate IM-14, 0.26 g (0.03 eq, 0.5 mmol) of $\text{Pd}(\text{dba})_2$, 2.93 g (2.0 eq, 30.5 mmol) of NaOtBu , 76 mL of toluene, 7.07 g (1.1 eq, 16.8 mmol) of bis[4-(naphthalen-1-yl)phenyl]amine, and 0.31 g (0.1 eq, 1.5 mmol) of $t\text{Bu}_3\text{P}$ were added in order, followed by refluxing while heating and stirring. The reaction solution was air cooled to room temperature. Water was added to the reaction solution and the organic layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected and washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound B46 (9.03 g, yield 83%) as a white solid. As measured by FAB-MS, mass number $m/z=712$ was observed as a molecular ion peak and Compound B46 was identified.

Synthesis of Compound C47

[0188] Amine Compound C47 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 6:





Synthesis of Intermediate IM-15

[0189] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (77.6 mmol) of 3-phenyl-1H-indole, 1.34 g (0.03 eq, 2.3 mmol) of $\text{Pd}(\text{dba})_2$, 8.95 g (1.2 eq, 93.1 mmol) of NaO^tBu , 388 mL of toluene, 27.10 g (1.1 eq, 85.4 mmol) of 2-bromo-1-chloro-3-iodobenzene, and 1.57 g (0.1 eq, 7.8 mmol) of $t\text{Bu}_3\text{P}$ were added in order, followed by refluxing while heating and stirring. The reaction solution was air cooled to room temperature. Water was added to the reaction solution and an organic layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected and washed with a saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-15 (25.55 g, yield 86%). As measured by FAB-MS, mass number $m/z=382$ was observed as a molecular ion peak and Intermediate IM-15 was identified.

Synthesis of Intermediate IM-16

[0190] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (39.2 mmol) of Intermediate IM-15, 0.88 g (0.1 eq, 3.9 mmol) of $\text{Pd}(\text{OAc})_2$, 19.16 g (1.5 eq, 58.8 mmol) of Cs_2CO_3 , 196 mL of toluene, 14.45 g (4.0 eq, 156.8 mmol) of norbornadiene, and 2.26 g (0.22 eq, 8.6 mmol) of PPh_3 were added in order and refluxed at about 120° C. while stirring. After air cooling the reaction solution to room temperature, water was added to the reaction solution and an organic layer was isolated. Toluene was added to the aqueous

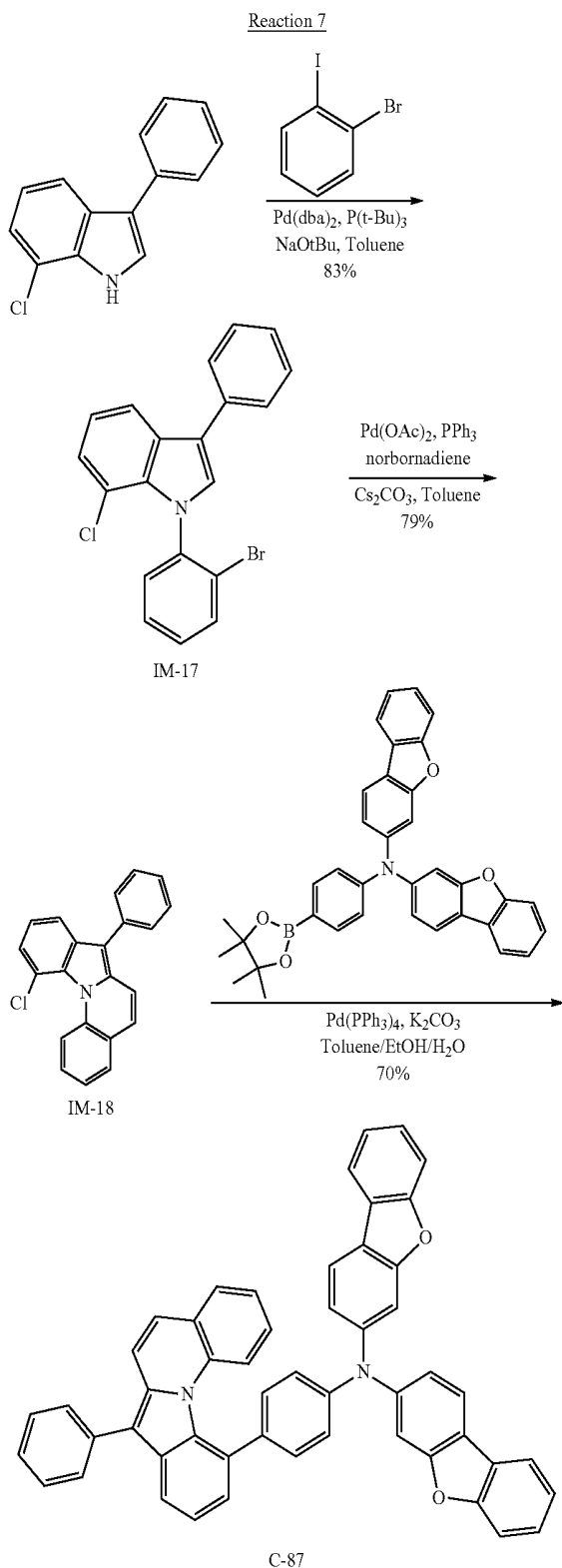
solution and additional organic layers were extracted. The organic layers were collected, washed with a saline solution, and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-16 (11.18 g, yield 87%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-16 was identified.

Synthesis of Compound C47

[0191] Under an argon atmosphere, to a three-neck, 500 mL flask, 8.00 g (24.4 mmol) of Intermediate IM-16, 15.77 g (1.1 eq, 26.8 mmol) of N -[4-(naphthalen-1-yl)phenyl]- N -[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]dibenzofuran-1-amine, 10.12 g (3.0 eq, 73.2 mmol) of K_2CO_3 , 1.41 g (0.05 eq, 1.2 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 170 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound C47 (13.78 g, yield 75%) as a white solid. As measured by FAB-MS, mass number $m/z=752$ was observed as a molecular ion peak and Intermediate C47 was identified.

Synthesis of Compound C87

[0192] Amine Compound C87 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 7:



Synthesis of Intermediate IM-17

[0193] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (65.9 mmol) of 7-chloro-3-phenyl-1H-indole, 1.14 g (0.03 eq, 2.0 mmol) of Pd(dba)₂, 7.60 g (1.2 eq, 79.1 mmol) of NaO^tBu, 388 mL of toluene, 20.50 g (1.1 eq, 72.5 mmol) of 1-bromo-2-iodobenzene, and 1.33 g (0.1 eq, 6.6 mmol) of ^tBu₃P were added in order, followed by refluxing while heating and stirring. After air cooling the reaction solution to room temperature, water was added to the reaction solution and an organic layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected, washed with a saline solution, and dried over MgSO₄. MgSO₄ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-17 (20.92 g, yield 83%). As measured by FAB-MS, mass number m/z=382 was observed as a molecular ion peak and Intermediate IM-17 was identified.

Synthesis of Intermediate IM-18

[0194] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (39.2 mmol) of Intermediate IM-17, 0.88 g (0.1 eq, 3.9 mmol) of Pd(OAc)₂, 19.16 g (1.5 eq, 58.8 mmol) of Cs₂CO₃, 196 mL of toluene, 14.45 g (4.0 eq, 156.8 mmol) of norbornadiene and 2.26 g (0.22 eq, 8.6 mmol) of PPh₃ were added in order and refluxed at about 120° C. while stirring. After air cooling the reaction solution to room temperature, water was added to the reaction solution and the aqueous layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected, washed with a saline solution, and dried over MgSO₄. MgSO₄ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-18 (10.15 g, yield 79%). As measured by FAB-MS, mass number m/z=327 was observed as a molecular ion peak and Intermediate IM-18 was identified.

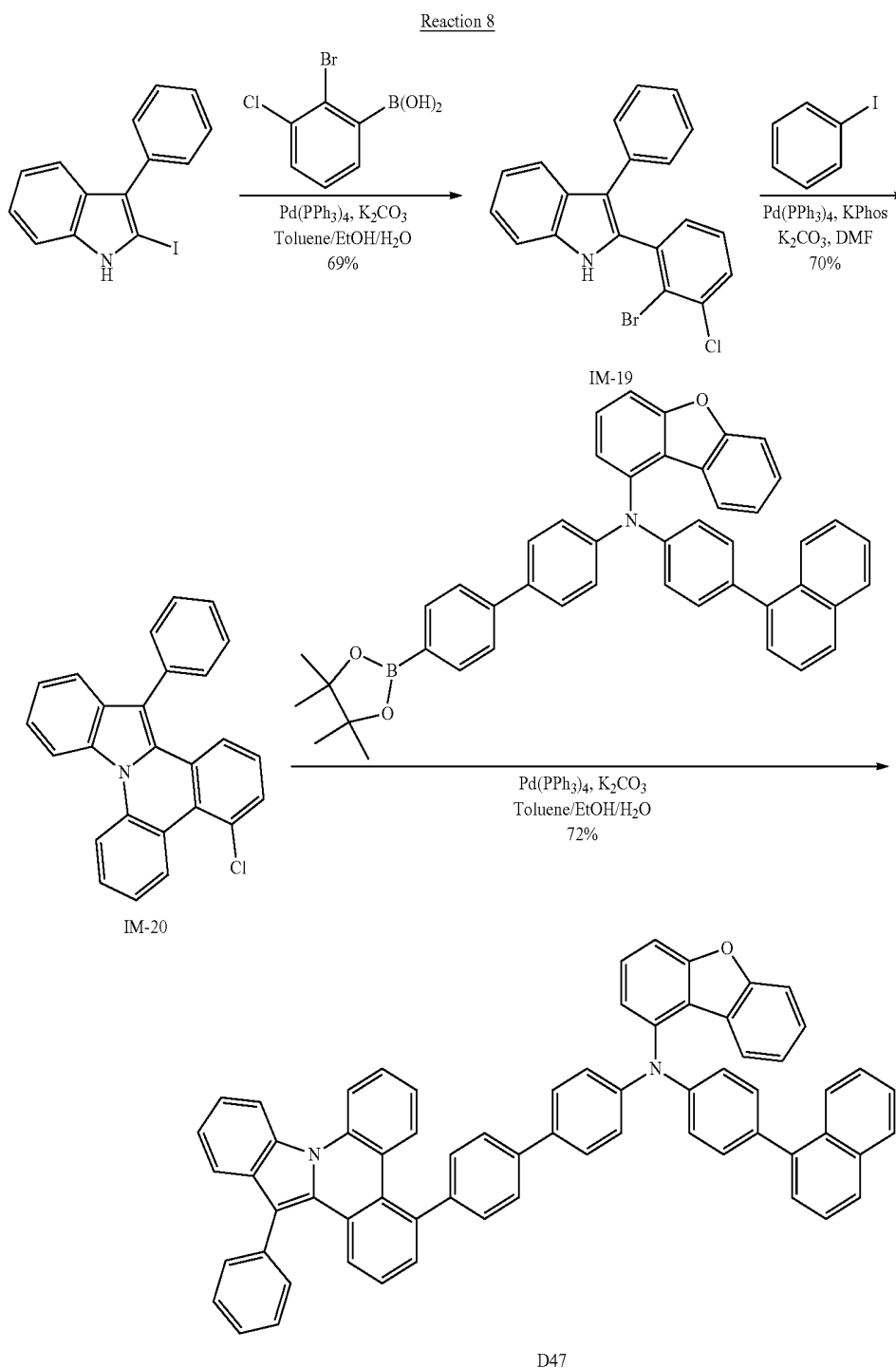
Synthesis of Compound C87

[0195] Under an argon atmosphere, to a three-neck, 500 mL flask, 8.00 g (24.4 mmol) of Intermediate IM-18, 14.80 g (1.1 eq, 26.8 mmol) of N-(dibenzofuran-3-yl)-N-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]dibenzofuran-3-amine, 10.12 g (3.0 eq, 73.2 mol) of K₂CO₃, 1.41 g (0.05 eq, 1.2 mmol) of Pd(PPh₃)₄, and 170 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO₄. MgSO₄ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound C87 (12.25 g, yield 70%) as a white solid. As measured by FAB-MS, mass number m/z=716 was observed as a molecular ion peak and Intermediate C87 was identified.

Synthesis of Compound D47

[0196] Amine Compound D47 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 8:

2.72 g (0.05 eq, 2.3 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 329 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution



Synthesis of Intermediate IM-19

[0197] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (47.00 mmol) of 2-iodo-3-phenyl-1H-indole, 12.16 g (1.1 eq, 51.7 mmol) of 2-bromo-3-chlorophenylboronic acid, 19.49 g (3.0 eq, 141.0 mmol) of K_2CO_3 ,

was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatogra-

phy (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-19 (12.41 g, yield 69%). As measured by FAB-MS, mass number $m/z=382$ was observed as a molecular ion peak and Intermediate IM-19 was identified.

Synthesis of Intermediate IM-20

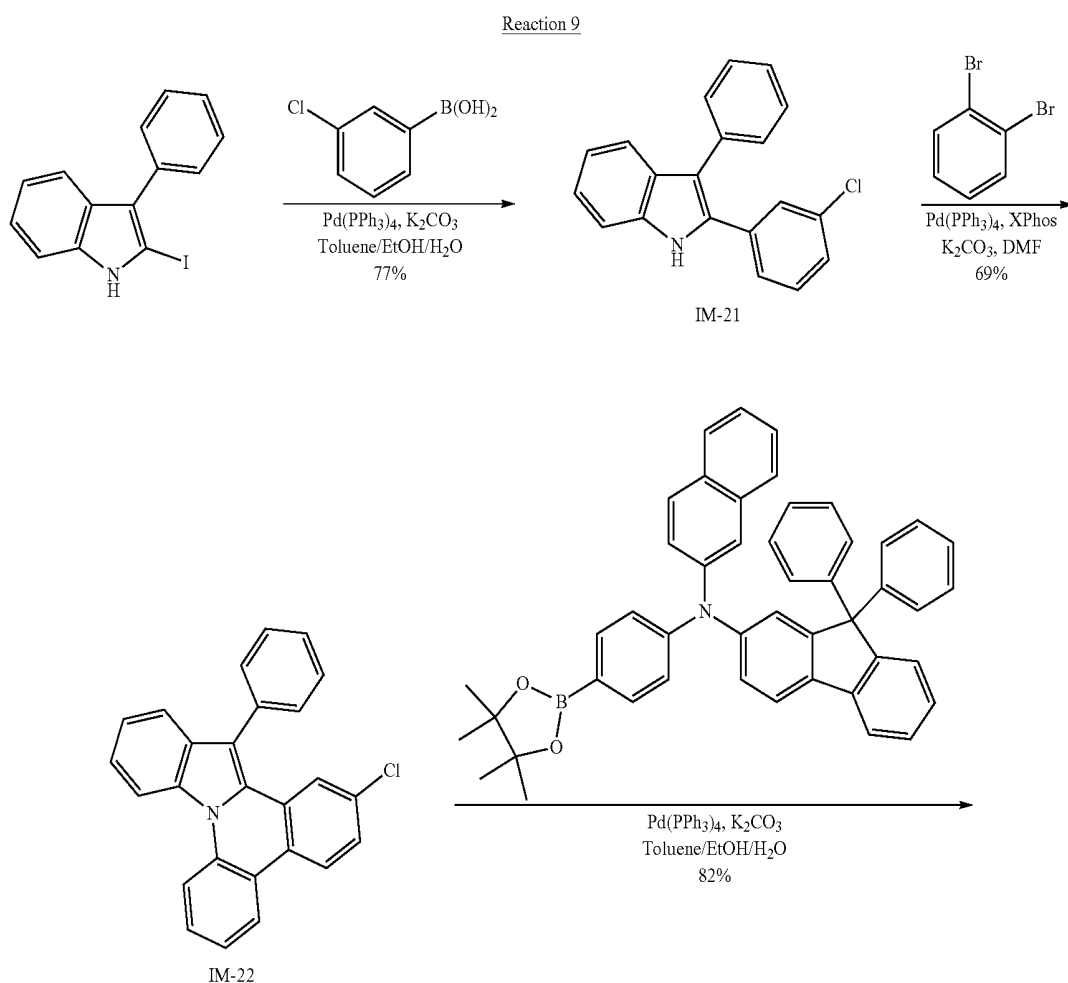
[0198] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (26.1 mmol) of Intermediate IM-19, 5.86 g (1.1 eq, 28.7 mmol) of iodobenzene, 10.83 g (3.0 eq, 78.4 mmol) of K_2CO_3 , 3.02 g (0.1 eq, 2.6 mmol) of $Pd(PPh_3)_4$, 1.25 g (0.1 eq, 2.6 mmol) of XPhos, and 105 mL of DMF were added in order, followed by heating and stirring at about 140° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-20 (6.91 g, yield 70%). As measured by FAB-MS, mass number $m/z=377$ was observed as a molecular ion peak and Intermediate IM-20 was identified.

Synthesis of Compound D47

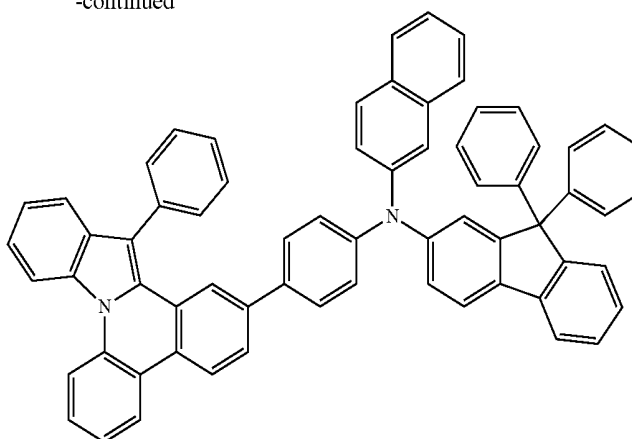
[0199] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-20, 9.66 g (1.1 eq, 14.6 mmol) of N-[4-(naphthalen-1-yl)phenyl]-N-[4'-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-(1,1'-biphenyl)-4-yl]dibenzofuran-1-amine, 5.49 g (3.0 eq, 39.7 mol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $Pd(PPh_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound D47 (8.38 g, yield 72%) as a white solid. As measured by FAB-MS, mass number $m/z=879$ was observed as a molecular ion peak and Compound D47 was identified.

Synthesis of Compound D60

[0200] Amine Compound D60 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 9:



-continued



D60

Synthesis of Intermediate IM-21

[0201] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (47.00 mmol) of 2-iodo-3-phenyl-1H-indole, 8.08 g (1.1 eq, 51.7 mmol) of 3-chlorophenylboronic acid, 19.49 g (3.0 eq, 141.0 mmol) of K_2CO_3 , 2.72 g (0.05 eq, 2.3 mmol) of $Pd(PPh_3)_4$, and 329 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-21 (10.99 g, yield 77%). As measured by FAB-MS, mass number $m/z=303$ was observed as a molecular ion peak and Intermediate IM-21 was identified.

Synthesis of Intermediate IM-22

[0202] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (32.9 mmol) of Intermediate IM-21, 8.54 g (1.1 eq, 36.2 mmol) of 1,2-dibromobenzene, 13.65 g (3.0 eq, 98.8 mmol) of K_2CO_3 , 3.80 g (0.1 eq, 3.3 mmol) of $Pd(PPh_3)_4$, 1.57 g (0.1 eq, 3.3 mmol) of XPhos, and 132 mL of DMF were added in order, followed by heating and stirring at about 140° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was

concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-22 (8.58 g, yield 69%). As measured by FAB-MS, mass number $m/z=377$ was observed as a molecular ion peak and Intermediate IM-22 was identified.

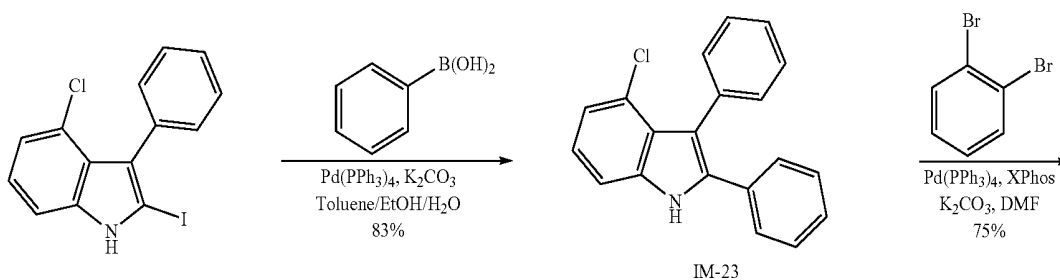
Synthesis of Compound D60

[0203] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-22, 9.63 g (1.1 eq, 14.6 mmol) of N-(naphthalen-2-yl)-9,9-diphenyl-N-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]-9H-fluoren-2-amine, 5.49 g (3.0 eq, 39.7 mol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $Pd(PPh_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound D60 (9.52 g, yield 82%) as a white solid. As measured by FAB-MS, mass number $m/z=877$ was observed as a molecular ion peak and Compound D60 was identified.

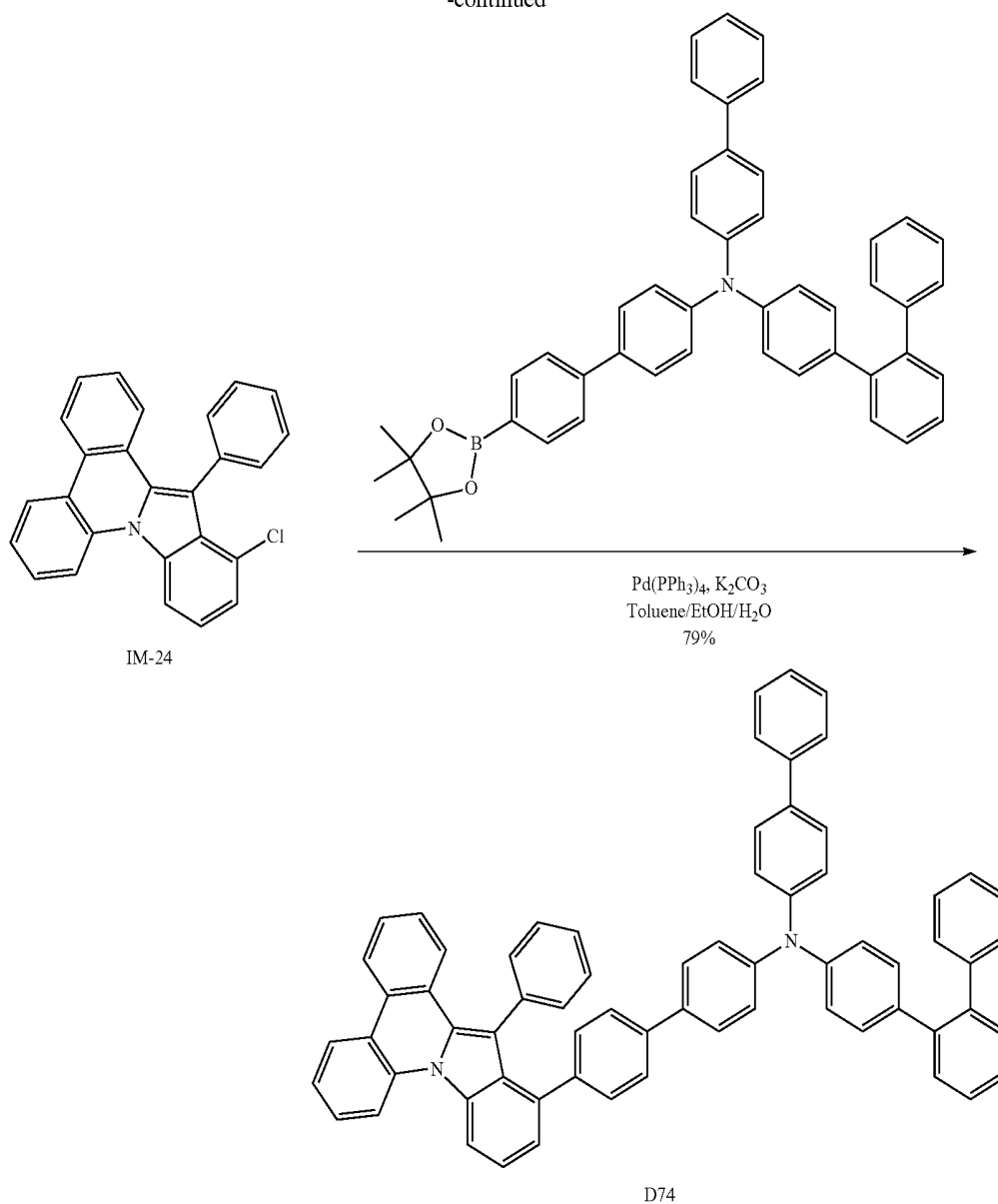
Synthesis of Compound D74

[0204] Amine Compound D74 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 10:

Reaction 10



-continued



Synthesis of Intermediate IM-23

[0205] Under an argon atmosphere, to a three-neck, 500 mL flask, 15.00 g (42.4 mmol) of 4-chloro-2-iodo-3-phenyl-1H-indole, 5.69 g (1.1 eq, 46.7 mmol) of boronic acid, 17.59 g (3.0 eq, 127.3 mmol) of K_2CO_3 , 2.45 g (0.05 eq, 2.1 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 296 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After cooling in the air to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-23 (10.70 g, yield 83%). As measured by FAB-MS, mass number $m/z=303$ was observed as a molecular ion peak and Intermediate IM-23 was identified.

Synthesis of Intermediate IM-24

[0206] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (32.9 mmol) of Intermediate IM-23, 8.54 g (1.1 eq, 36.2 mmol) of 1,2-dibromobenzene, 13.65 g (3.0 eq, 98.8 mmol) of K_2CO_3 , 3.80 g (0.1 eq, 3.3 mmol) of $\text{Pd}(\text{PPh}_3)_4$, 1.57 g (0.1 eq, 3.3 mmol) of XPhos, and 132 mL of DMF were added in order, followed by heating and stirring at about 140° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-24 (9.33 g, yield 75%). As measured by FAB-MS, mass number $m/z=377$ was observed as a molecular ion peak and Intermediate IM-24 was identified.

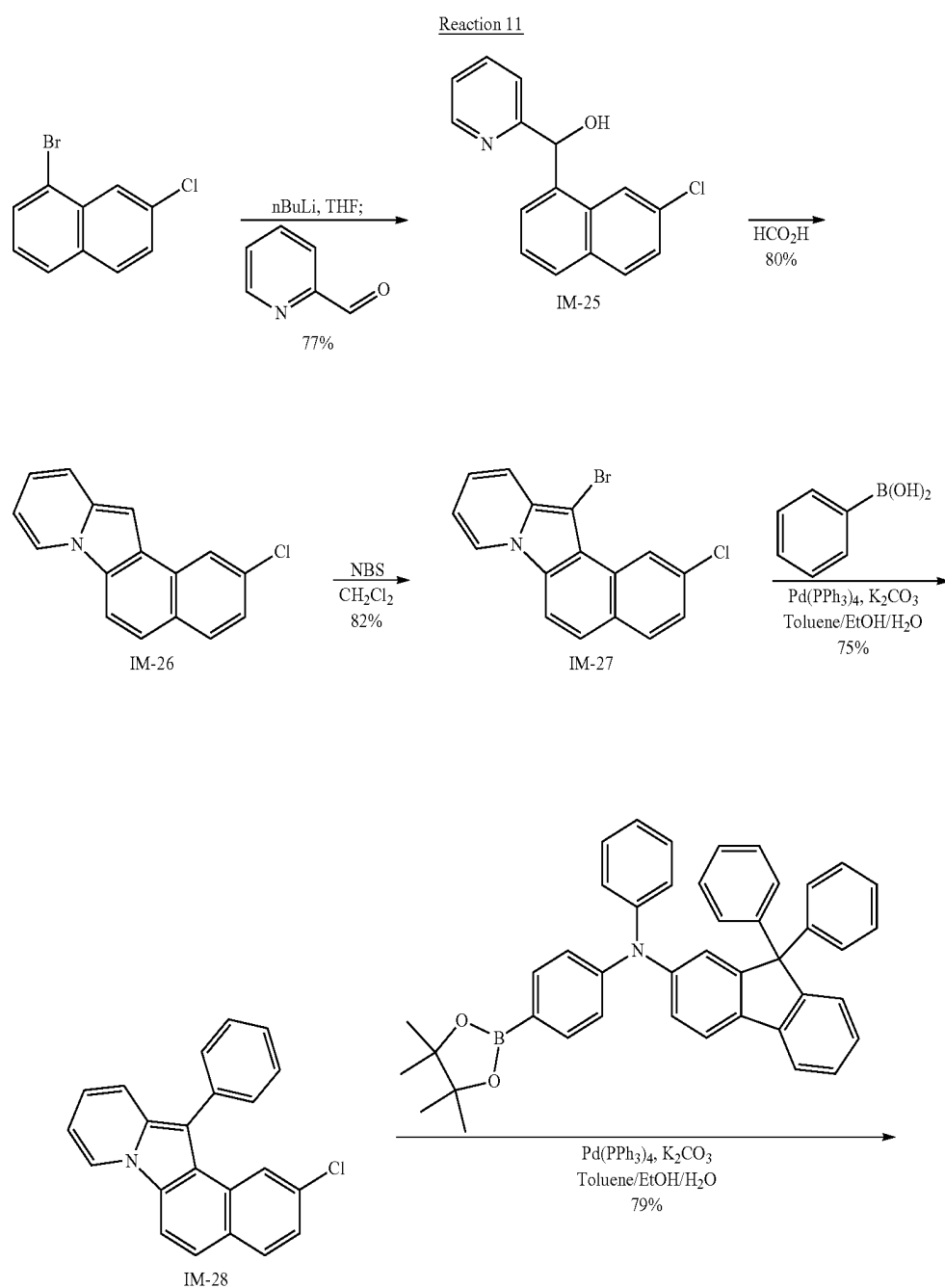
Synthesis of Compound D74

[0207] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-24, 9.83 g (1.1 eq, 14.6 mmol) of N-[(1,1'-biphenyl)-4-yl]-N-[4'-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-(1,1'-biphenyl)-4-yl]-(1,1':2',1''-terphenyl)-4-amine, 5.49 g (3.0 eq, 39.7 mol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $Pd(PPh_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After cooling in the air to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with

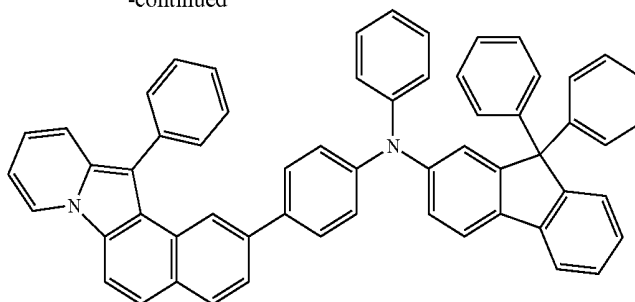
a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound D74 (9.32 g, yield 79%) as a white solid. As measured by FAB-MS, mass number $m/z=891$ was observed as a molecular ion peak and Compound D74 was identified.

Synthesis of Compound E6

[0208] Amine Compound E6 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 11:



-continued



E6

Synthesis of Intermediate IM-25

[0209] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 25.00 g (103.5 mmol) of 1-bromo-7-chloronaphthalene and 345 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 71.2 mL (1.1 eq) of a nBuLi/hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (29 mL, 1 mol/L) of 12.20 g (1.1 eq, 113.9 mmol) of picolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-25 (21.50 g, yield 77%). As measured by FAB-MS, mass number $m/z=269$ was observed as a molecular ion peak and Intermediate IM-25 was identified.

Synthesis of Intermediate IM-26

[0210] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (74.1 mmol) of Intermediate IM-25 and 247 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120°C . After air cooling the reaction solution to room temperature, the reaction solution was cooled and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-26 (14.93 g, yield 80%). As measured by FAB-MS, mass number $m/z=251$ was observed as a molecular ion peak and Intermediate IM-26 was identified.

Synthesis of Intermediate IM-27

[0211] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (47.7 mmol) of IM-26, 239 mL of CH_2Cl_2 , and 10.18 g (1.2 eq, 57.2 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with CHCl_3 was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution

and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-27 (12.92 g, yield 82%). As measured by FAB-MS, mass number $m/z=330$ was observed as a molecular ion peak and Intermediate IM-27 was identified.

Synthesis of Intermediate IM-28

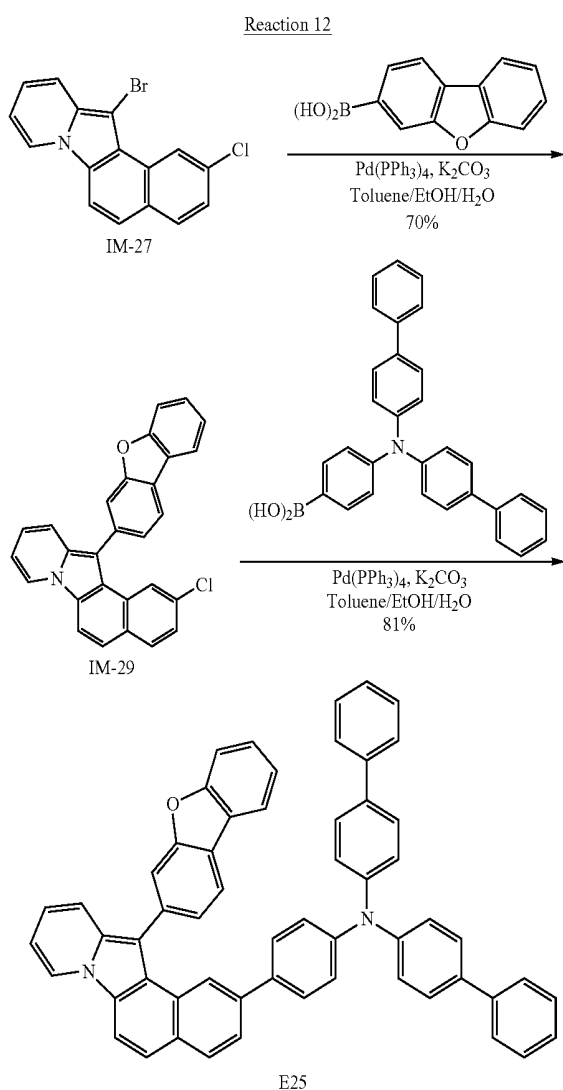
[0212] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (30.2 mmol) of Intermediate IM-27, 4.06 g (1.1 eq, 33.3 mmol) of phenylboronic acid, 12.54 g (3.0 eq, 90.7 mmol) of K_2CO_3 , 1.75 g (0.05 eq, 1.5 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 212 mL of a mixture solution of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled and then extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-28 (7.44 g, yield 75%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-28 was identified.

Synthesis of Compound E6

[0213] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-28, 8.90 g (1.1 eq, 14.6 mmol) of N,9,9-triphenyl-N-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]-9H-fluorene-2-amine, 5.49 g (3.0 eq, 39.7 mmol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound E6 (7.20 g, yield 70%) as a white solid. As measured by FAB-MS, mass number $m/z=776$ was observed as a molecular ion peak and Compound E6 was identified.

Synthesis of Compound E25

[0214] Amine Compound E25 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 12:



Synthesis of Intermediate IM-29

[0215] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (30.2 mmol) of IM-27, 7.05 g (1.1 eq, 33.3

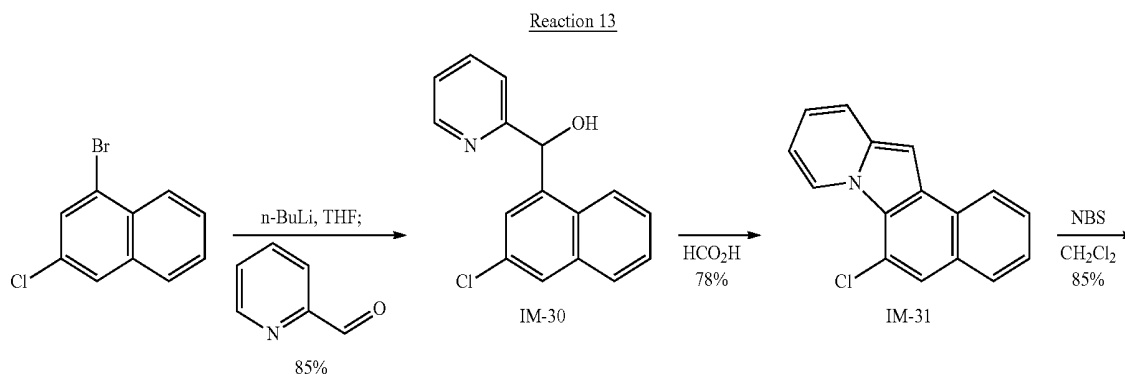
mmol) of dibenzofuran-3-ylboronic acid, 12.54 g (3.0 eq, 90.7 mmol) of K₂CO₃, 1.75 g (0.05 eq, 1.5 mmol) of Pd(PPh₃)₄, and 212 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO₄. MgSO₄ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-29 (8.85 g, yield 70%). As measured by FAB-MS, mass number m/z=417 was observed as a molecular ion peak and Intermediate IM-29 was identified.

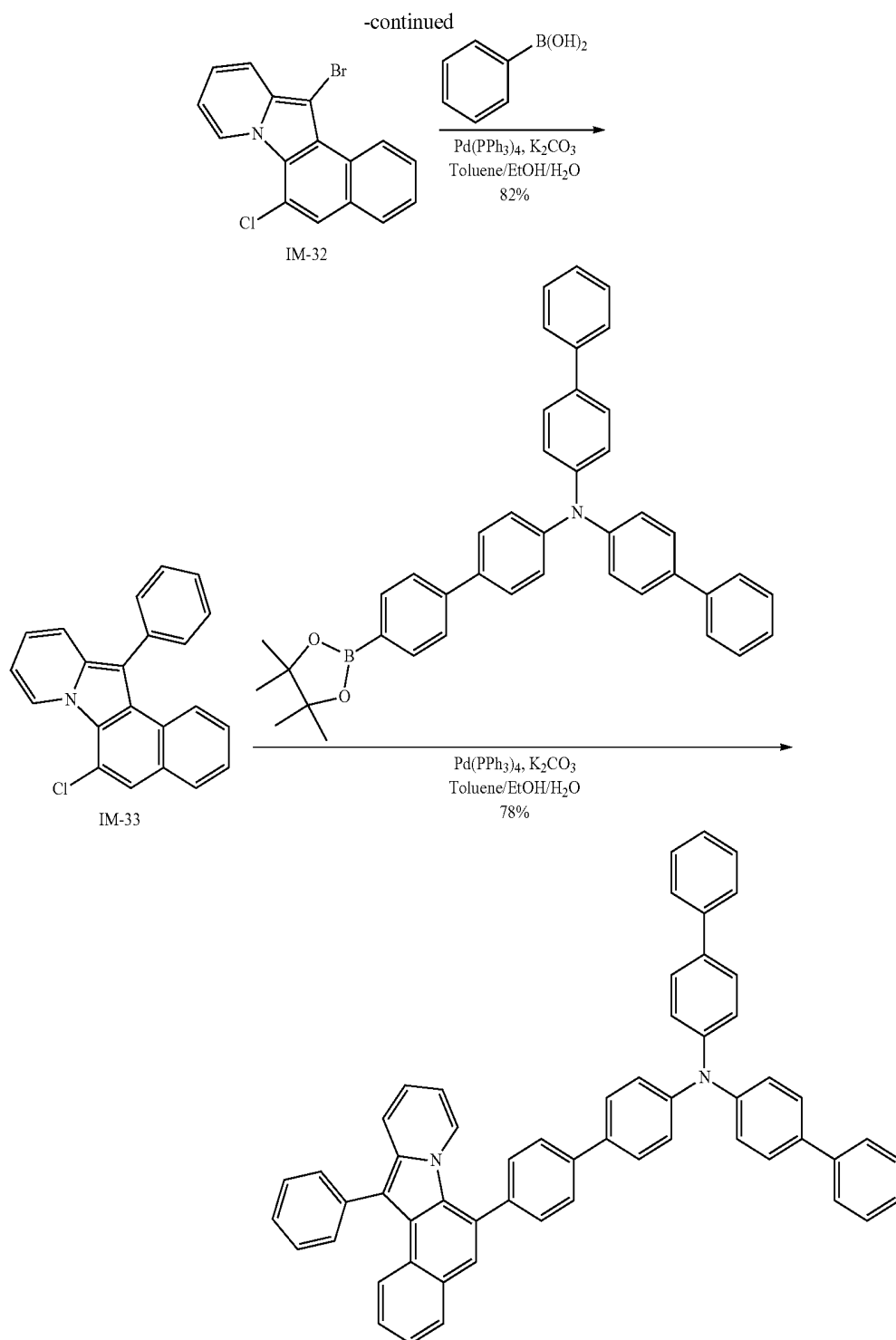
Synthesis of Compound E25

[0216] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (12.0 mmol) of Intermediate IM-29, 5.81 g (1.1 eq, 13.2 mmol) of 4-di[(1,1'-biphenyl)-4-yl]aminophenylboronic acid, 4.96 g (3.0 eq, 35.9 mmol) of K₂CO₃, 0.69 g (0.05 eq, 0.6 mmol) of Pd(PPh₃)₄, and 84 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order, followed by heating and stirring at about 80° C. After air cooling to room temperature, the reaction solution was extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO₄. MgSO₄ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound E25 (7.55 g, yield 81%) as a white solid. As measured by FAB-MS, mass number m/z=778 was observed as a molecular ion peak and Compound E25 was identified.

Synthesis of Compound E55

[0217] Amine Compound E55 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 13:





Synthesis of Intermediate IM-30

[0218] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 25.00 g (103.5 mmol) of 1-bromo-3-chloronaphthalene and 345 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 71.2 mL (1.1 eq) of a nBuLi/n-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a

THF solution (29 mL, 1 mol/L) of 12.20 g (1.1 eq, 113.9 mmol) of picolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an

aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-30 (23.73 g, yield 85%). As measured by FAB-MS, mass number $m/z=269$ was observed as a molecular ion peak and Intermediate IM-30 was identified.

Synthesis of Intermediate IM-31

[0219] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (74.1 mmol) of Intermediate IM-30 and 247 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120°C . After air cooling to room temperature, the reaction solution was further cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-31 (14.56 g, yield 78%). As measured by FAB-MS, mass number $m/z=251$ was observed as a molecular ion peak and Intermediate IM-31 was identified.

Synthesis of Intermediate IM-32

[0220] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (47.7 mmol) of IM-31, 239 mL of CH_2Cl_2 , and 10.18 g (1.2 eq, 57.2 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with CHCl_3 was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-32 (13.40 g, yield 85%). As measured by FAB-MS, mass number $m/z=330$ was observed as a molecular ion peak and Intermediate IM-32 was identified.

Synthesis of Intermediate IM-33

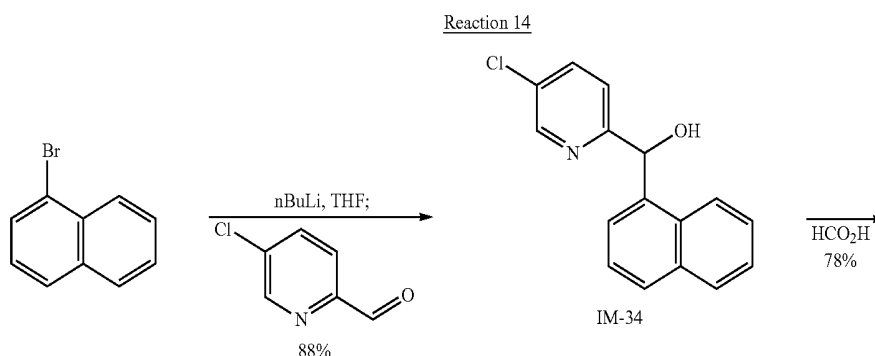
[0221] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (30.2 mmol) of Intermediate IM-33, 4.06 g (1.1 eq, 33.3 mmol) of phenylboronic acid, 12.54 g (3.0 eq, 90.7 mmol) of K_2CO_3 , 1.75 g (0.05 eq, 1.5 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 212 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and then extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-33 (7.44 g, yield 75%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-33 was identified.

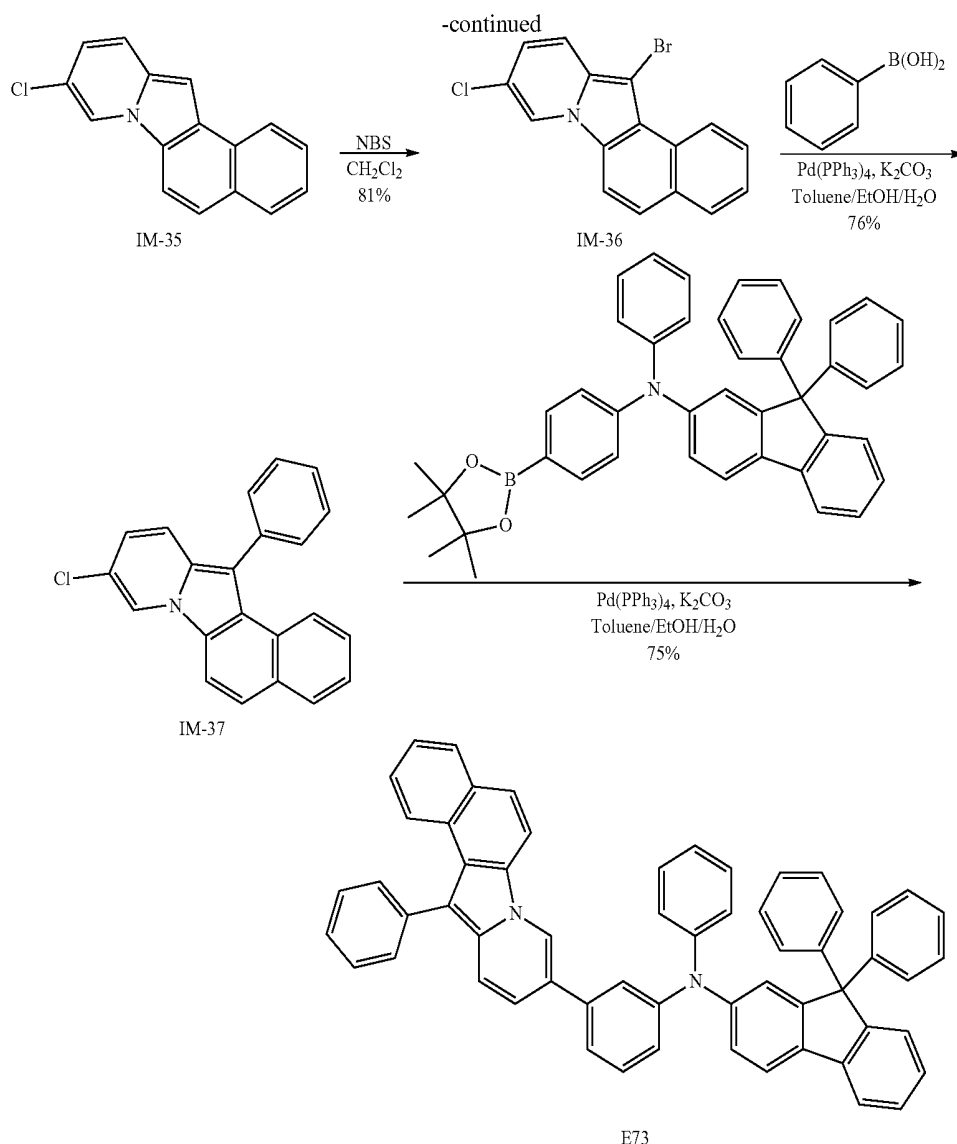
Synthesis of Compound E55

[0222] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-33, 10.06 g (1.1 eq, 14.6 mmol) of N,N-di[(1,1'-biphenyl)-4-yl]-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-(1,1'-biphenyl)-4-amine, 5.49 g (3.0 eq, 39.7 mmol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound E55 (9.10 g, yield 78%) as a white solid. As measured by FAB-MS, mass number $m/z=764$ was observed as a molecular ion peak and Compound E55 was identified.

Synthesis of Compound E73

[0223] Amine Compound E73 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 14:





Synthesis of Intermediate IM-34

[0224] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 20.00 g (96.6 mmol) of 1-bromonaphthalene and 322 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 66.4 mL (1.1 eq) of a nBuLi/n-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (27 mL, 1 mol/L) of 15.04 g (1.1 eq, 106.2 mmol) of 5-chloropicolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-34 (22.93 g, yield 88%).

As measured by FAB-MS, mass number $m/z=269$ was observed as a molecular ion peak and Intermediate IM-34 was identified.

Synthesis of Intermediate IM-35

[0225] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (74.1 mmol) of Intermediate IM-34 and 247 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120°C . After air cooling the reaction solution to room temperature, the reaction solution was further cooled and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-35 (14.56 g, yield 78%). As measured by FAB-MS, mass number $m/z=251$ was observed as a molecular ion peak and Intermediate IM-35 was identified.

Synthesis of Intermediate IM-36

[0226] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (47.7 mmol) of IM-35, 239 mL of CH_2Cl_2 , and 10.18 g (1.2 eq, 57.2 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with CHCl_3 was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-36 (12.77 g, yield 81%). As measured by FAB-MS, mass number $m/z=330$ was observed as a molecular ion peak and Intermediate IM-36 was identified.

Synthesis of Intermediate IM-37

[0227] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (30.2 mmol) of Intermediate IM-36, 4.06 g (1.1 eq, 33.3 mmol) of phenylboronic acid, 12.54 g (3.0 eq, 90.7 mmol) of K_2CO_3 , 1.75 g (0.05 eq, 1.5 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 212 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica

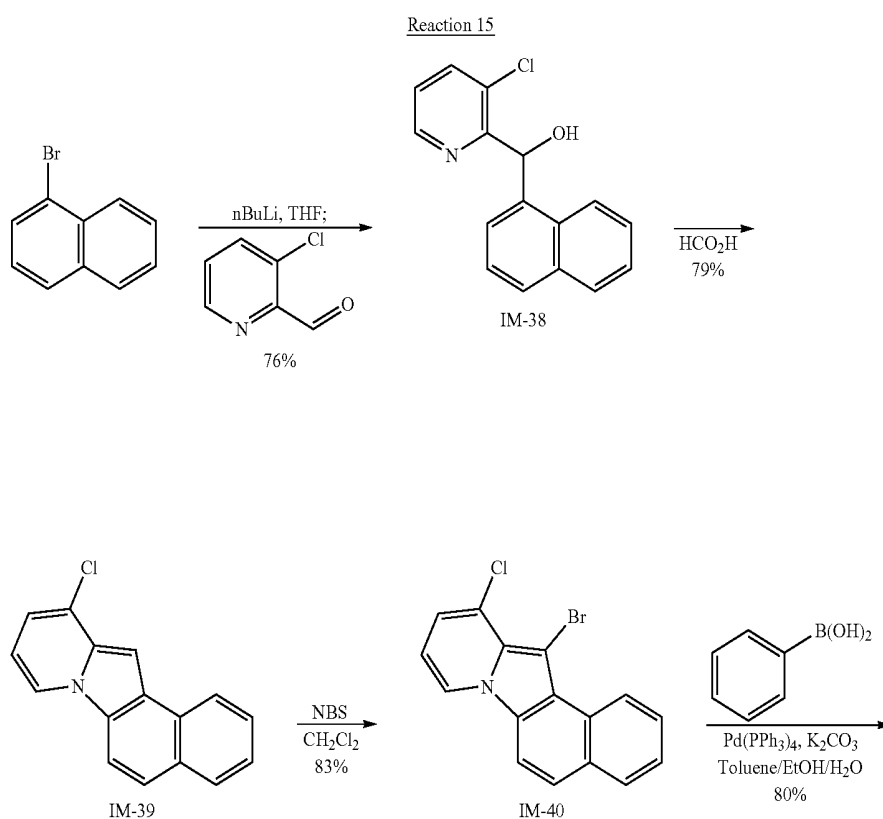
gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-37 (7.73 g, yield 78%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-37 was identified.

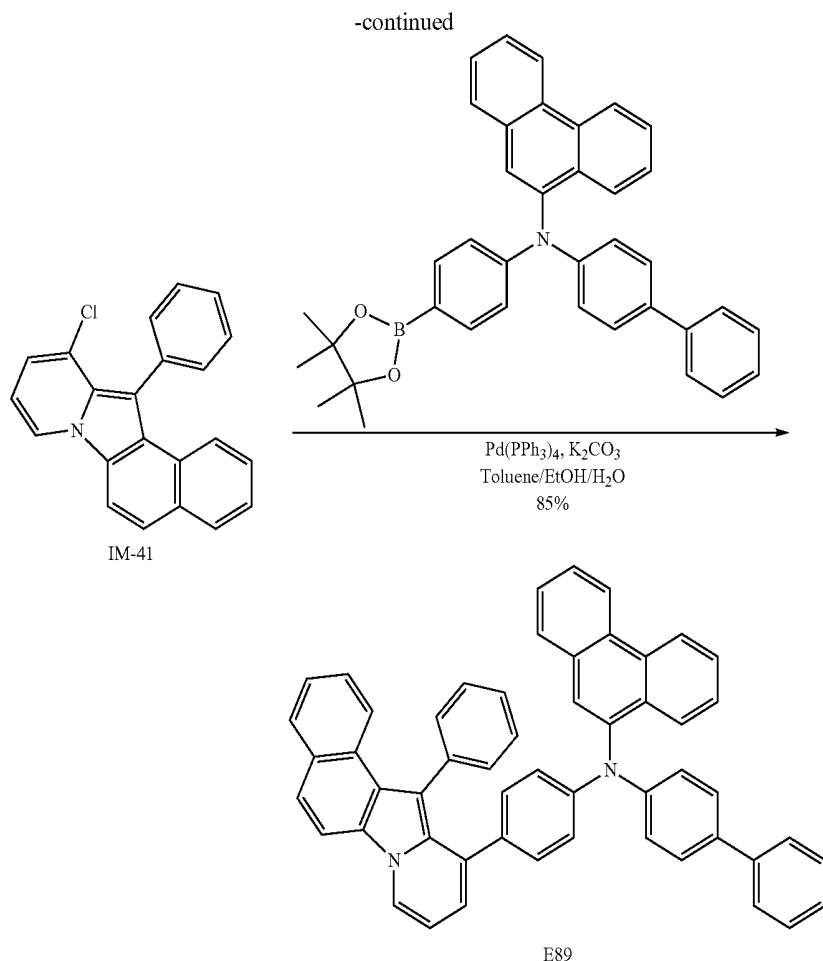
Synthesis of Compound E73

[0228] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-37, 10.06 g (1.1 eq, 14.6 mmol) of N,9,9-triphenyl-N-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]-9H-fluoren-2-amine, 5.49 g (3.0 eq, 39.7 mmol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound E73 (8.88 g, yield 75%) as a white solid. As measured by FAB-MS, mass number $m/z=776$ was observed as a molecular ion peak and Compound E73 was identified.

Synthesis of Compound E89

[0229] Amine Compound E89 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 15:





Synthesis of Intermediate IM-38

[0230] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 20.00 g (96.6 mmol) of 1-bromonaphthalene and 322 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 66.4 mL (1.1 eq) of a nBuLi/n-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (27 mL, 1 mol/L) of 15.04 g (1.1 eq, 106.2 mmol) of 3-chloropicolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-38 (19.80 g, yield 76%). As measured by FAB-MS, mass number $m/z=269$ was observed as a molecular ion peak and Intermediate IM-38 was identified.

Synthesis of Intermediate IM-39

[0231] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (74.1 mmol) of Intermediate IM-38 and

247 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120°C . After air cooling to room temperature, the reaction solution was further cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-39 (14.74 g, yield 78%). As measured by FAB-MS, mass number $m/z=251$ was observed as a molecular ion peak and Intermediate IM-39 was identified.

Synthesis of Intermediate IM-40

[0232] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (47.7 mmol) of Intermediate IM-39, 239 mL of CH_2Cl_2 , and 10.18 g (1.2 eq, 57.2 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with CHCl_3 was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and

toluene as a developing solution) to obtain Intermediate IM-40 (13.08 g, yield 83%). As measured by FAB-MS, mass number $m/z=330$ was observed as a molecular ion peak and Intermediate IM-40 was identified.

Synthesis of Intermediate IM-41

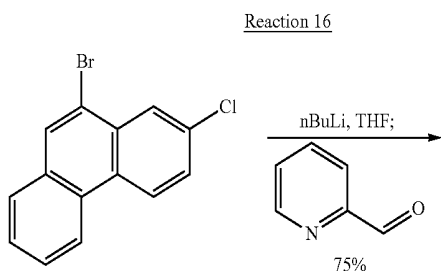
[0233] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (30.2 mmol) of Intermediate IM-40, 4.06 g (1.1 eq, 33.3 mmol) of phenylboronic acid, 12.54 g (3.0 eq, 90.7 mmol) of K_2CO_3 , 1.75 g (0.05 eq, 1.5 mmol) of $Pd(PPh_3)_4$, and 212 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80° C. The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-41 (7.93 g, yield 80%). As measured by FAB-MS, mass number $m/z=327$ was observed as a molecular ion peak and Intermediate IM-41 was identified.

Synthesis of Compound E89

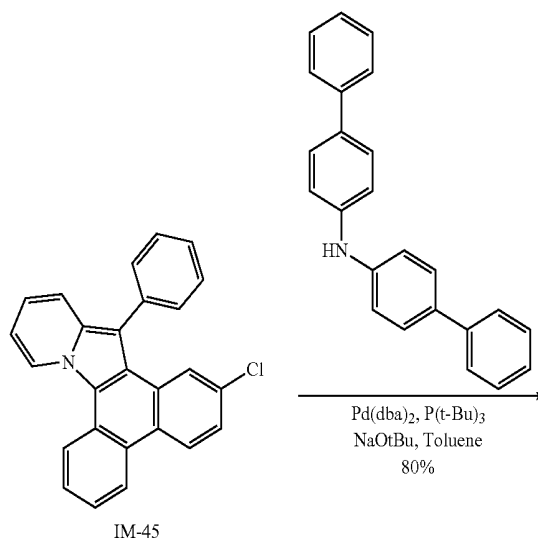
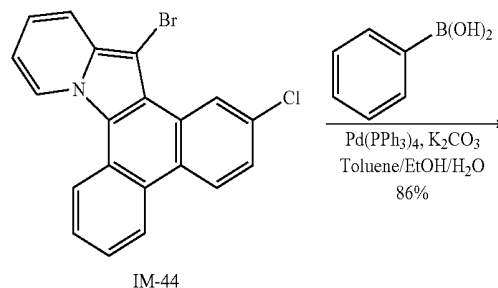
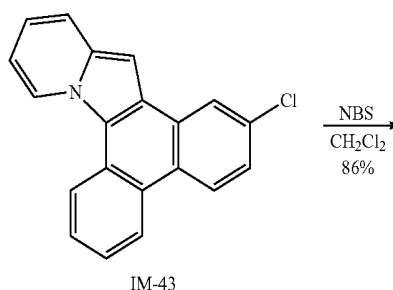
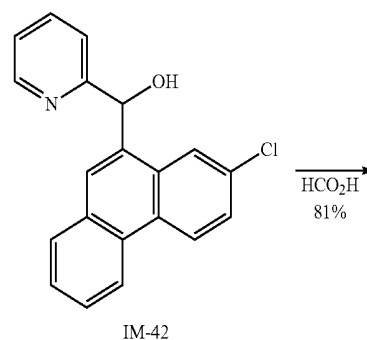
[0234] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-41, 9.19 g (1.1 eq, 14.6 mmol) of *N*-[(1,1'-biphenyl)-4-yl]-*N*-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]phenanthren-9-amine, 5.49 g (3.0 eq, 39.7 mmol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $Pd(PPh_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80° C. The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound E89 (9.24 g, yield 85%) as a white solid. As measured by FAB-MS, mass number $m/z=712$ was observed as a molecular ion peak and Compound E89 was identified.

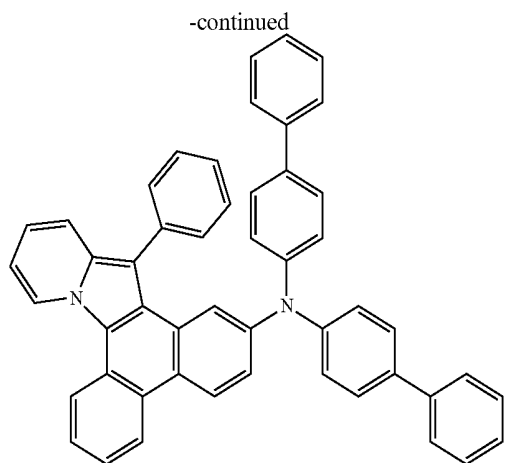
Synthesis of Compound F21

[0235] Amine Compound F21 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 16:



-continued





F21

Synthesis of Intermediate IM-42

[0236] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 25.00 g (85.7 mmol) of 10-bromo-2-chlorophenanthrene and 286 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 59.0 mL (1.1 eq) of a $n\text{BuLi}/n\text{-hexane}$ solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (24 mL, 1 mol/L) of 10.10 g (1.1 eq, 94.3 mmol) of picolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-42 (20.57 g, yield 75%). As measured by FAB-MS, mass number $m/z=319$ was observed as a molecular ion peak and Intermediate IM-42 was identified.

Synthesis of Intermediate IM-43

[0237] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (62.5 mmol) of Intermediate IM-42 and 208 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120°C . After air cooling the reaction solution to room temperature, the reaction solution was further cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-43 (15.29 g, yield 81%). As measured by FAB-MS, mass number $m/z=301$ was observed as a molecular ion peak and Intermediate IM-43 was identified.

Synthesis of Intermediate IM-44

[0238] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (39.8 mmol) of Intermediate IM-43, 199 mL of CH_2Cl_2 , and 8.49 g (1.2 eq, 47.7 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with CHCl_3 was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-44 (13.02 g, yield 86%). As measured by FAB-MS, mass number $m/z=380$ was observed as a molecular ion peak and Intermediate IM-44 was identified.

Synthesis of Intermediate IM-45

[0239] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (26.3 mmol) of Intermediate IM-44, 3.52 g (1.1 eq, 28.9 mmol) of phenylboronic acid, 10.89 g (3.0 eq, 78.8 mmol) of K_2CO_3 , 1.52 g (0.05 eq, 1.3 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 184 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-45 (8.54 g, yield 86%). As measured by FAB-MS, mass number $m/z=377$ was observed as a molecular ion peak and Intermediate IM-45 was identified.

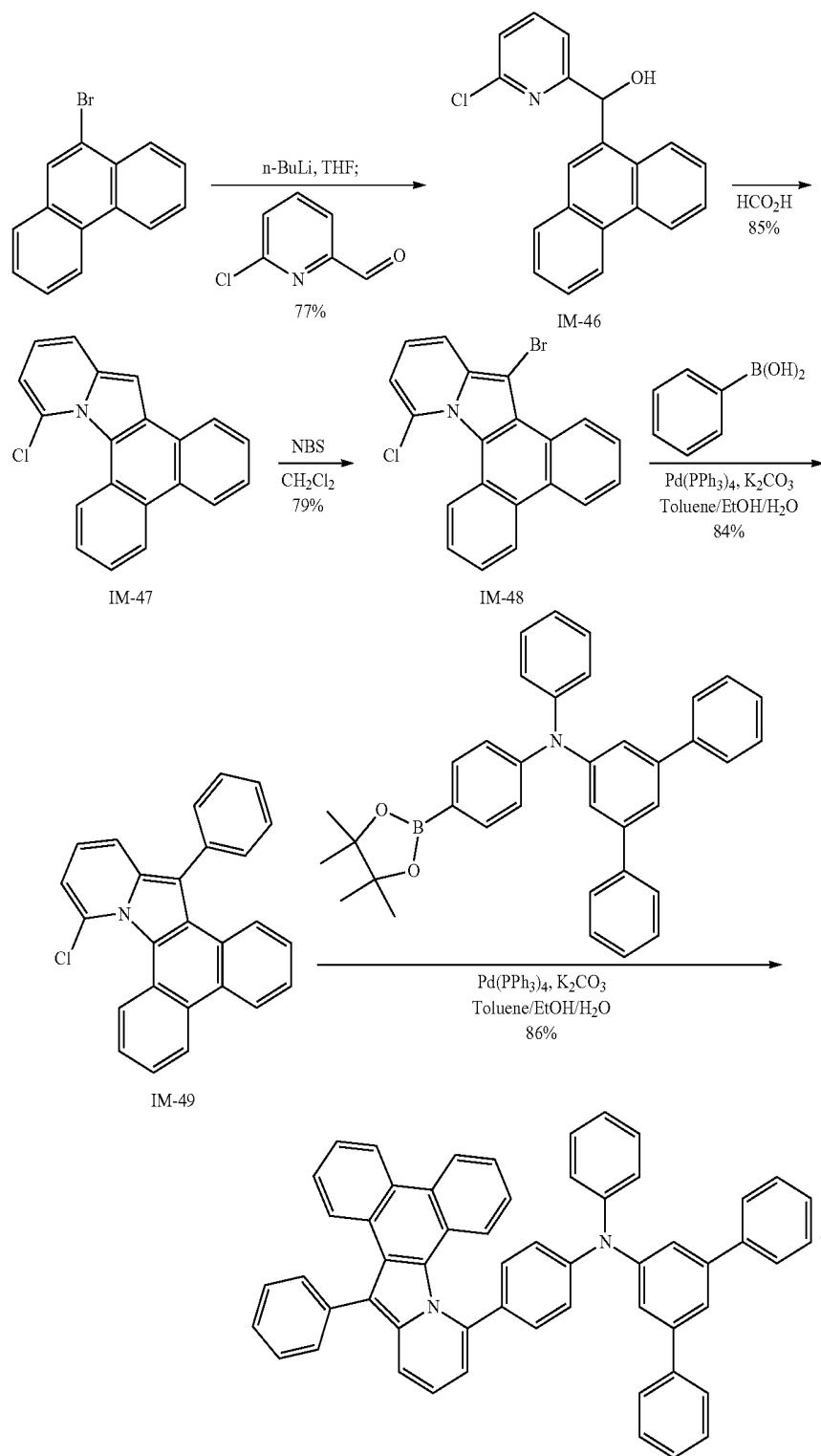
Synthesis of Compound F21

[0240] Under an argon atmosphere, to a three-neck, 200 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-45, 0.23 g (0.03 eq, 0.4 mmol) of $\text{Pd}(\text{dba})_2$, 2.54 g (2.0 eq, 26.5 mmol) of NaO^tBu , 66 mL of toluene, 4.68 g (1.1 eq, 14.6 mmol) of di[(1,1'-biphenyl)-4-yl]amine, and 0.27 g (0.1 eq, 1.3 mmol) of $^t\text{Bu}_3\text{P}$ were added in order, followed by refluxing while heating and stirring. After cooling the reaction solution in the air to room temperature, water was added to the reaction solution and the organic layer was isolated. Toluene was added to the aqueous solution and additional organic layers were extracted. The organic layers were collected and washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound F21 (7.01 g, yield 80%) as a white solid. As measured by FAB-MS, mass number $m/z=662$ was observed as a molecular ion peak and Compound F21 was identified.

Synthesis of Compound F63

[0241] Amine Compound F63 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 17:

Reaction 17



Synthesis of Intermediate IM-46

[0242] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 25.00 g (97.2 mmol) of 9-bromophenanthrene and 324 mL (0.3 M) of THF were added, and while stirring at

about -78°C ., 66.8 mL (1.1 eq) of a $n\text{BuLi}/n\text{-hexane}$ solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (27 mL, 1 mol/L) of 15.14 g (1.1 eq, 106.9 mmol)

of 6-chloropicolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-46 (23.94 g, yield 77%). As measured by FAB-MS, mass number $m/z=319$ was observed as a molecular ion peak and Intermediate IM-46 was identified.

Synthesis of Intermediate IM-47

[0243] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (62.5 mmol) of Intermediate IM-46 and 208 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120° C. After air cooling the reaction solution to room temperature, the reaction solution was further cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and an organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-47 (16.04 g, yield 85%). As measured by FAB-MS, mass number $m/z=301$ was observed as a molecular ion peak and Intermediate IM-47 was identified.

Synthesis of Intermediate IM-48

[0244] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (39.8 mmol) of IM-47, 199 mL of CH_2Cl_2 , and 8.49 g (1.2 eq, 47.7 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with $CHCl_3$ was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to

obtain Intermediate IM-48 (11.96 g, yield 79%). As measured by FAB-MS, mass number $m/z=380$ was observed as a molecular ion peak and Intermediate IM-48 was identified.

Synthesis of Intermediate IM-49

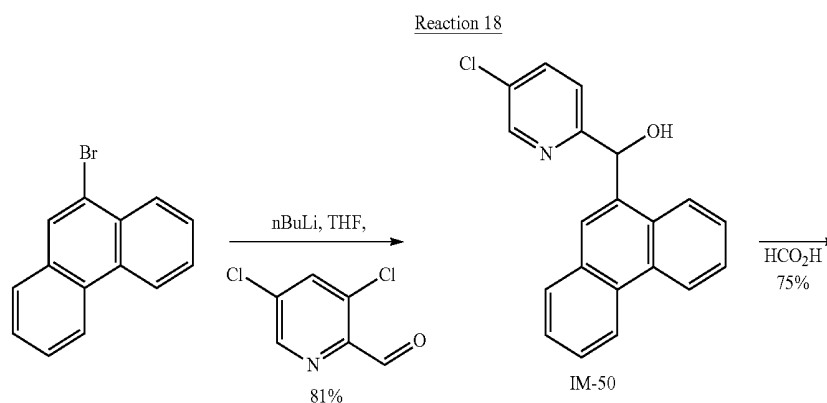
[0245] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (26.3 mmol) of Intermediate IM-48, 3.52 g (1.1 eq, 28.9 mmol) of phenylboronic acid, 10.89 g (3.0 eq, 78.8 mmol) of K_2CO_3 , 1.52 g (0.05 eq, 1.3 mmol) of $Pd(PPh_3)_4$, and 184 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80° C. The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-49 (8.34 g, yield 84%). As measured by FAB-MS, mass number $m/z=377$ was observed as a molecular ion peak and Intermediate IM-49 was identified.

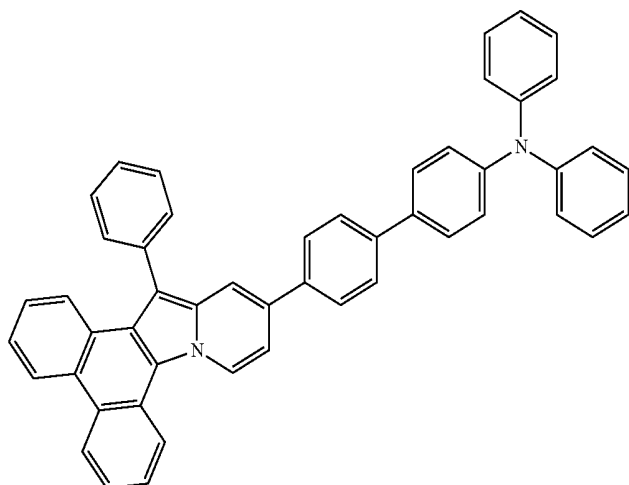
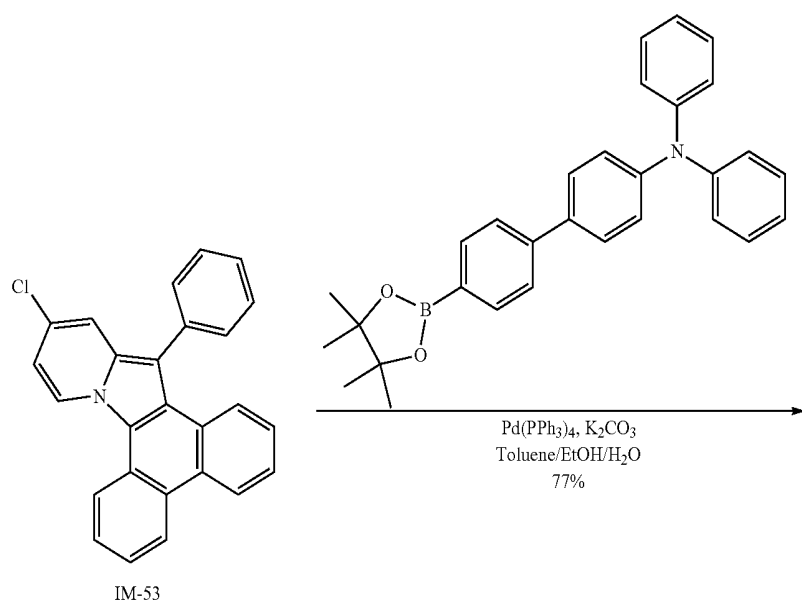
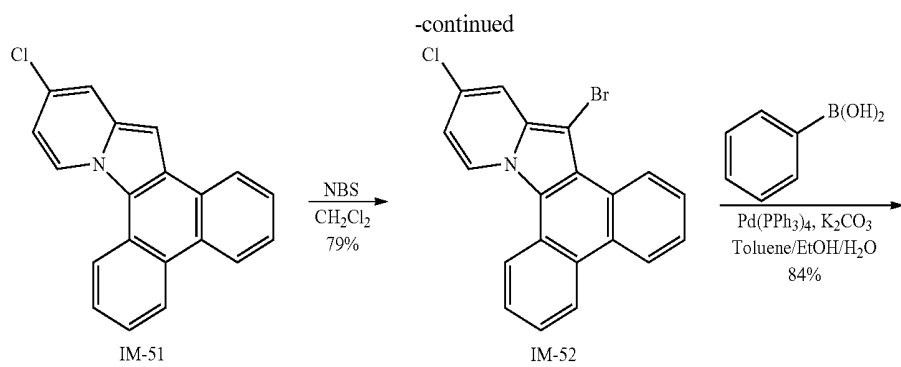
Synthesis of Compound F63

[0246] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-49, 7.62 g (1.1 eq, 14.6 mmol) of N-phenyl-N-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)-[1,1':3',1''-terphenyl]-5'-amine, 5.49 g (3.0 eq, 39.7 mmol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $Pd(PPh_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80° C. The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over $MgSO_4$. $MgSO_4$ was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound F63 (8.31 g, yield 85%) as a white solid. As measured by FAB-MS, mass number $m/z=738$ was observed as a molecular ion peak and Compound F63 was identified.

Synthesis of Compound F82

[0247] Amine Compound F82 according to an embodiment of the present disclosure may be synthesized, for example, by Reaction 18:





Synthesis of Intermediate IM-50

[0248] Under an argon atmosphere, to a three-neck, 1,000 mL flask, 25.00 g (97.2 mmol) of 9-bromophenanthrene and 324 mL (0.3 M) of THF were added, and while stirring at about -78°C ., 66.8 mL (1.1 eq) of a nBuLi/n-hexane solution of 1.6 mol/L was added dropwise thereto. After stirring for about 1 hour at the same temperature, a THF solution (27 mL, 1 mol/L) of 15.14 g (1.1 eq, 106.9 mmol) of 5-chloropicolinaldehyde was added dropwise thereto and stirred for about 30 minutes at the same temperature. Then, the temperature was increased to room temperature and additional stirring was performed. After securing the disappearance of raw materials, the reaction solution was cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-50 (25.18 g, yield 81%). As measured by FAB-MS, mass number $m/z=319$ was observed as a molecular ion peak and Intermediate IM-50 was identified.

Synthesis of Intermediate IM-51

[0249] Under an argon atmosphere, to a three-neck, 500 mL flask, 20.00 g (62.5 mmol) of Intermediate IM-50 and 208 mL (0.3 M) of formic acid were added, followed by stirring and heating at about 120°C . After cooling the reaction solution in the air to room temperature, the reaction solution was further cooled with water and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with an aqueous sodium bicarbonate solution and a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-51 (14.15 g, yield 75%). As measured by FAB-MS, mass number $m/z=301$ was observed as a molecular ion peak and Intermediate IM-51 was identified.

Synthesis of Intermediate IM-52

[0250] Under an argon atmosphere, to a three-neck, 500 mL flask, 12.00 g (39.8 mmol) of Intermediate IM-51, 199 mL of CH_2Cl_2 , and 8.49 g (1.2 eq, 47.7 mmol) of N-bromosuccinimide were added in order and stirred at room temperature. Water was added to the reaction solution, and extraction with CHCl_3 was performed. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-52 (11.96 g, yield 79%). As measured by FAB-MS, mass number $m/z=380$ was observed as a molecular ion peak and Intermediate IM-52 was identified.

Synthesis of Intermediate IM-53

[0251] Under an argon atmosphere, to a three-neck, 500 mL flask, 10.00 g (26.3 mmol) of Intermediate IM-52, 3.52 g (1.1 eq, 28.9 mmol) of phenylboronic acid, 10.89 g (3.0 eq, 78.8 mmol) of K_2CO_3 , 1.52 g (0.05 eq, 1.3 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 184 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Intermediate IM-53 (8.34 g, yield 84%). As measured by FAB-MS, mass number $m/z=377$ was observed as a molecular ion peak and Intermediate IM-53 was identified.

Synthesis of Compound F82

[0252] Under an argon atmosphere, to a three-neck, 300 mL flask, 5.00 g (13.2 mmol) of Intermediate IM-53, 6.51 g (1.1 eq, 14.6 mmol) of N,N-diphenyl-4'-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-(1,1'-biphenyl)-4-amine, 5.49 g (3.0 eq, 39.7 mmol) of K_2CO_3 , 0.76 g (0.05 eq, 0.7 mmol) of $\text{Pd}(\text{PPh}_3)_4$, and 93 mL of a mixture of toluene/ethanol (EtOH)/water (4/2/1) were added in order and stirred while heating at about 80°C . The reaction solution was air cooled to room temperature and extracted with toluene. The aqueous layer was removed, and the organic layer was washed with a saturated saline solution and dried over MgSO_4 . MgSO_4 was filtered and the organic layer was concentrated, and the crude product thus obtained was separated by silica gel column chromatography (using a mixture of hexane and toluene as a developing solution) to obtain Compound F82 (6.74 g, yield 77%) as a white solid. As measured by FAB-MS, mass number $m/z=662$ was observed as a molecular ion peak and Compound F82 was identified.

2. Manufacture and Evaluation of Organic Electroluminescence Device Including Amine Compound

Manufacture of Organic Electroluminescence Device

[0253] Example organic electroluminescence devices including amine compounds according to embodiments of the present disclosure in their hole transport layers were manufactured by the method below. The organic electroluminescence devices of Examples 1 to 18 were manufactured using the amine compounds of Compound A1, Compound A28, Compound A57, Compound B36, Compound B46, Compound C47, Compound C87, Compound D47, Compound D60, Compound D74, Compound E6, Compound E25, Compound E55, Compound E73, Compound E89, Compound F21, Compound F63, and Compound F82, respectively, as materials for hole transport layers. The organic electroluminescence devices of Comparative Examples 1 to 6 were manufactured using Comparative Compounds R1 to R6, respectively, as materials for hole transport layers.

[0254] The compounds used in Examples 1 to 18 and Comparative Examples 1 to 6 are listed in Table 1:

TABLE 1

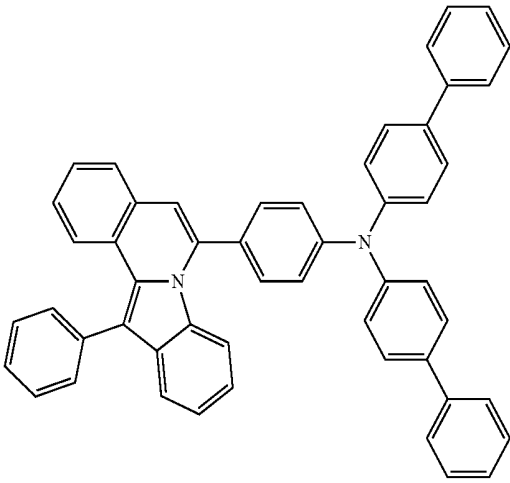
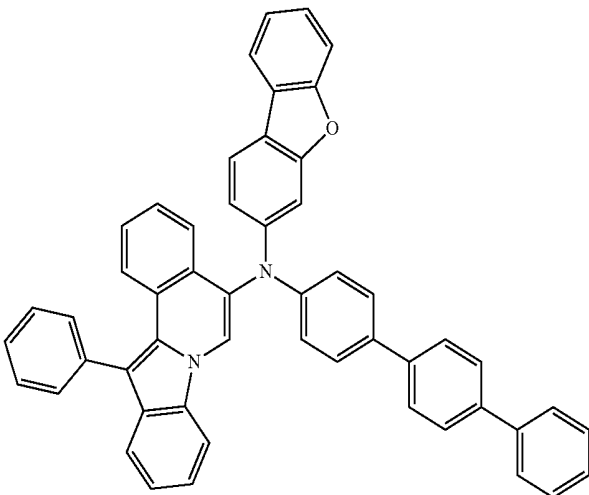
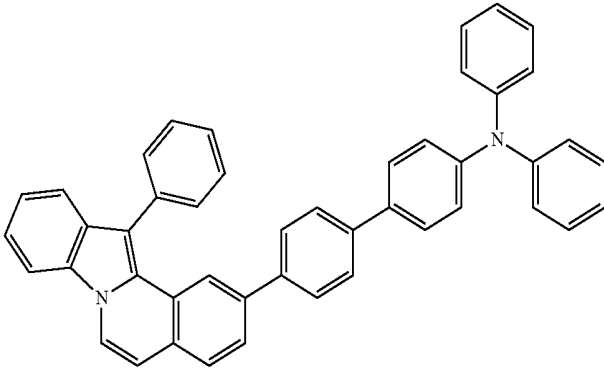
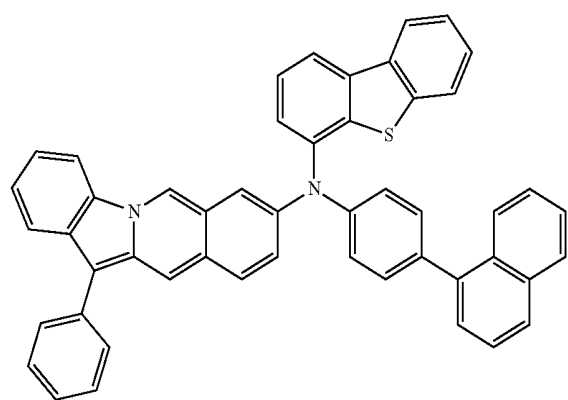
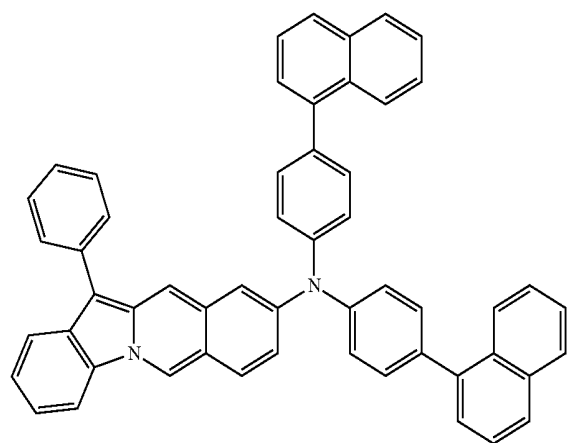
 A1	Compound A1
 A28	Compound A28
 A57	Compound 57

TABLE 1-continued



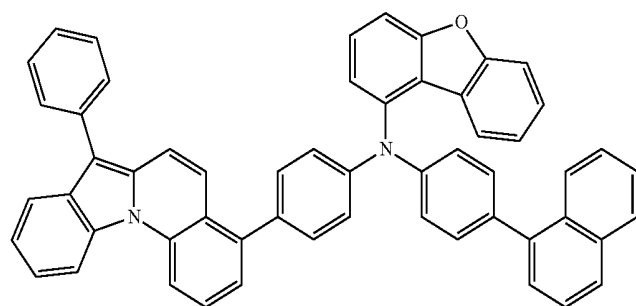
Compound B36

B36



Compound B46

B46



Compound C47

C47

TABLE 1-continued

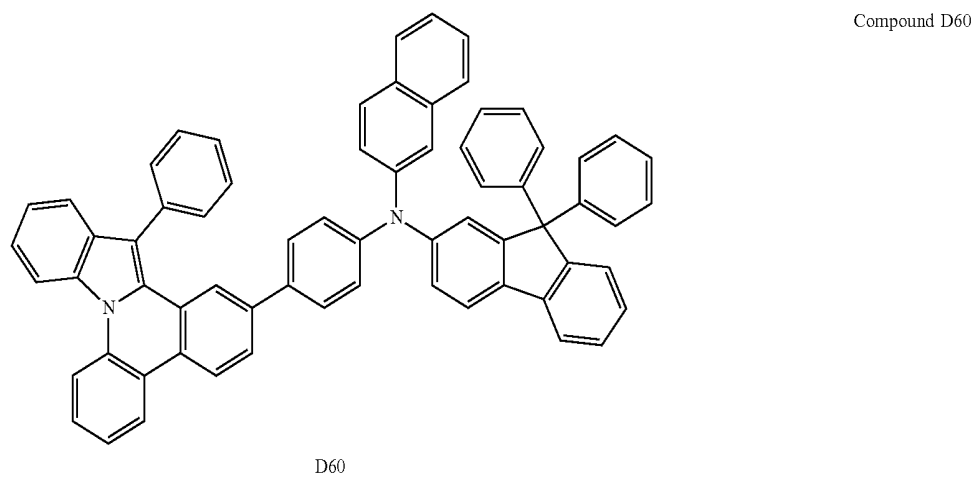
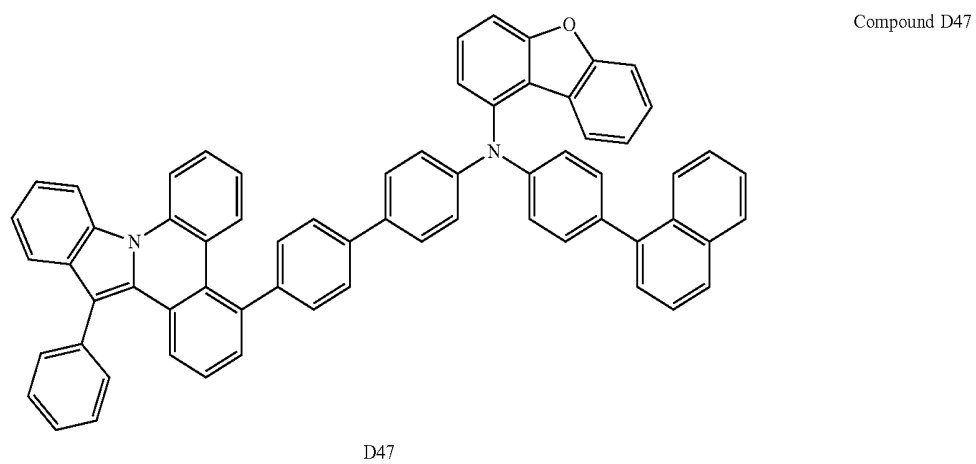
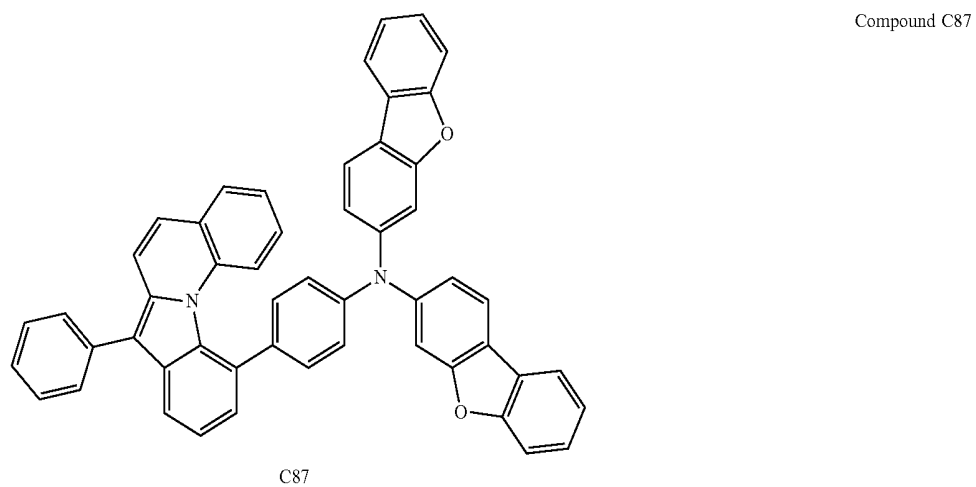


TABLE 1-continued

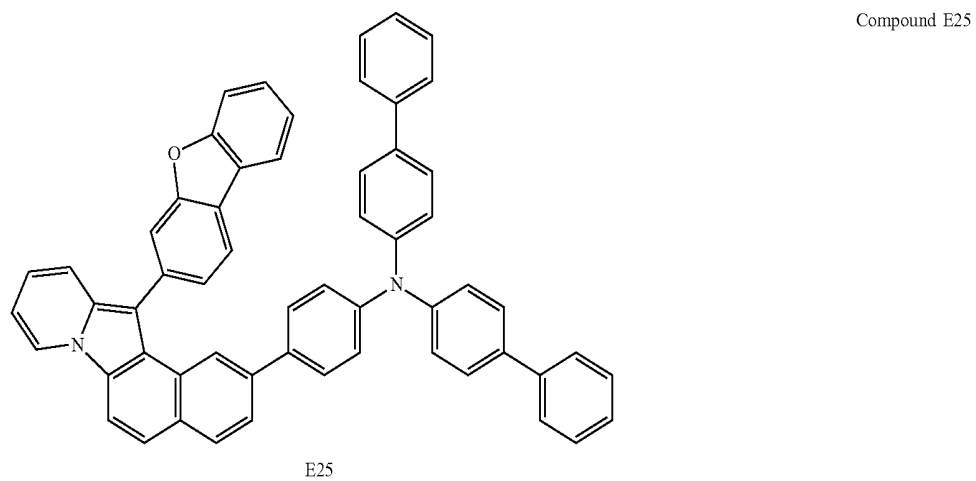
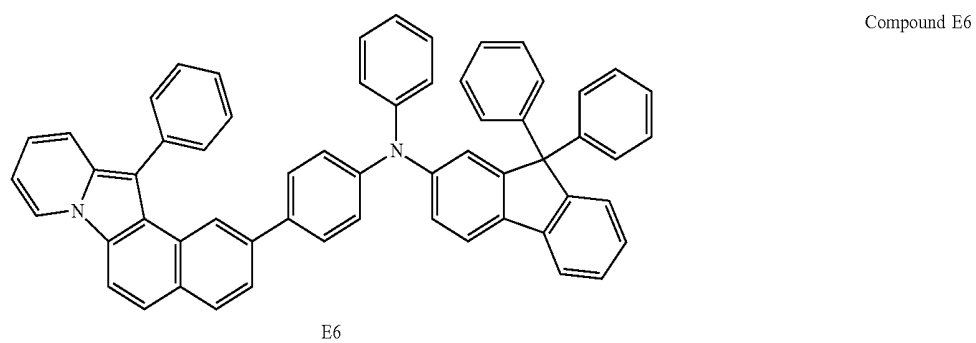
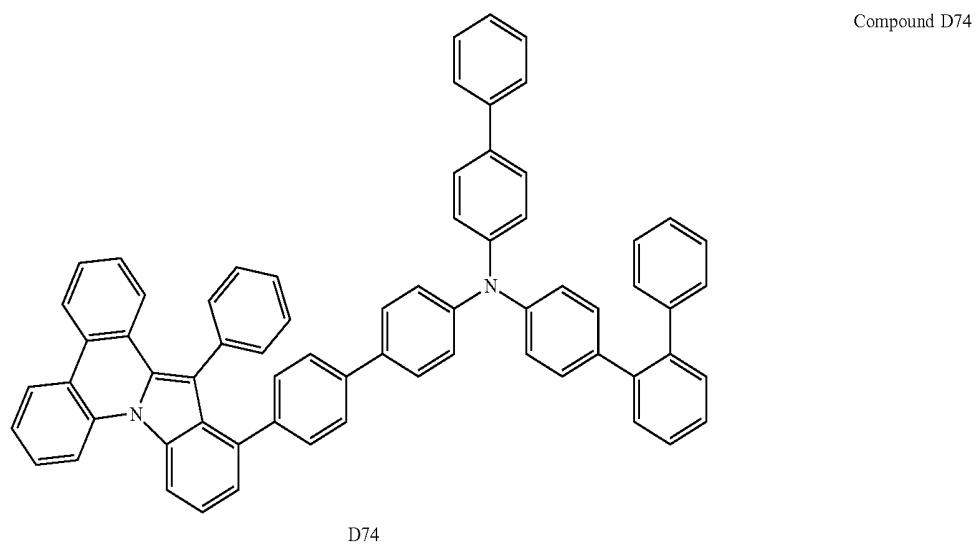
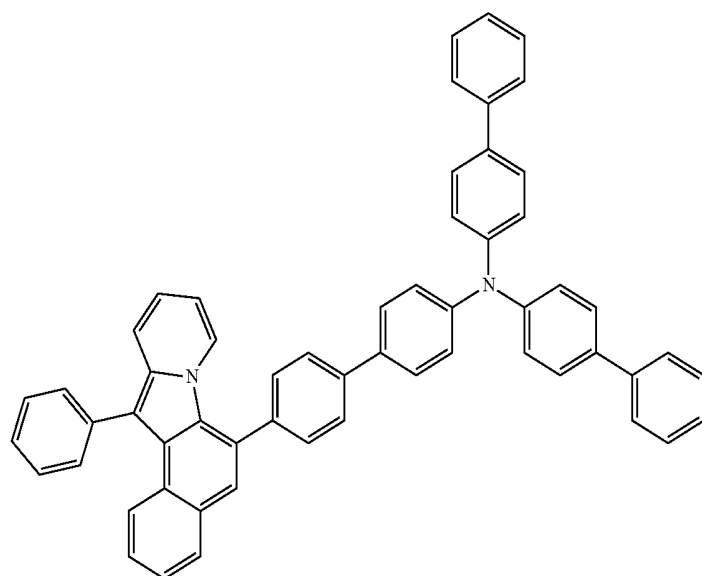
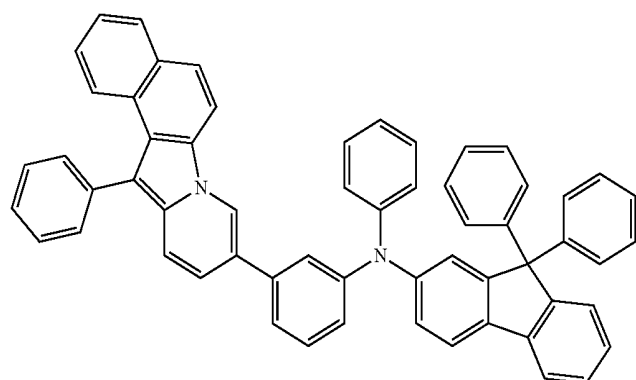


TABLE 1-continued



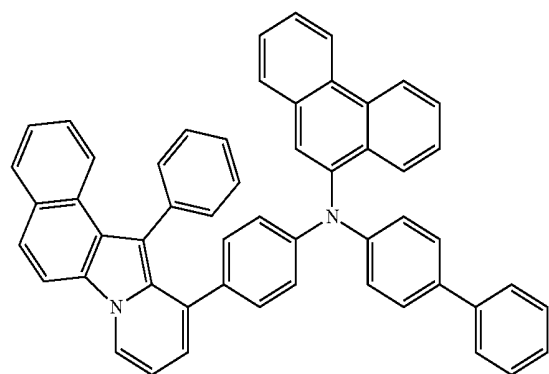
Compound E55

E55



Compound E73

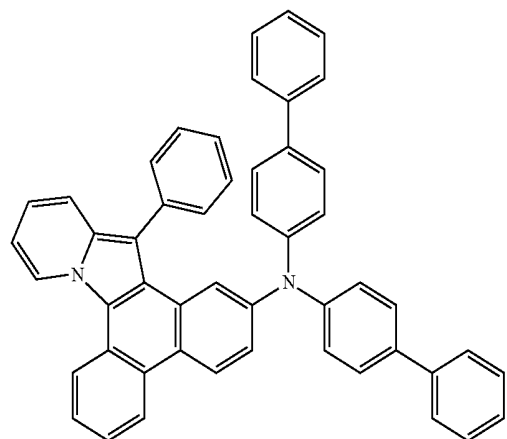
E73



Compound E89

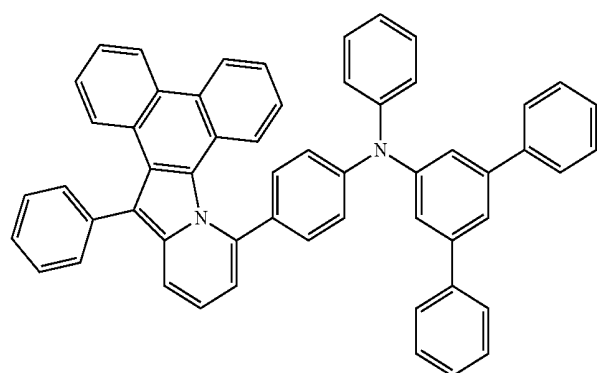
E89

TABLE 1-continued



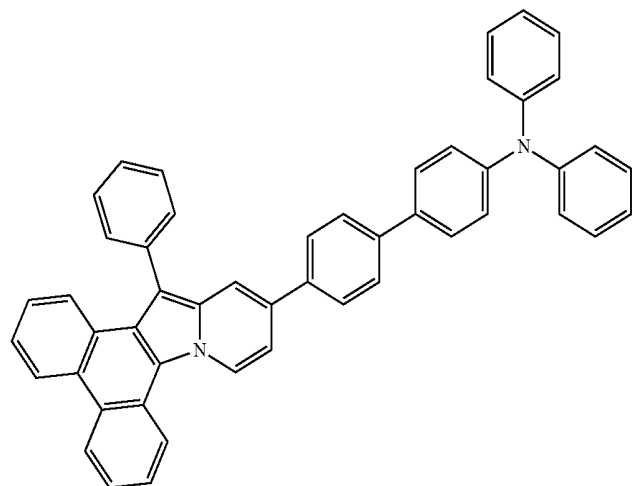
F21

Compound F21



F63

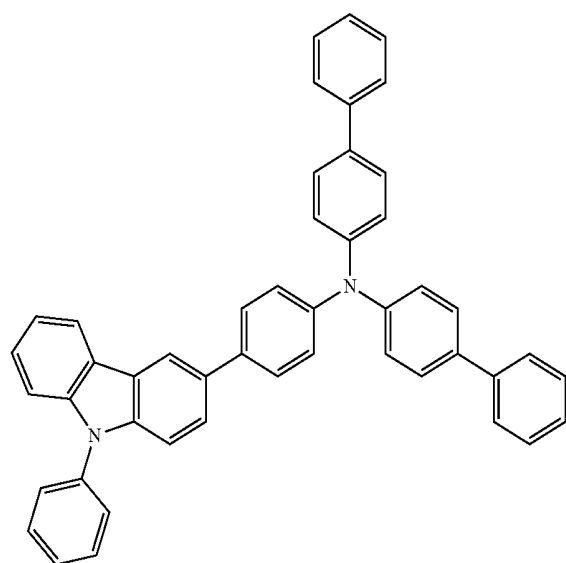
Compound F63



F82

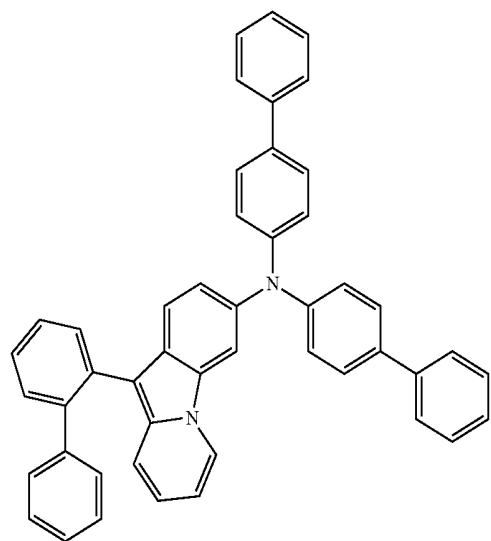
Compound F82

TABLE 1-continued



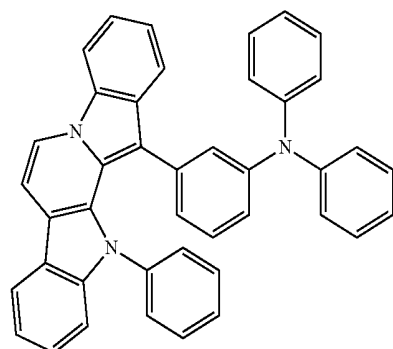
Comparative Compound R1

R1



Comparative Compound R2

R2



Comparative Compound R3

R3

TABLE 1-continued

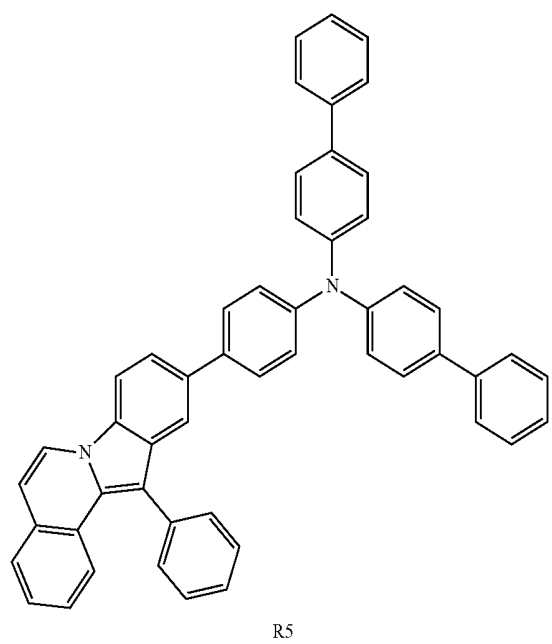
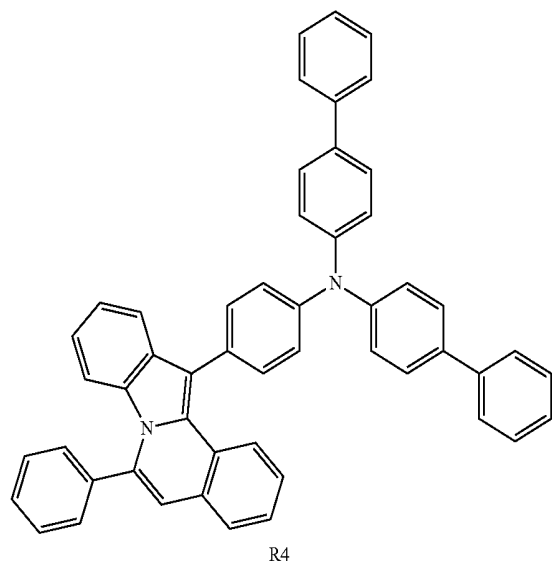
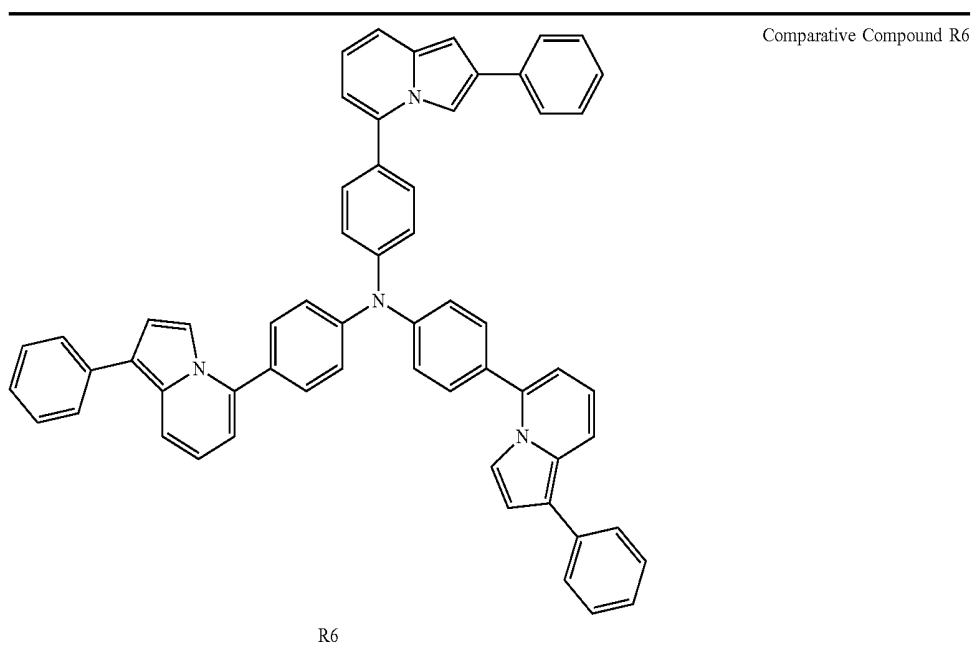


TABLE 1-continued



[0255] On a glass substrate, ITO was patterned to a thickness of about 1,500 Å, washed with ultra-pure water, and subjected to UV ozone treatment for about 10 minutes. Then, a hole injection layer was formed by depositing 2-TNATA to a thickness of about 600 Å. Then, a hole transport layer was formed by depositing the Example Compound or the Comparative Compound to a thickness of about 300 Å.

[0256] After that, an emission layer was formed using ADN doped with 3% TBP to a thickness of about 250 Å. Then, an electron transport layer was formed by depositing Alq₃ to a thickness of about 250 Å and an electron injection layer was formed by depositing LiF to a thickness of about 10 Å.

[0257] Then, a second electrode was formed by depositing Al to a thickness of about 1,000 Å.

[0258] The hole injection layer, the hole transport layer, the emission layer, the electron transport layer, the electron injection layer and the second electrode were each formed using a vacuum deposition apparatus.

Evaluation of Properties of Organic Electroluminescence Device

[0259] The evaluation results of the organic electroluminescence devices according to Example 1 to Example 18 and Comparative Example 1 to Comparative Example 6 are shown in Table 2. In Table 2, the driving voltage, the emission efficiency, and the device life of the organic electroluminescence devices thus manufactured are compared and shown. In the evaluation results of the properties of the Examples and the Comparative Examples in Table 2, the emission efficiency is the efficiency value at a current density of 10 mA/cm², and the device life is the half-life at a current density of 1.0 mA/cm².

[0260] The current density, voltage, and emission efficiency of the organic electroluminescence devices of the Examples and the Comparative Examples were measured using a 2400 series Source Meter (Keithley Instrument Co.),

a luminous brightness measurement apparatus, CS-200 (Konica Minolta Co.), and PC Program LabVIEW 2.0 (National Instrument Co., Japan).

TABLE 2

Device manufacturing example	Hole transport layer material	Voltage (V)	Emission efficiency (cd/A)	Device life [LT50] (hrs)
Example 1	Compound A1	5.4	7.8	2050
Example 2	Compound A28	5.5	7.8	2000
Example 3	Compound A57	5.6	7.6	2000
Example 4	Compound B36	5.7	7.9	2050
Example 5	Compound B46	5.6	8.0	1950
Example 6	Compound C47	5.9	8.0	1900
Example 7	Compound C87	5.6	7.7	2050
Example 8	Compound D47	5.9	7.9	2050
Example 9	Compound D60	5.8	7.8	2100
Example 10	Compound D74	5.7	7.8	2100
Example 11	Compound E6	5.6	7.7	2050
Example 12	Compound E25	5.6	7.7	2000
Example 13	Compound E55	5.8	7.6	2000
Example 14	Compound E73	5.7	7.8	2050
Example 15	Compound E89	5.8	7.8	2000
Example 16	Compound F21	5.6	7.6	2100
Example 17	Compound F63	5.8	7.8	2050
Example 18	Compound F82	5.6	7.6	2000
Comparative Example 1	Comparative Compound R1	6.3	6.4	1600
Comparative Example 2	Comparative Compound R2	6.2	6.4	1650
Comparative Example 3	Comparative Compound R3	6.5	6.0	1650
Comparative Example 4	Comparative Compound R4	6.0	7.0	1800
Comparative Example 5	Comparative Compound R5	6.0	7.0	1850
Comparative Example 6	Comparative Compound R6	6.7	5.8	1550

[0261] Referring to the results of Table 2, it may be found that the example organic electroluminescence devices using the amine compounds according to embodiments of the

present disclosure as hole transport materials showed a low driving voltage, excellent device efficiency, and good life characteristics.

[0262] It may be found that each of Example 1 to Example 18 showed a lower driving voltage, higher emission efficiency, and improved half-life compared to each of Comparative Example 1 to Comparative Example 6.

[0263] In Example 1 to Example 10, the amine compounds in Compound Group 1 were used as hole transport layer materials. In Example 11 to Example 18, the amine compounds in Compound Group 2 were used as the hole transport layer materials. For example, in Example 1 to Example 10, amine compounds according to embodiments of the present disclosure, in which an aromatic hydrocarbon ring was condensed with the pyridine ring of a pyridoindole moiety were used as hole transport layer materials, and in Example 11 to Example 18, amine compounds according to embodiments of the present disclosure in which an aromatic hydrocarbon ring was condensed with the indole ring of a pyridoindole moiety were used as hole transport layer materials. Referring to the results of Table 2, it was found that all devices including the amine compounds of Compound Group 1 and Compound Group 2 showed better emission efficiency and improved life characteristics than the devices of the Comparative Examples. In addition, referring to the results of Example 1 to Example 7, excellent emission efficiency and life characteristics were shown regardless of the particular position of a hexagonal hydrocarbon ring.

[0264] In addition, in Example 8 to Example 10 and Example 16 to Example 18, amine compounds including two hexagonal hydrocarbon rings condensed with a pyridoindole moiety were used as hole transport layer materials. In this case, it was found that emission life characteristics were somewhat improved when compared with the other Examples. Without being bound by the correctness of any particular explanation or theory, it is thought that the highest occupied molecular orbital (HOMO) of a substituent including an arylamine moiety is expanded to the condensed rings in the pyridoindole moiety, and the greater delocalization enables improved stability of a radical state.

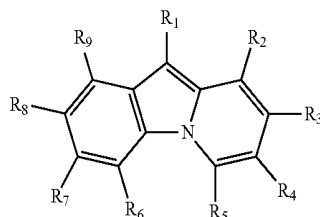
[0265] Comparative Example 1 corresponds to a case in which an amine compound having a carbazole group instead of a pyridoindole moiety is used. Comparative Example 2 corresponds to a case in which an amine compound includes a pyridoindole moiety but without a condensed hexagonal ring. Both cases showed inferior device life and emission efficiency when compared with the Examples. Without being bound by the correctness of any particular explanation or theory, it is thought that the delocalization of the HOMO over the arylamine moiety is decreased in these Comparative Examples compared to the Example Compounds, and as such, stability of a radical state is decreased.

[0266] Comparative Example 3 includes a pyridoindole moiety, but differs in that an additional indole ring is condensed with the pyridoindole (e.g., at the pyridine ring). In the structure of Comparative Example 3, it was found that carrier balance was collapsed, and both device efficiency and device life were degraded (e.g., simultaneously) compared to the Examples.

[0267] Each of Comparative Example 4 and Comparative Example 5 include a similar pyridoindole moiety and arylamine moiety as the amine compounds of the Examples, but device life was decreased when compared with the Examples. Without being bound by the correctness of any

particular explanation or theory, it is thought that the pyridoindole moiety is combined with the arylamine moiety at a position having particularly high reactivity, such that the stability of a radical state is degraded. For example, the arylamine moiety in Comparative Example 4 is combined with "HT" at position R₁ as denoted in Formula 2. The arylamine moiety in Comparative Example 5 is combined with "HT" at position R₈ as denoted in Formula 2. In each of the Example Compounds of the present disclosure, the R₁ and R₈ positions as denoted in Formula 2 are not combined with an arylamine moiety.

Formula 2



[0268] Comparative Example 6 includes a material having three nitrogen-containing heterocycles, and molecular symmetry was excessively high (e.g., three-fold symmetric around the nitrogen atom). Without being bound by the correctness of any particular explanation or theory, it is believed that molecular stacking was induced, and the amorphous properties of the compound were degraded. Accordingly, both device efficiency and device life were low (e.g., simultaneously) compared to the Examples.

[0269] Accordingly, referring to the results of Example 1 to Example 18 and Comparative Example 1 to Comparative Example 6, the amine compound according to an embodiment of the present disclosure included both (e.g., simultaneously) a pyridoindole moiety condensed with an aromatic hexagonal ring and an arylamine moiety, and by selecting a suitable combination position of the arylamine moiety and the pyridoindole moiety, both emission efficiency and device life may be improved (e.g., simultaneously).

[0270] For example, the amine compound according to an embodiment of the present disclosure may be used in a hole transport region and may improve the emission efficiency of an organic electroluminescence device.

[0271] The amine compound according to an embodiment of the present disclosure includes a pyridoindole moiety with which at least one hexagonal hydrocarbon ring is condensed, and an arylamine moiety that is combined with the pyridoindole moiety, such that the hole transport capacity of the compound may be increased, and tolerance to high heat and charge tolerance may be increased. Accordingly, the emission efficiency and device life of the organic electroluminescence device according to an embodiment of the present disclosure may be improved.

[0272] The amine compound according to an embodiment of the present disclosure may improve the emission efficiency and device life of an organic electroluminescence device.

[0273] The organic electroluminescence device according to an embodiment of the present disclosure includes the amine compound according to an embodiment of the present disclosure in a hole transport region and may achieve high efficiency.

[0274] As used herein, the terms “use”, “using”, and “used” may be considered synonymous with the terms “utilize”, “utilizing”, and “utilized”, respectively. Further, the use of “may” when describing embodiments of the present disclosure refers to “one or more embodiments of the present disclosure”.

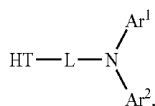
[0275] As used herein, the terms “substantially”, “about”, and similar terms are used as terms of approximation and not as terms of degree, and are intended to account for the inherent deviations in measured or calculated values that would be recognized by those of ordinary skill in the art.

[0276] Also, any numerical range recited herein is intended to include all subranges of the same numerical precision subsumed within the recited range. For example, a range of “1.0 to 10.0” is intended to include all subranges between (and including) the recited minimum value of 1.0 and the recited maximum value of 10.0, that is, having a minimum value equal to or greater than 1.0 and a maximum value equal to or less than 10.0, such as, for example, 2.4 to 7.6. Any maximum numerical limitation recited herein is intended to include all lower numerical limitations subsumed therein and any minimum numerical limitation recited in this specification is intended to include all higher numerical limitations subsumed therein. Accordingly, Applicant reserves the right to amend this specification, including the claims, to expressly recite any sub-range subsumed within the ranges expressly recited herein.

[0277] Although example embodiments of the present disclosure have been described herein, it is understood that the present disclosure should not be limited to these example embodiments, and that various changes and modifications can be made by one ordinary skilled in the art within the spirit and scope of the present disclosure, as defined by the following claims and equivalents thereof.

What is claimed is:

1. An organic electroluminescence device, comprising: a first electrode; a second electrode on the first electrode; and a plurality of organic layers between the first electrode and the second electrode, wherein at least one organic layer of the plurality of organic layers comprises an amine compound represented by Formula 1:



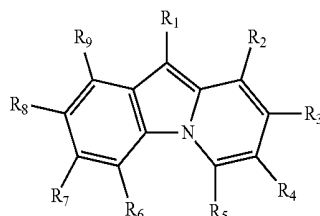
Formula 1

wherein, in Formula 1,

Ar_1 and Ar_2 are each independently a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

L is a direct linkage, a substituted or unsubstituted arylene group of 6 to 30 carbon atoms for forming a ring, or a substituted or unsubstituted heteroarylene group of 2 to 30 carbon atoms for forming a ring, and

HT is represented by Formula 2:



Formula 2

wherein, in Formula 2,

R_1 to R_9 are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

at least one pair selected from R_2 and R_3 , R_3 and R_4 , R_4 and R_5 , R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 is combined with each other to form a hexagonal hydrocarbon ring, and

when at least one pair of R_2 and R_3 , R_3 and R_4 , and R_4 and R_5 forms a hexagonal hydrocarbon ring, R_8 is a hydrogen atom.

2. The organic electroluminescence device of claim 1, wherein the plurality of organic layers comprises:

an emission layer; and

a hole transport region between the first electrode and the emission layer,

wherein the hole transport region comprises the amine compound represented by Formula 1.

3. The organic electroluminescence device of claim 2, wherein the emission layer is to emit blue light and/or green light.

4. The organic electroluminescence device of claim 1, wherein the plurality of organic layers comprises:

an emission layer;

a hole injection layer between the first electrode and the emission layer; and

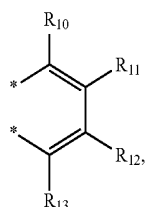
a hole transport layer between the hole injection layer and the emission layer,

wherein the hole transport layer comprises the amine compound represented by Formula 1.

5. The organic electroluminescence device of claim 1, wherein one or two pairs selected from R_2 and R_3 , R_3 and R_4 , and R_4 and R_5 each form the hexagonal hydrocarbon ring.

6. The organic electroluminescence device of claim 1, wherein one or two pairs selected from R_6 and R_7 , R_7 and R_8 , and R_8 and R_9 each form the hexagonal hydrocarbon ring.

7. The organic electroluminescence device of claim 1, wherein the hexagonal hydrocarbon ring is represented by Formula 3:



Formula 3

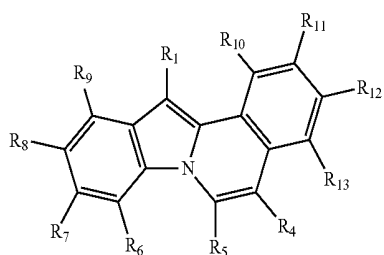
wherein, in Formula 3,

R_{10} to R_{13} are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms, and

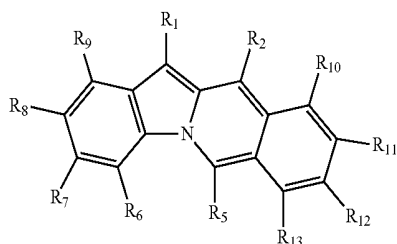
* is a combining part with Formula 2.

8. The organic electroluminescence device of claim 7, wherein any one of R_2 to R_9 or any one of R_{10} to R_{13} that is not a part of the hexagonal hydrocarbon ring, is combined with L in Formula 1.

9. The organic electroluminescence device of claim 7, wherein HT is represented by one selected from Formula 2-1a to Formula 2-1d:

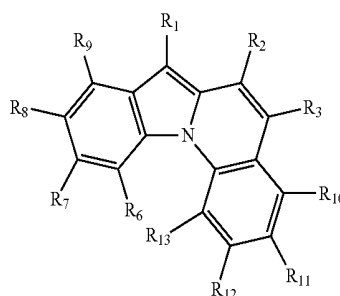


Formula 2-1a

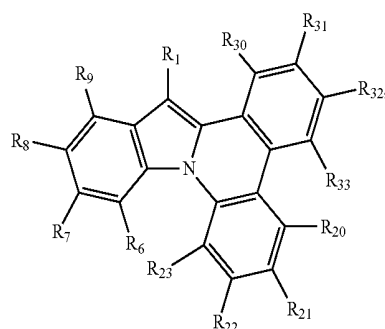


Formula 2-1b

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Formula 2-1c



Formula 2-1d

wherein, in Formula 2-1d,

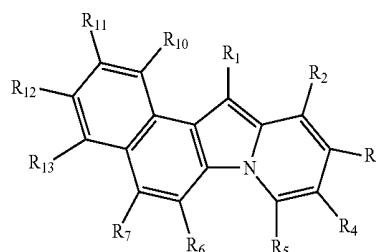
R_{20} to R_{23} and R_{30} to R_{33} are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

wherein, in Formula 2-1a to Formula 2-1d,

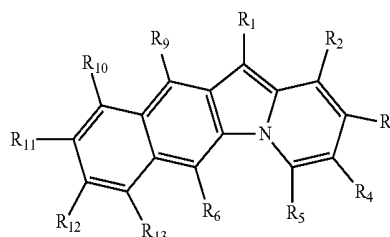
R_1 to R_9 are the same as defined in Formula 2, and

R_{10} to R_{13} are the same as defined in Formula 3.

10. The organic electroluminescence device of claim 7, wherein HT is represented by one selected from Formula 2-2a to Formula 2-2d:

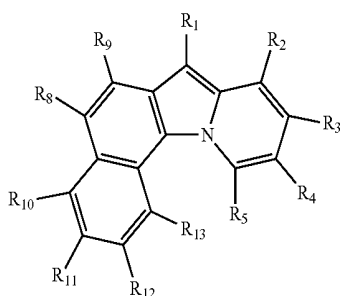


Formula 2-2a

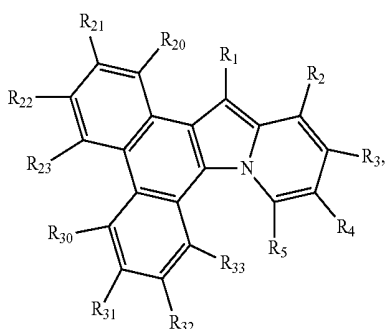


Formula 2-2b

-continued



Formula 2-2c



Formula 2-2d

wherein, in Formula 2-2d,

R_{20} to R_{23} and R_{30} to R_{33} are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

wherein, in Formula 2-2a to Formula 2-2d,

R_1 to R_9 are the same as defined in Formula 2, and

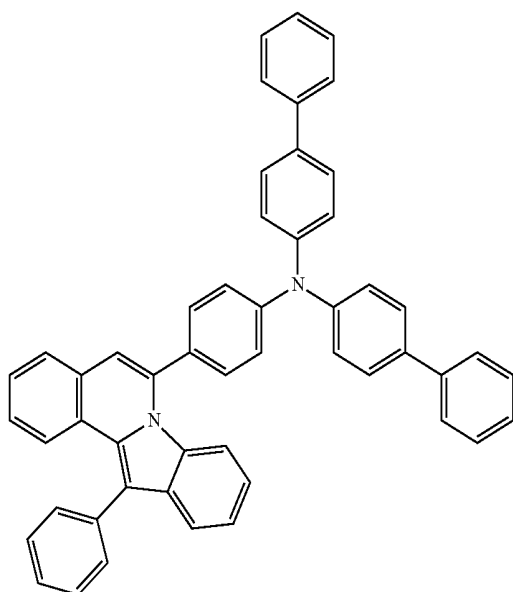
R_{10} to R_{13} are the same as defined in Formula 3.

11. The organic electroluminescence device of claim 1, wherein R_1 is an unsubstituted phenyl group, an unsubstituted naphthyl group, an unsubstituted biphenyl group, an unsubstituted dibenzofuranyl group, or an unsubstituted dibenzothiophene group.

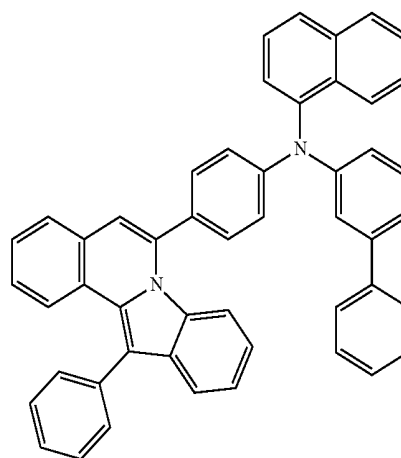
12. The organic electroluminescence device of claim 1, wherein L is a direct linkage, a substituted or unsubstituted phenylene group, a substituted or unsubstituted divalent biphenyl group, a substituted or unsubstituted divalent terphenyl group, a substituted or unsubstituted divalent phenanthrene group, a substituted or unsubstituted naphthylene group, or a substituted or unsubstituted divalent dibenzofuran group.

13. The organic electroluminescence device of claim 1, wherein the amine compound represented by Formula 1 is represented by at least one selected from Compound Group 1 and Compound Group 2:

Compound Group 1



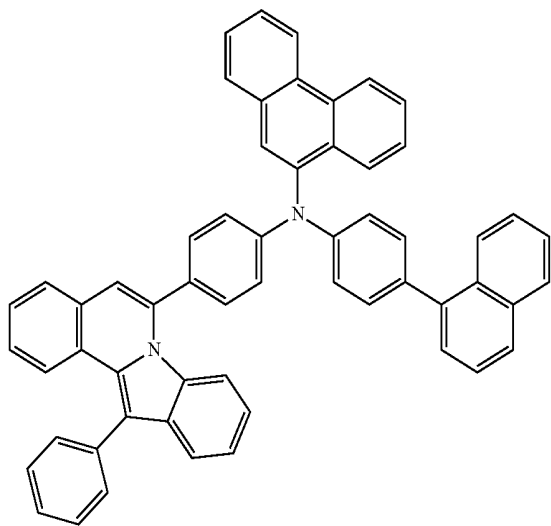
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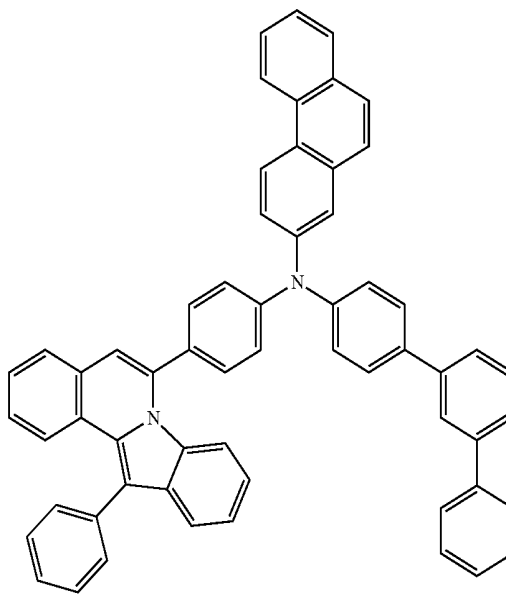
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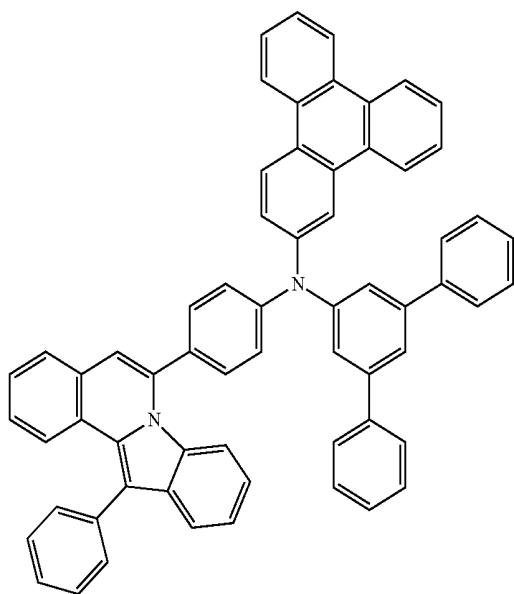
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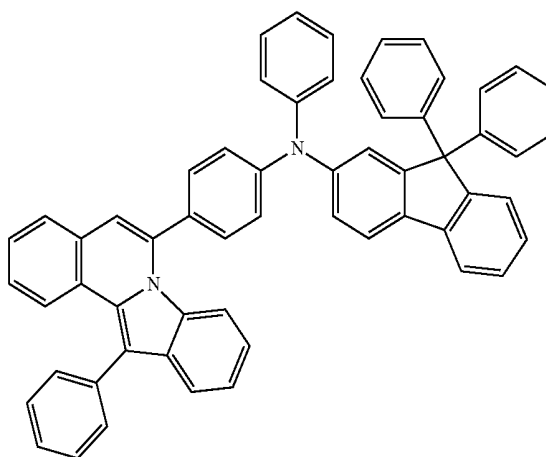
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A5



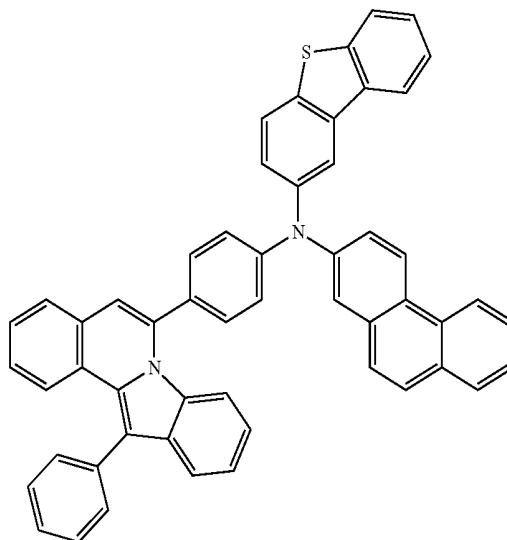
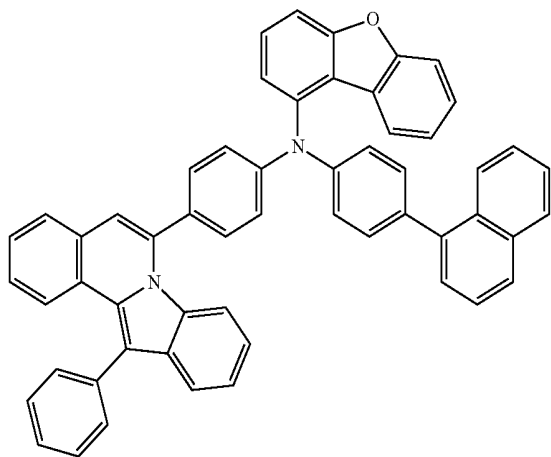
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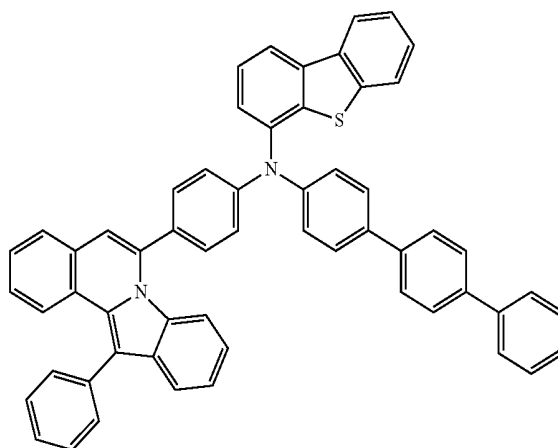
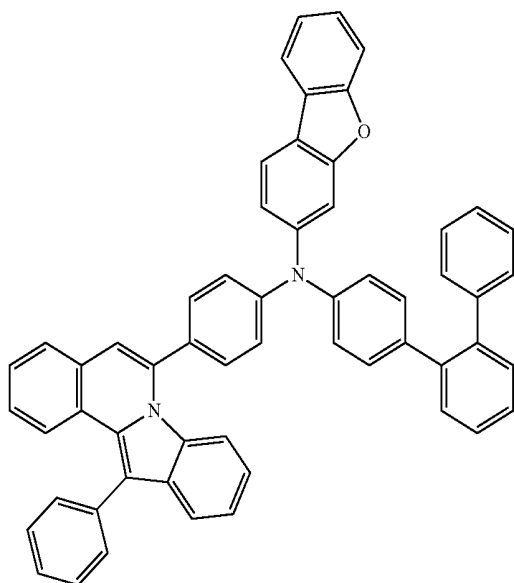
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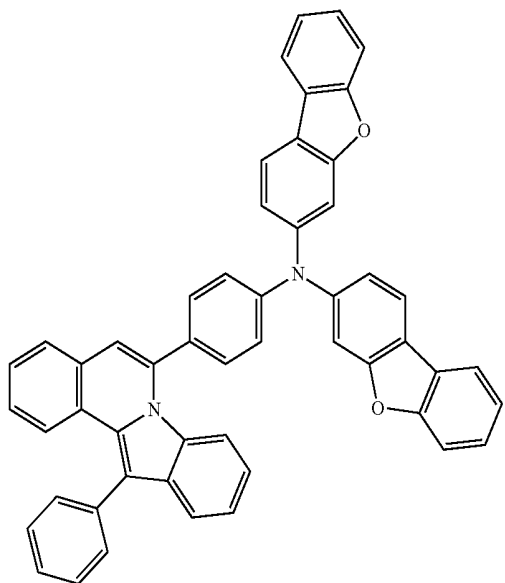
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A10

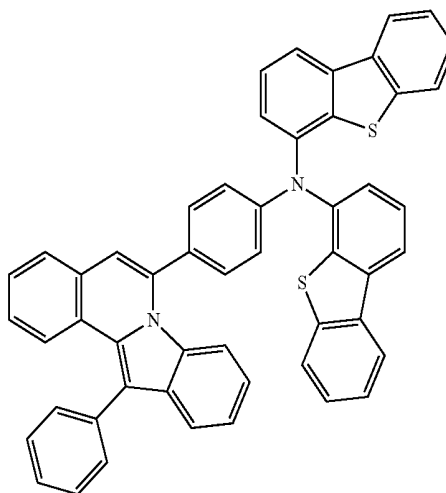


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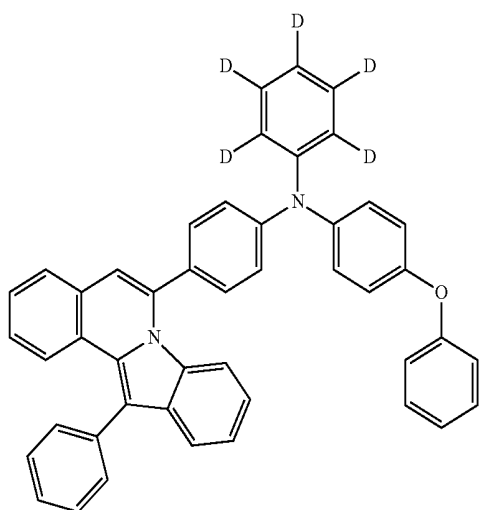
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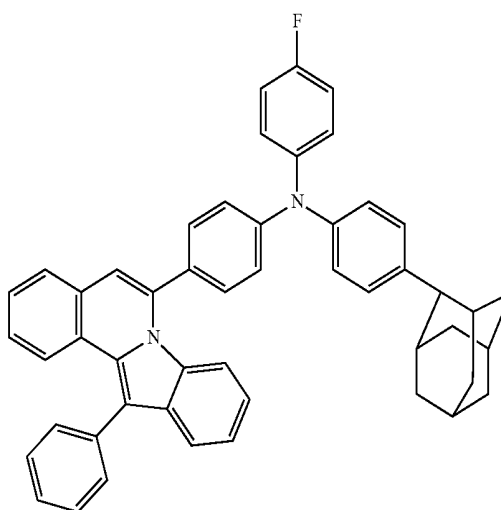
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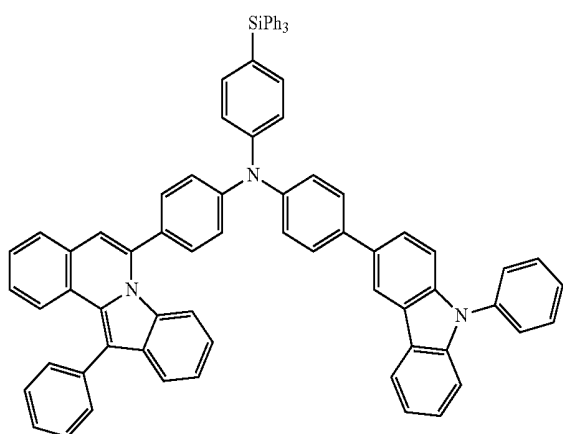
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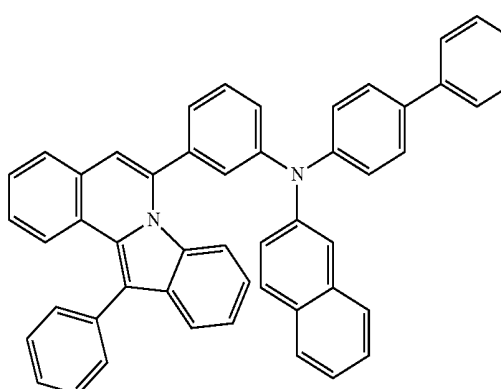
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A15

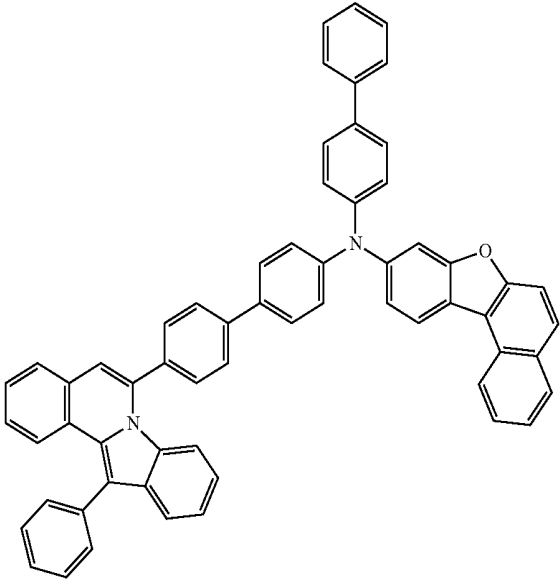


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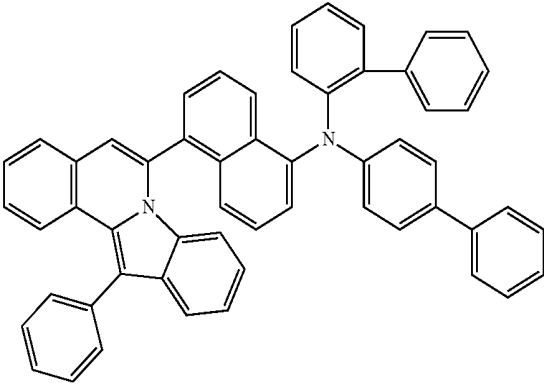


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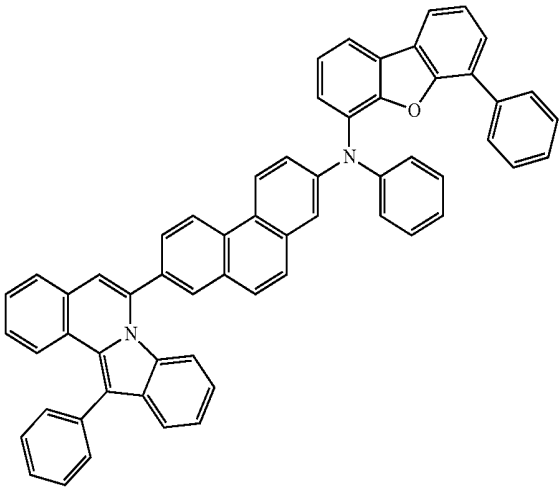
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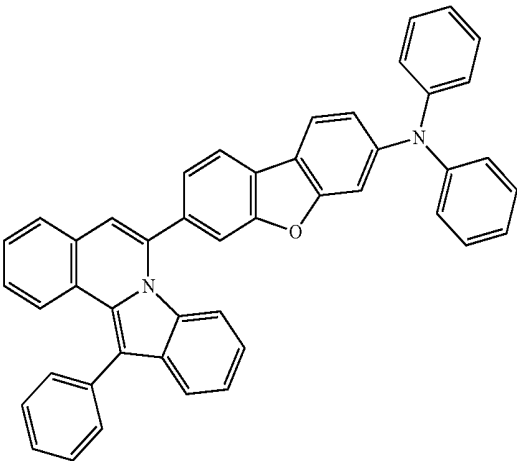
A18



A19

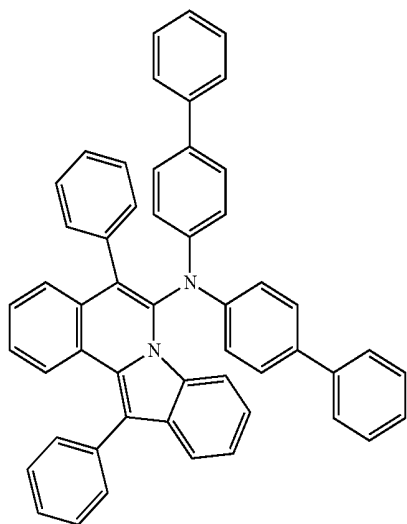


A20

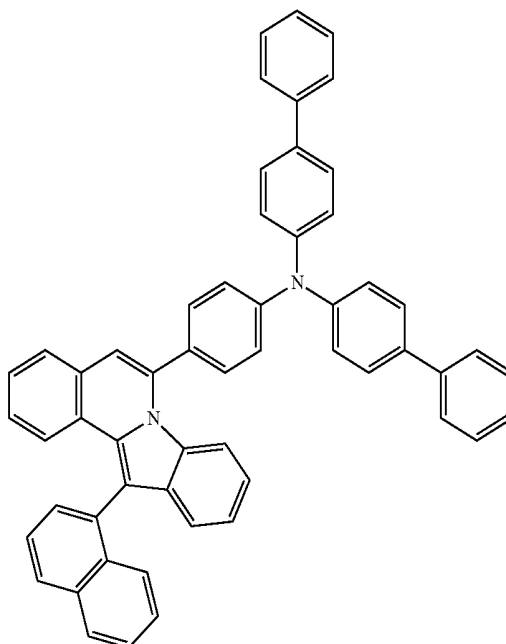


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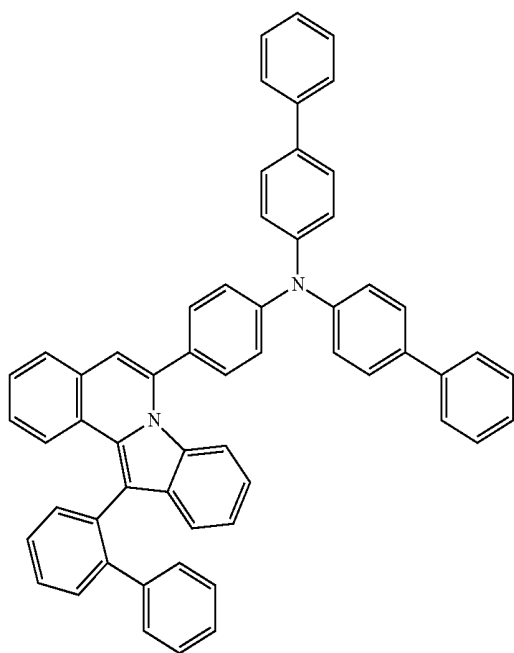
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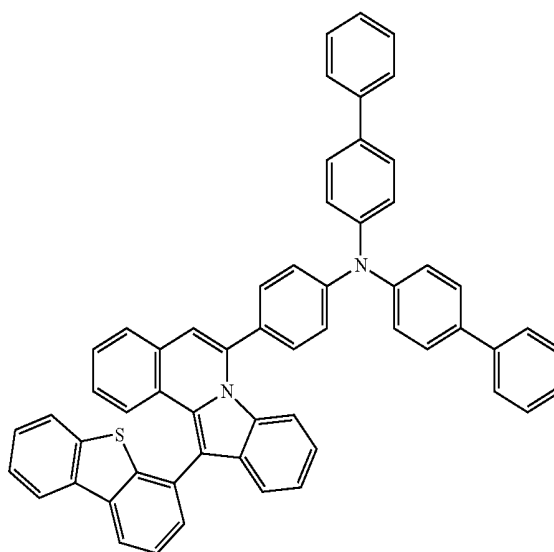
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A23

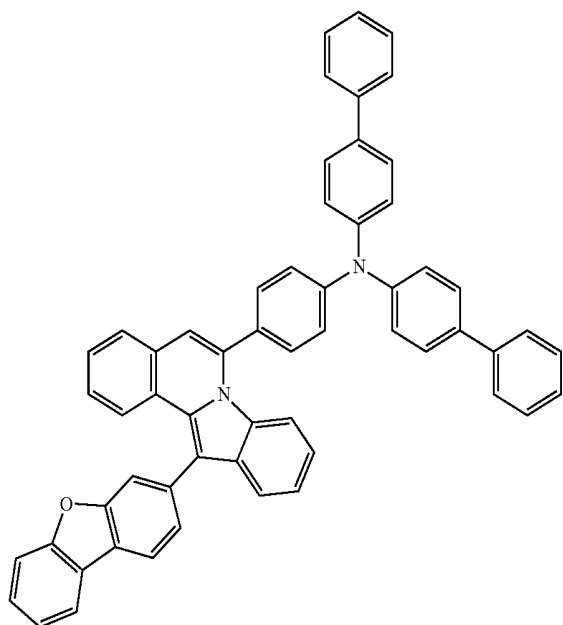


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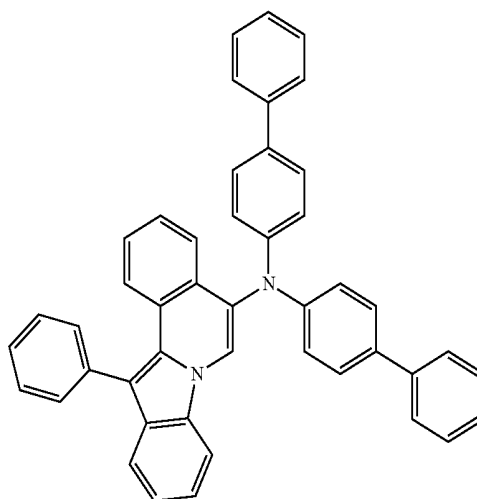


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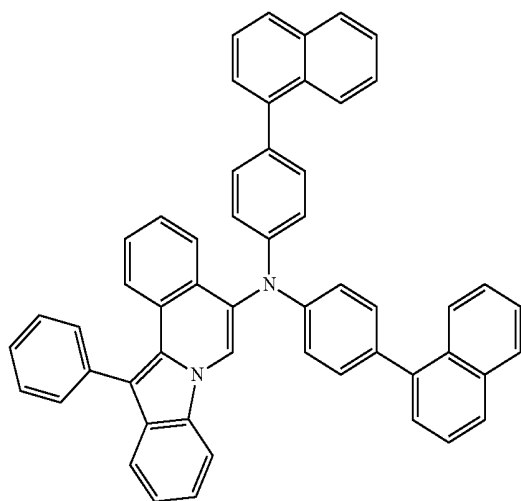
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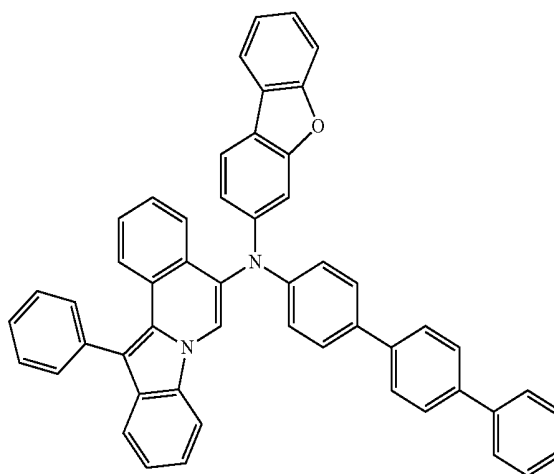
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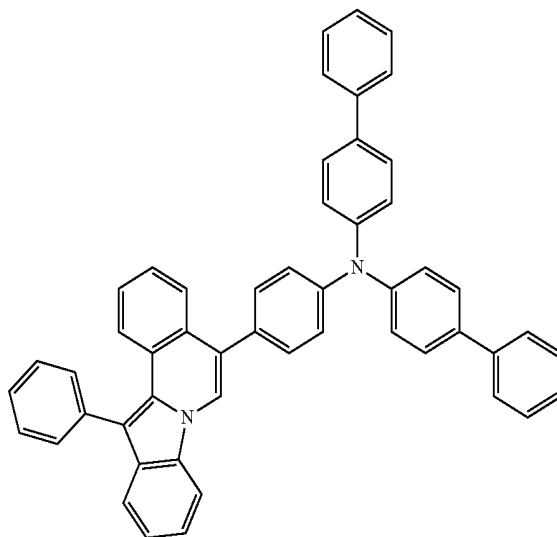
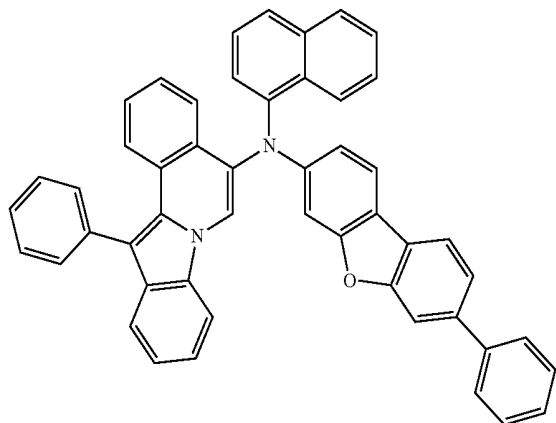
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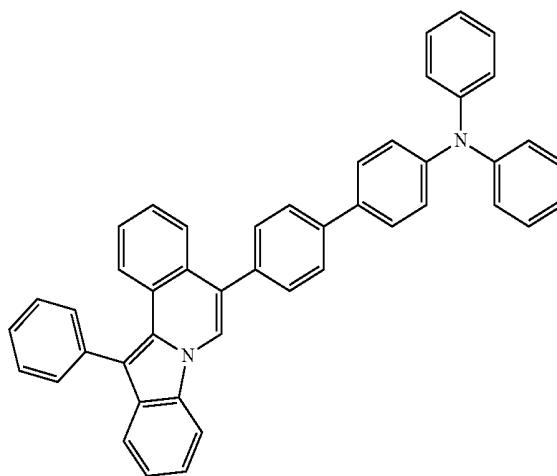
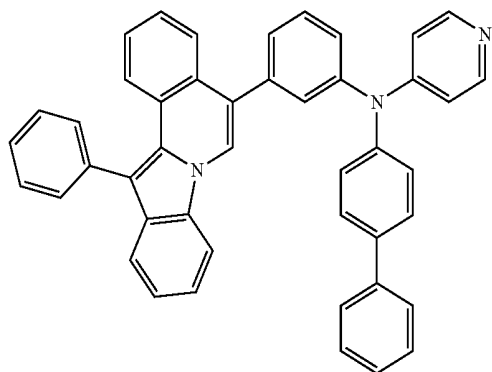
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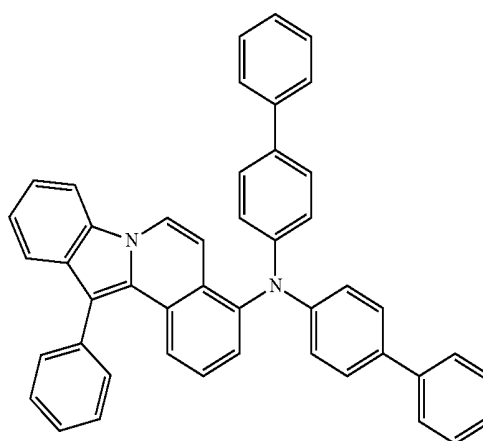
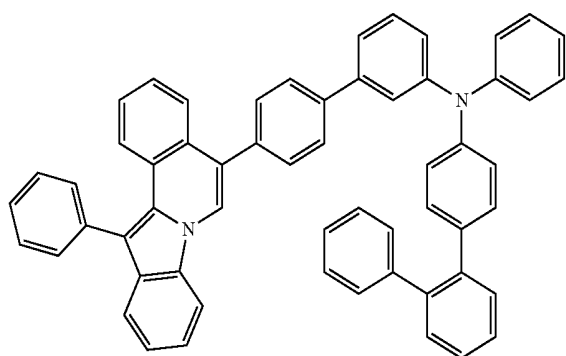
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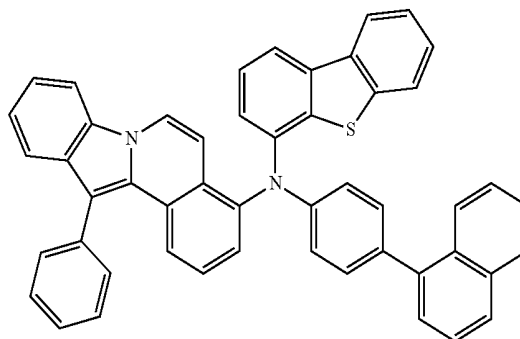
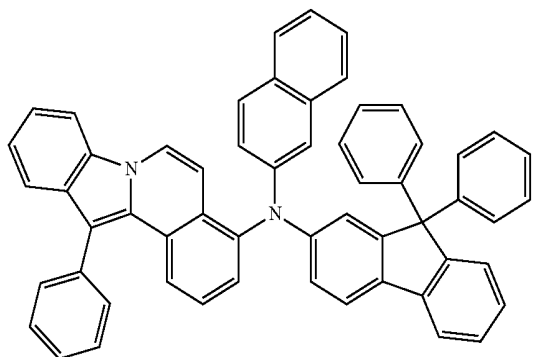
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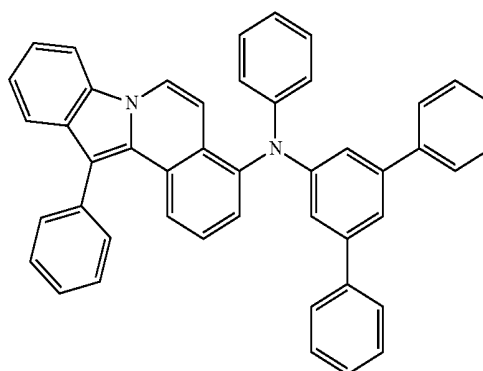
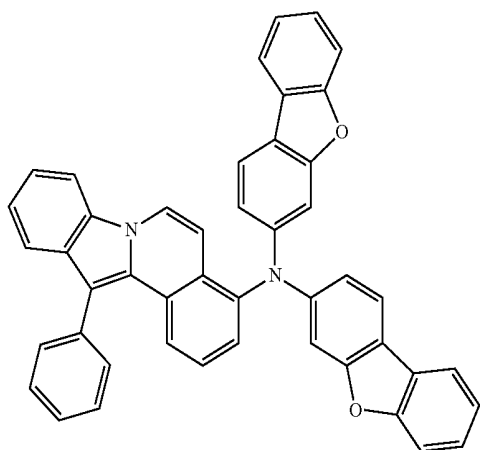
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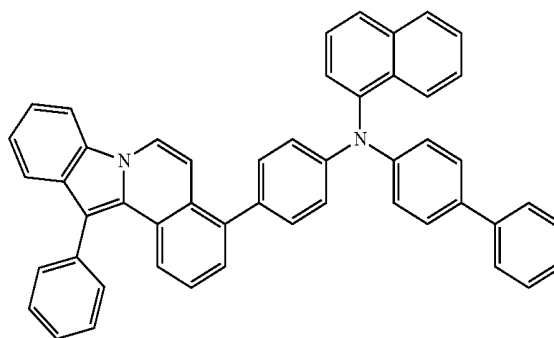
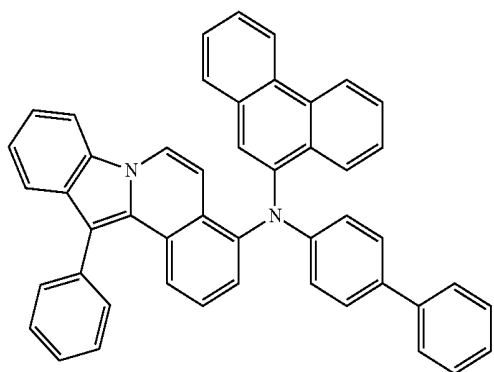
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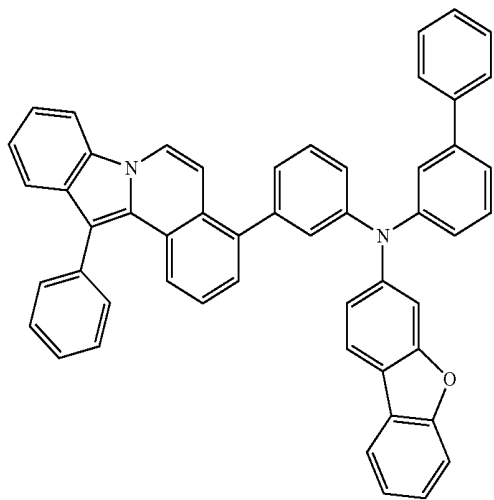
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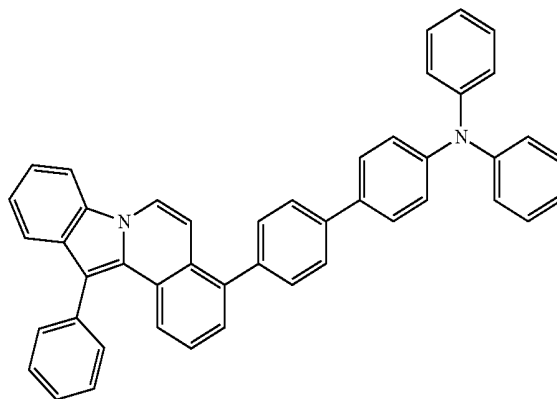


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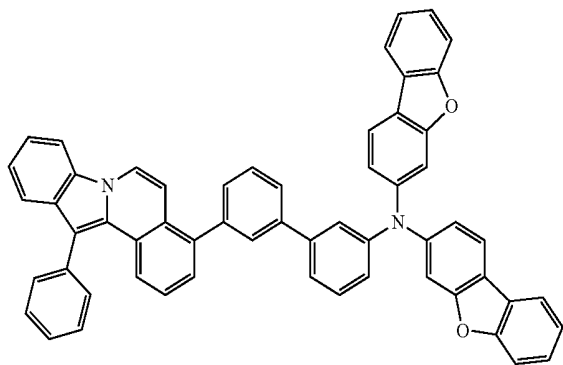
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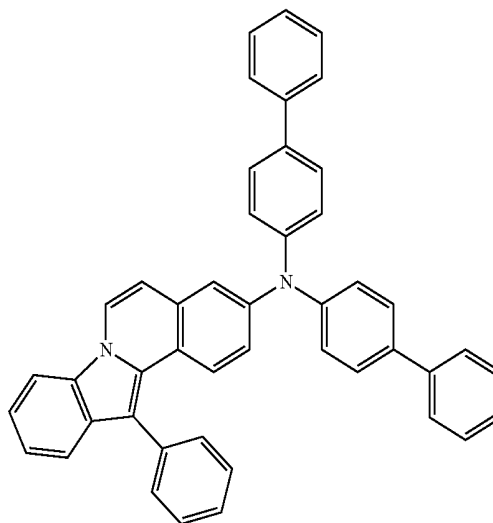
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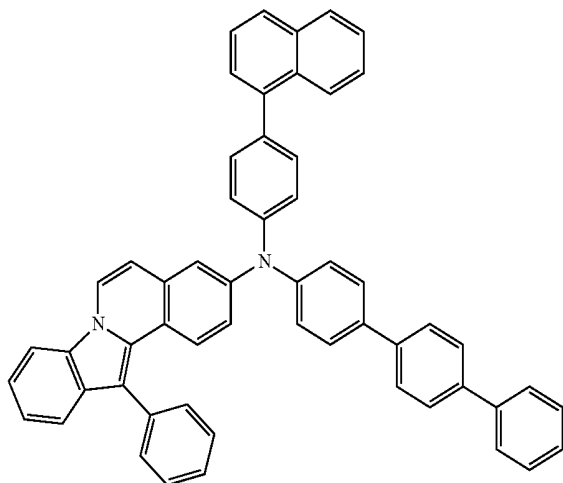
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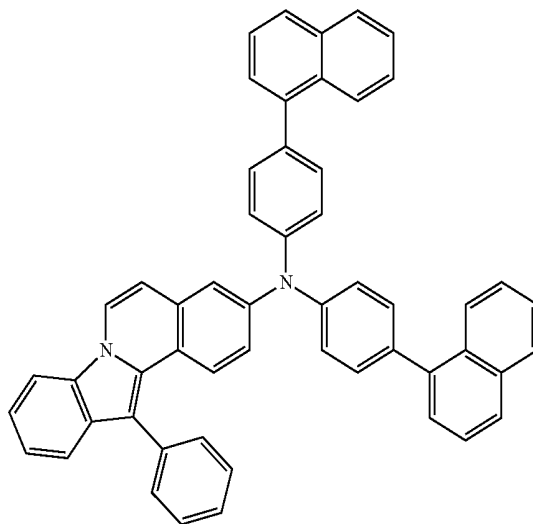
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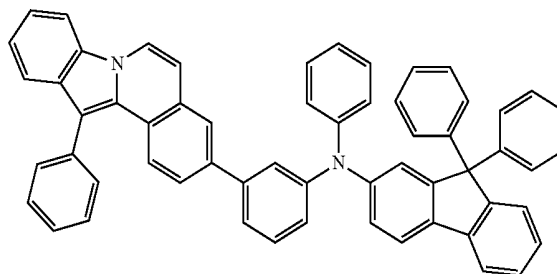
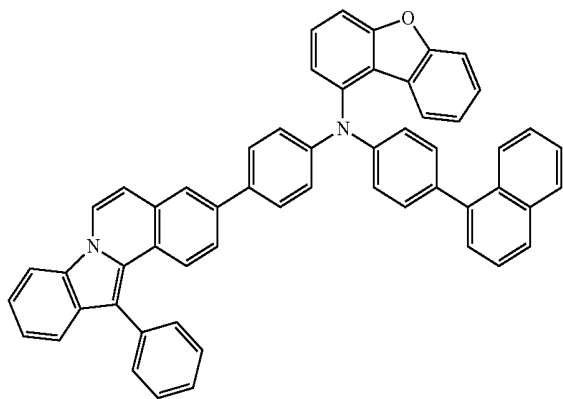
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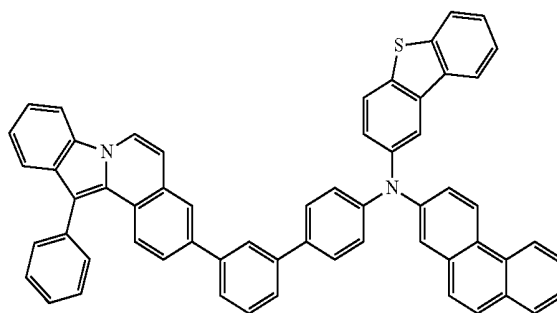
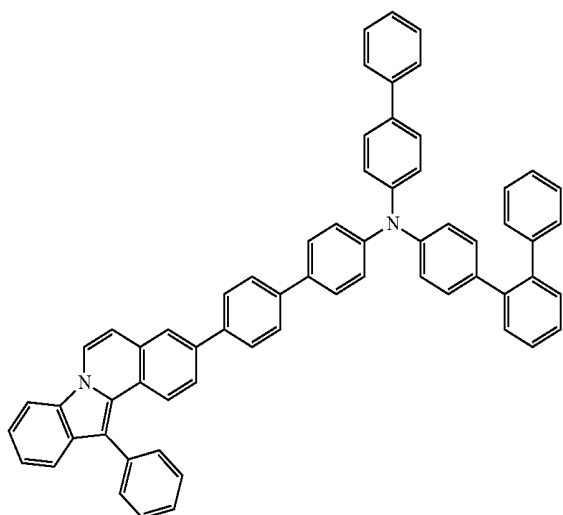
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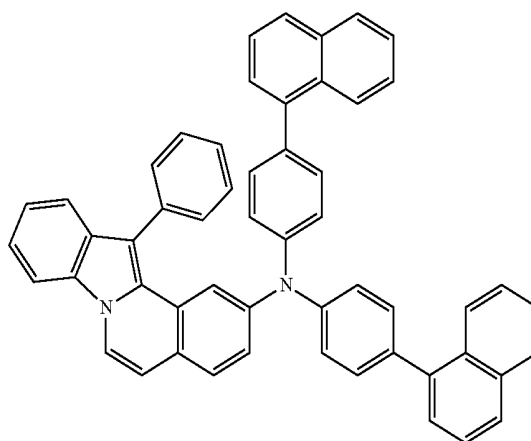
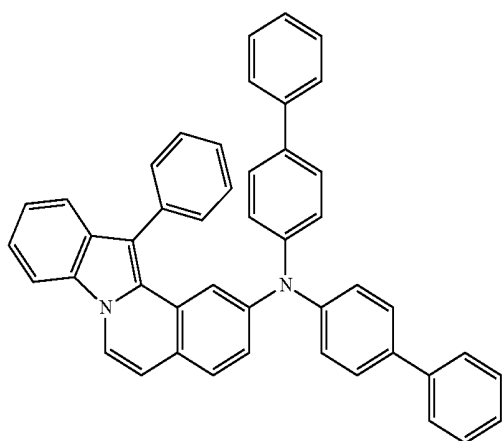
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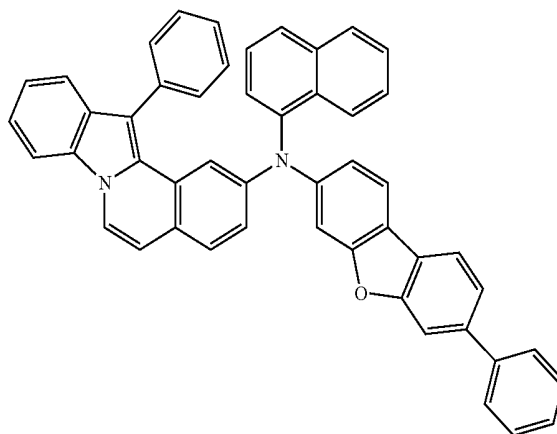
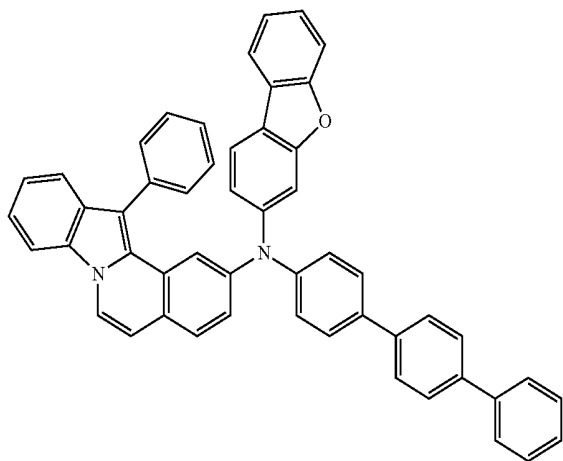
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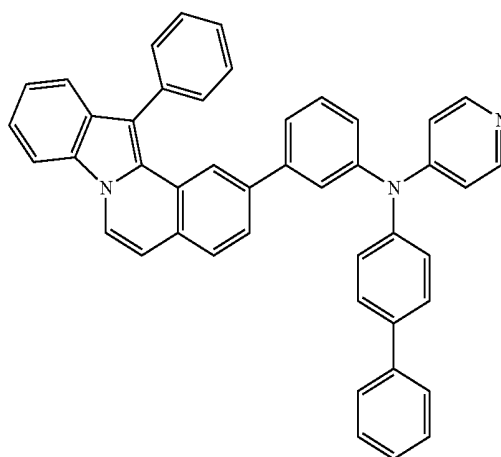
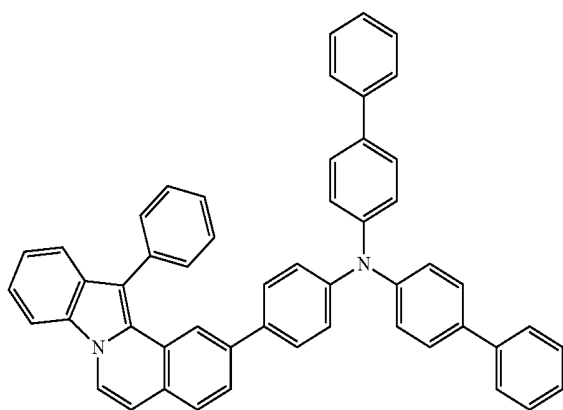
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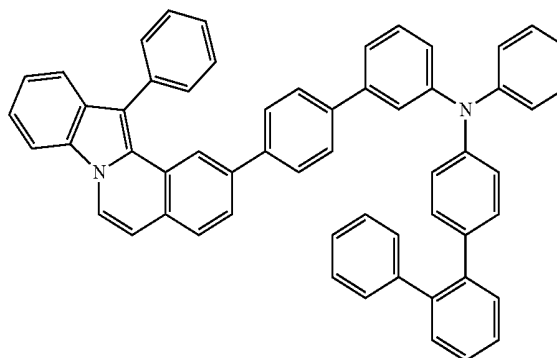
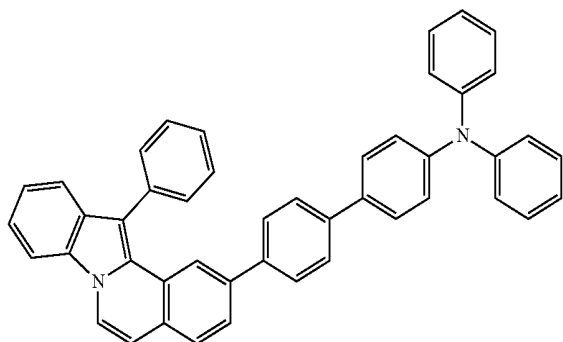
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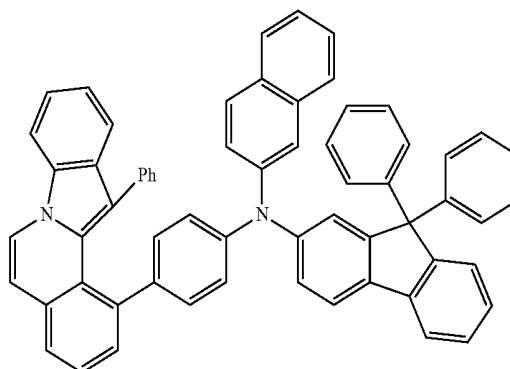
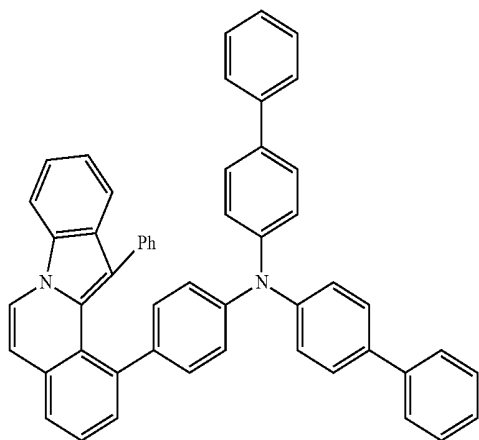
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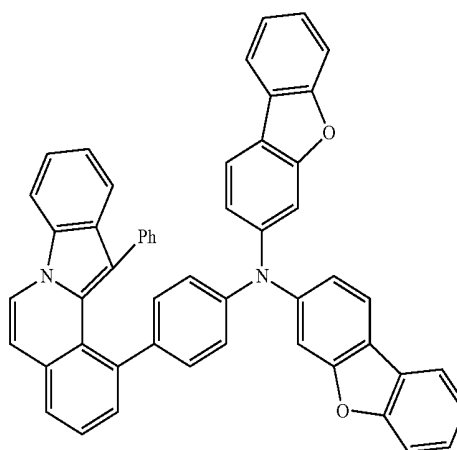
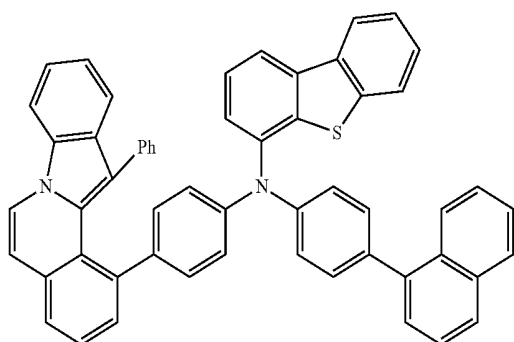
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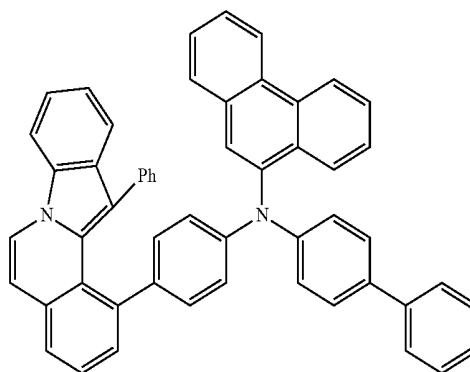
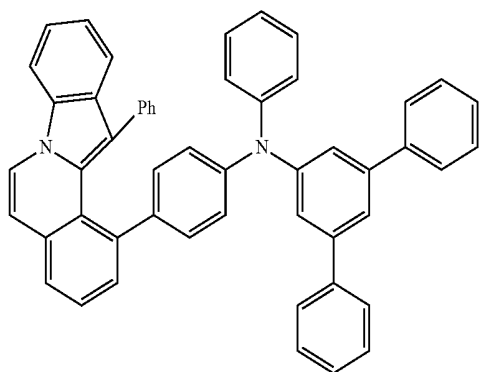
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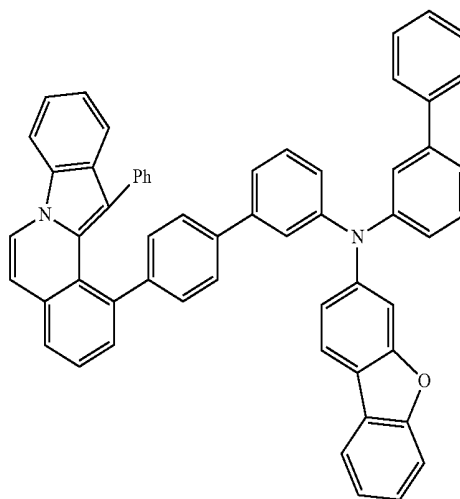
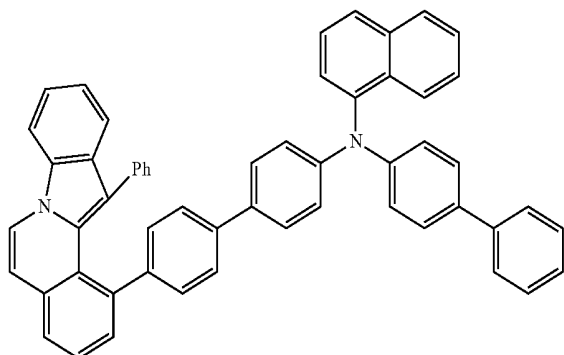
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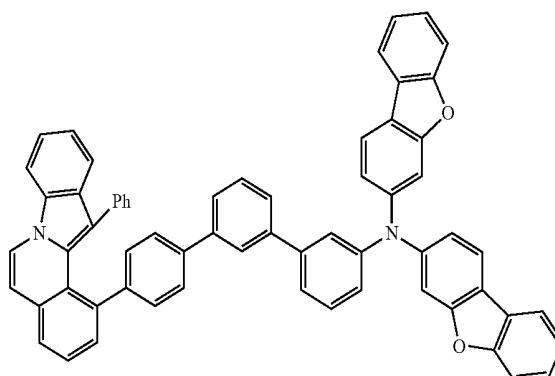
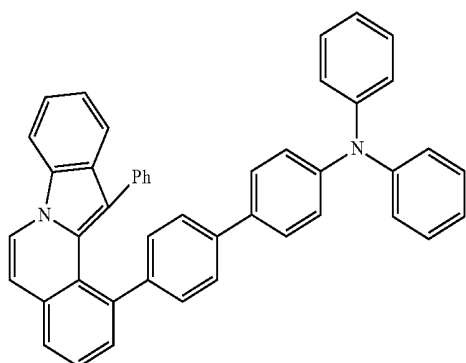
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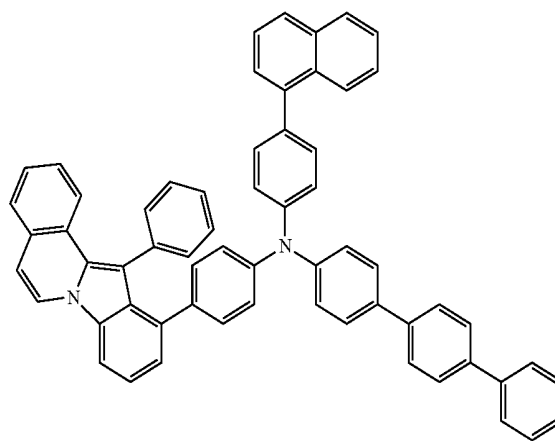
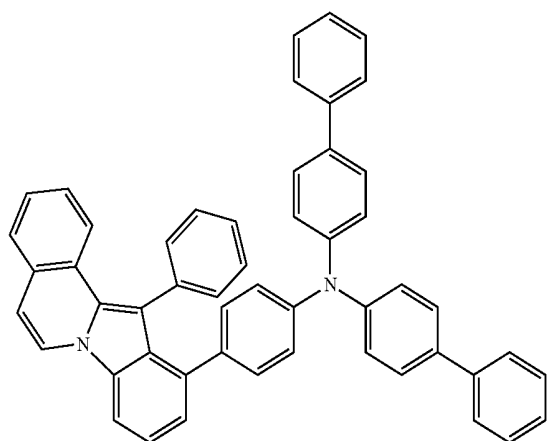
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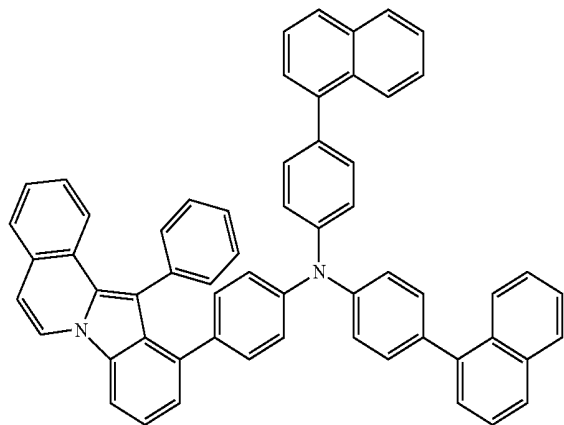
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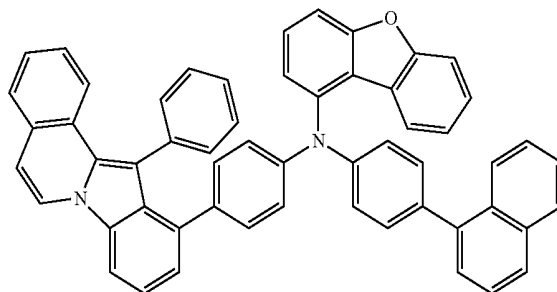


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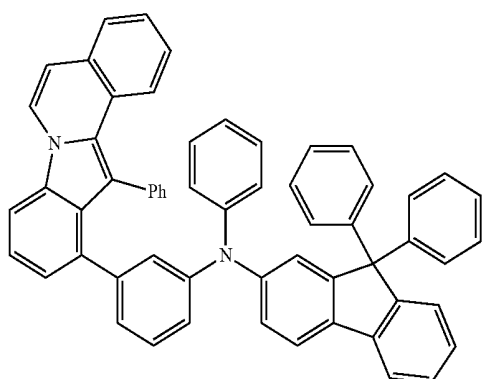
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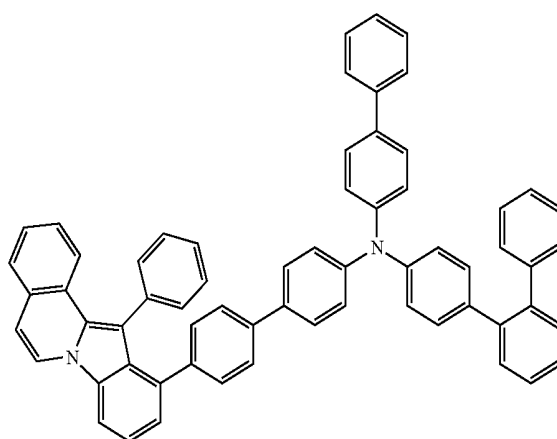
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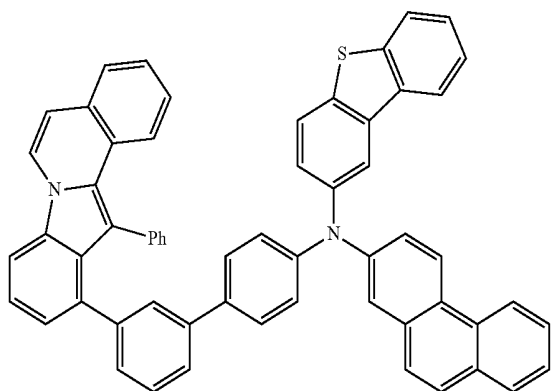
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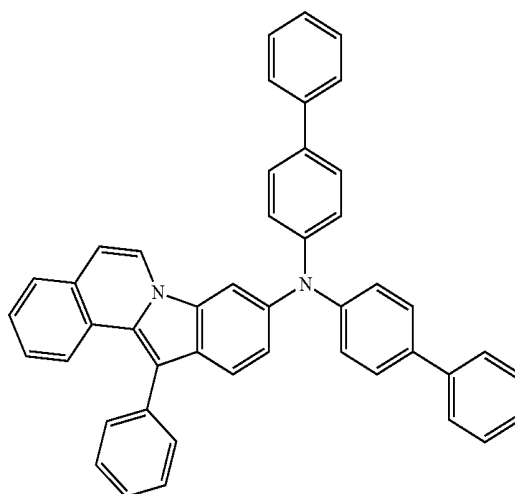
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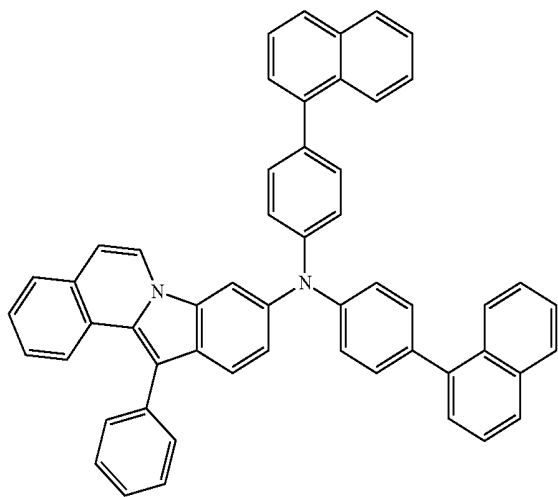


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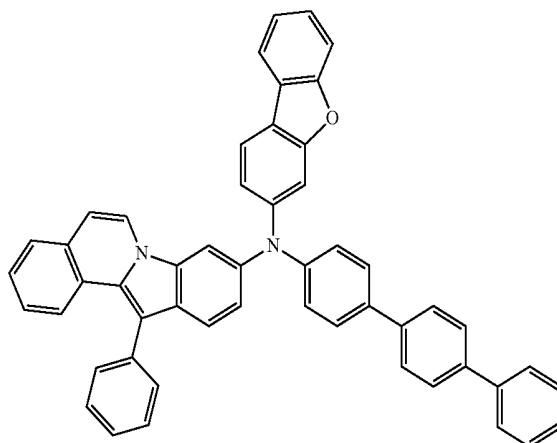


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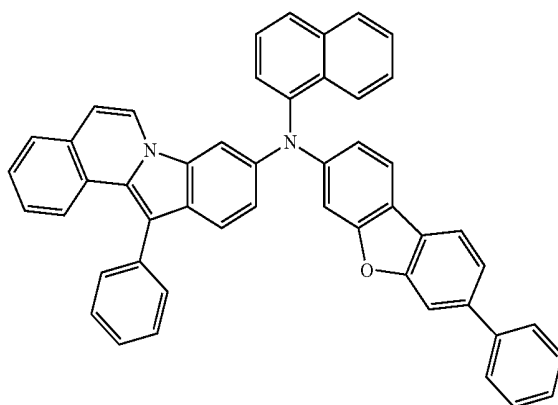
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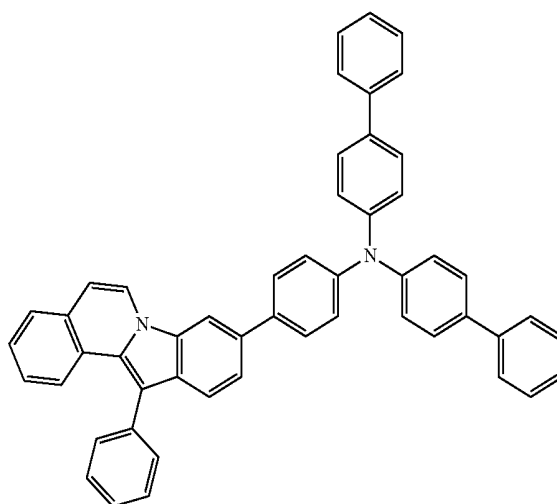
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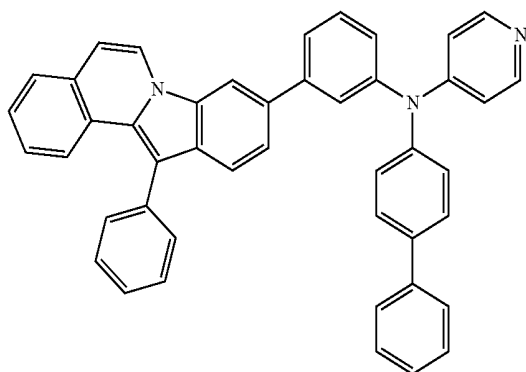
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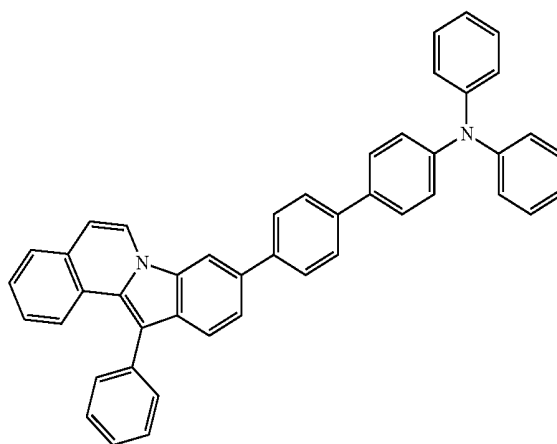
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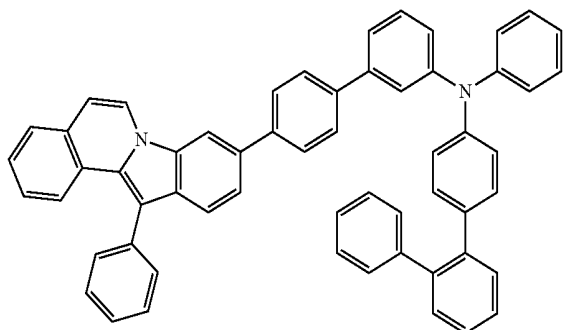


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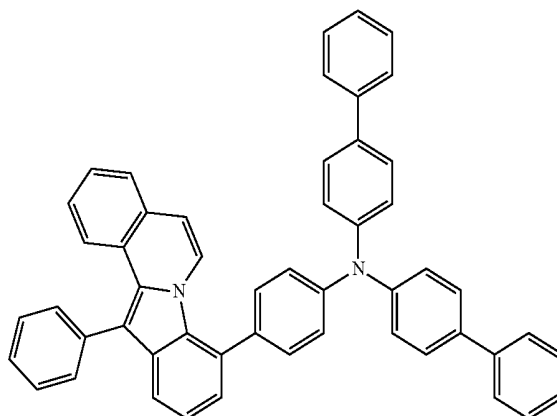


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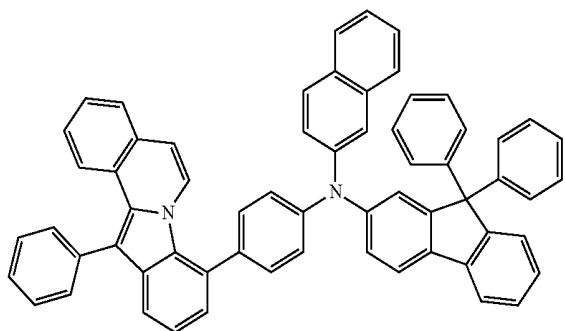
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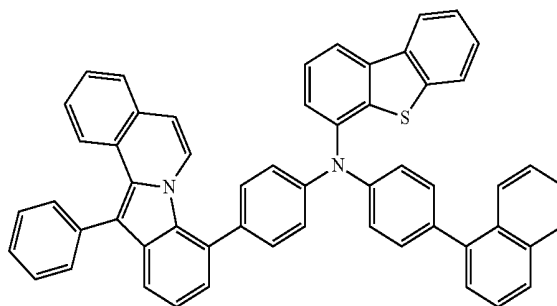
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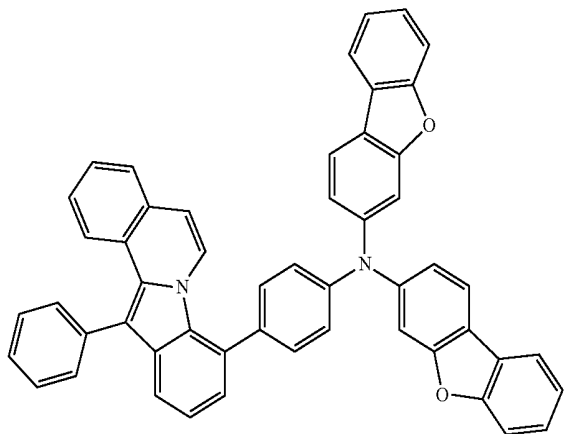
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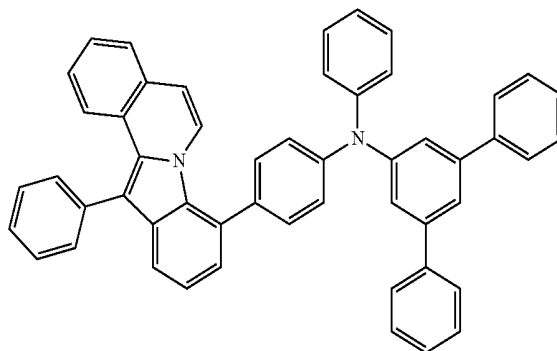
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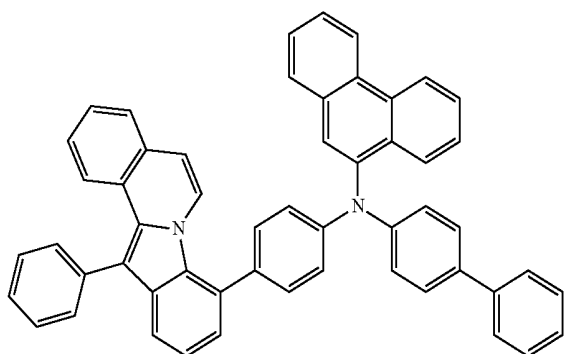
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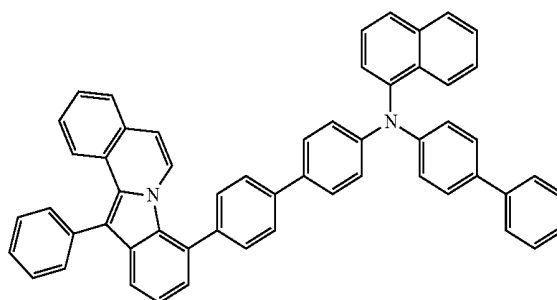
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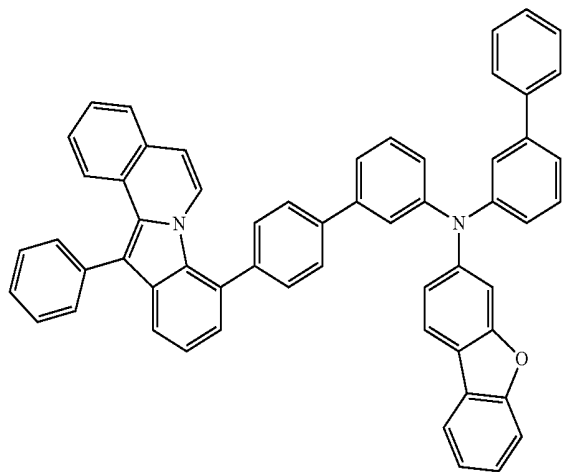


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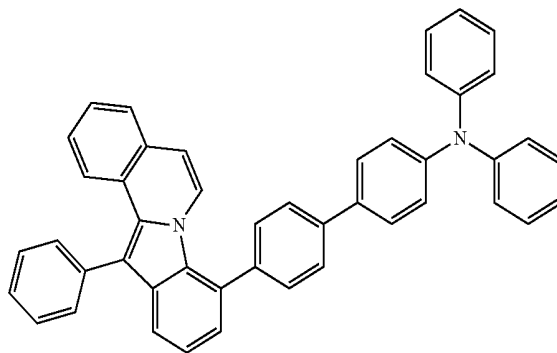


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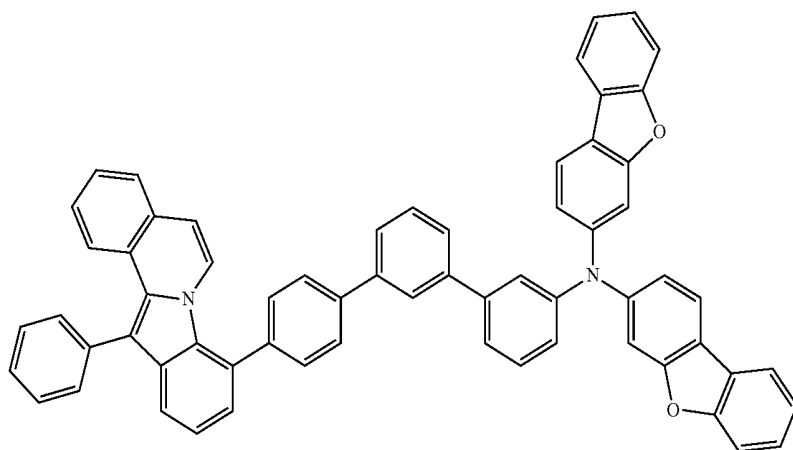
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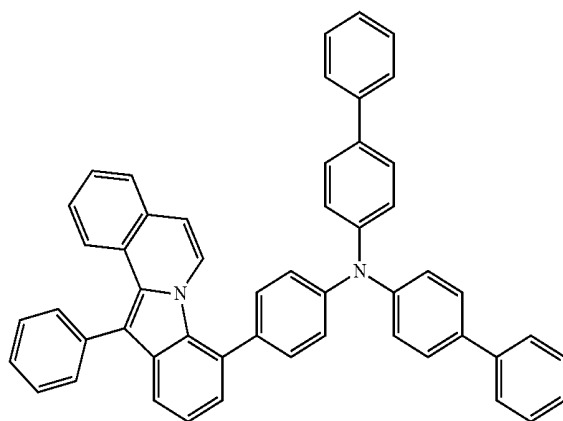
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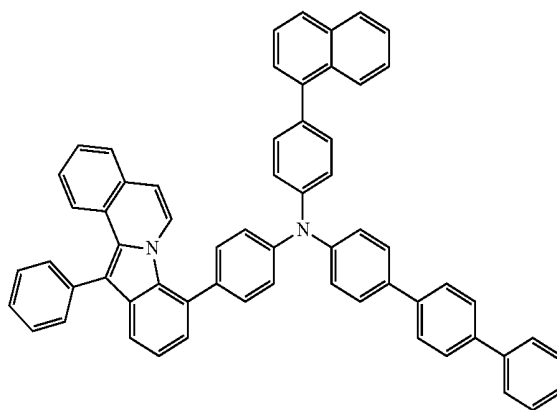
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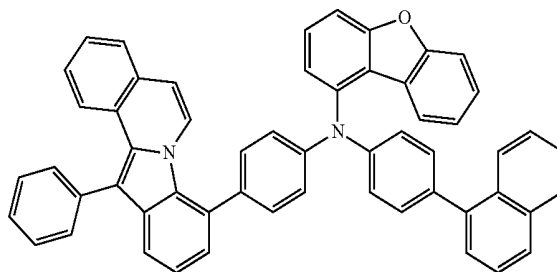
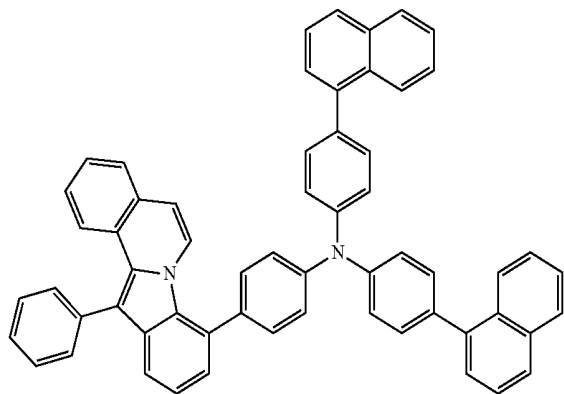
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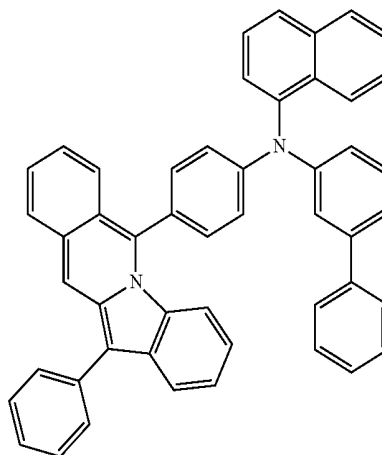
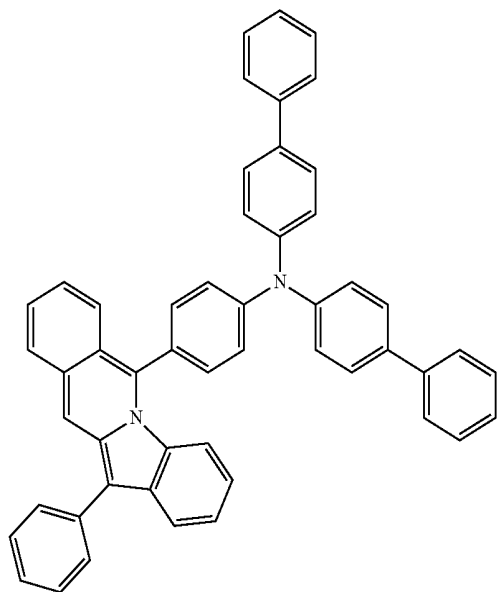
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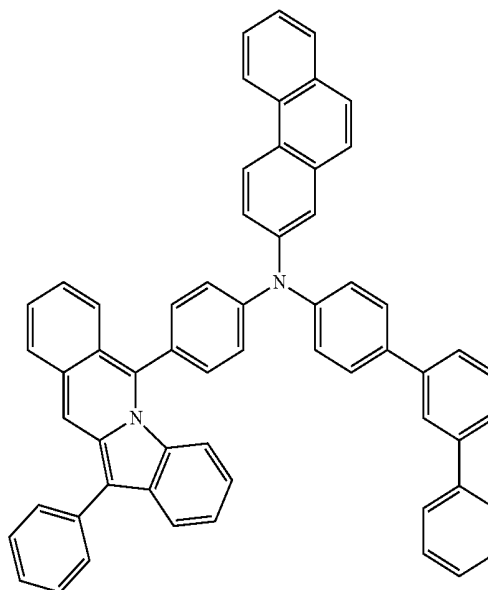
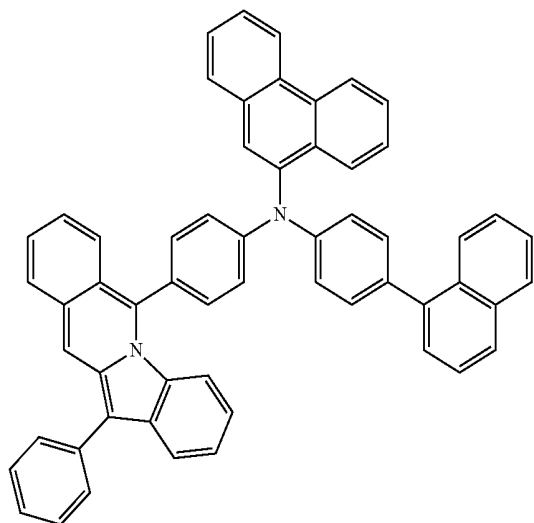
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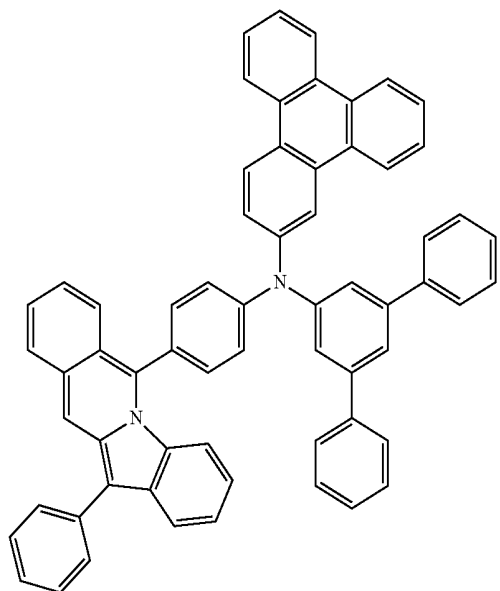


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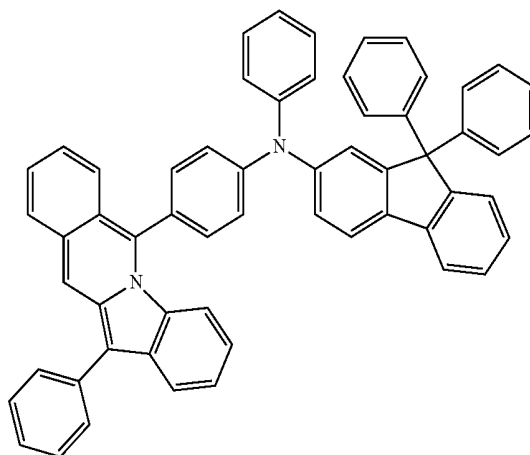


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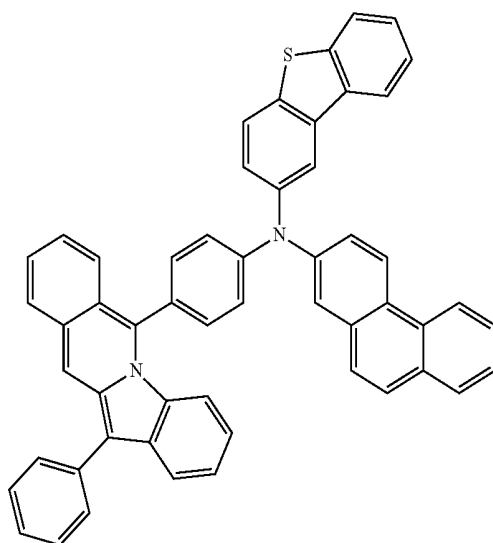
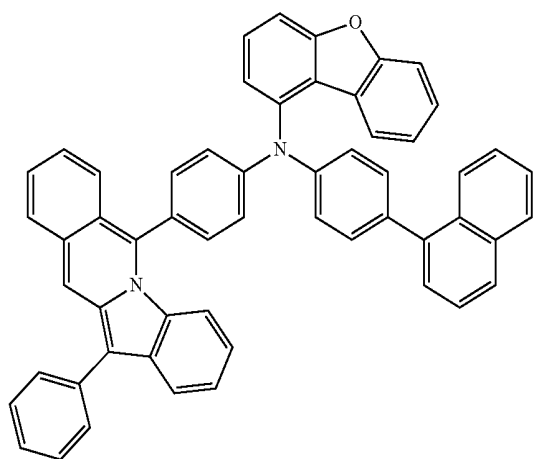
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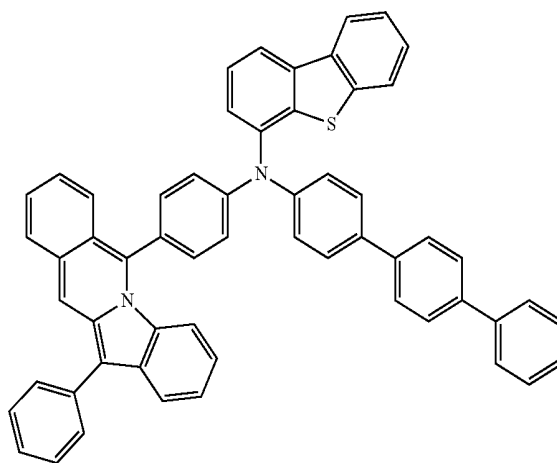
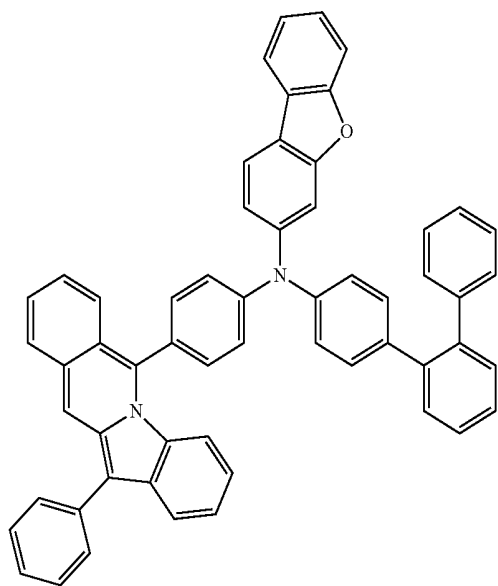
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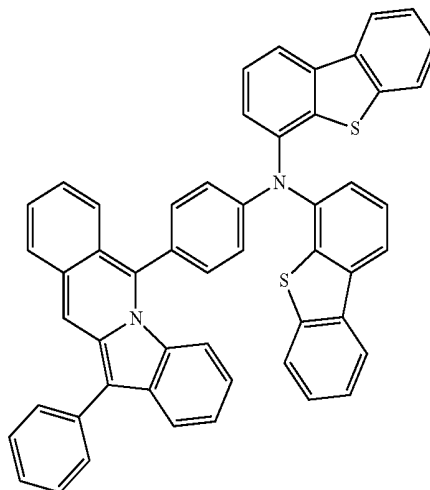
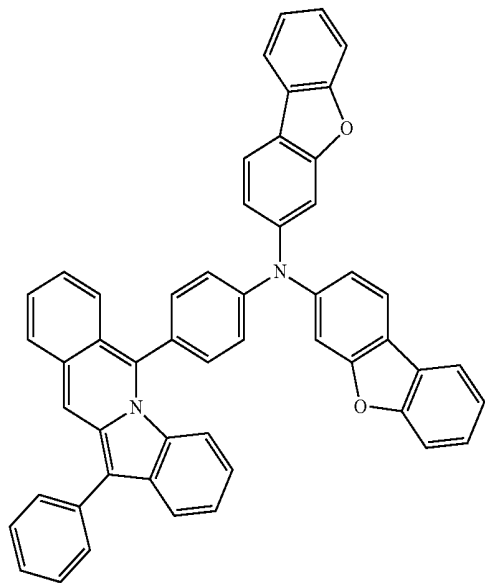
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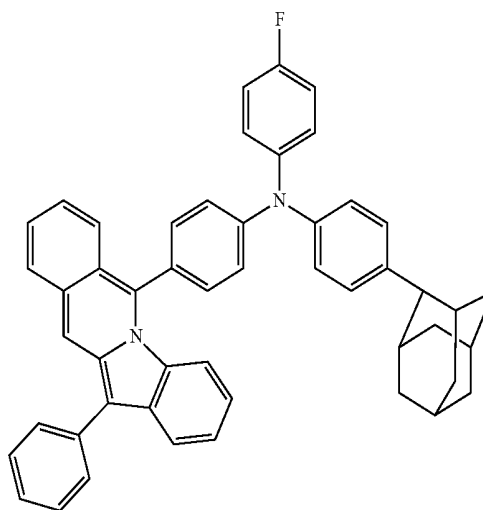
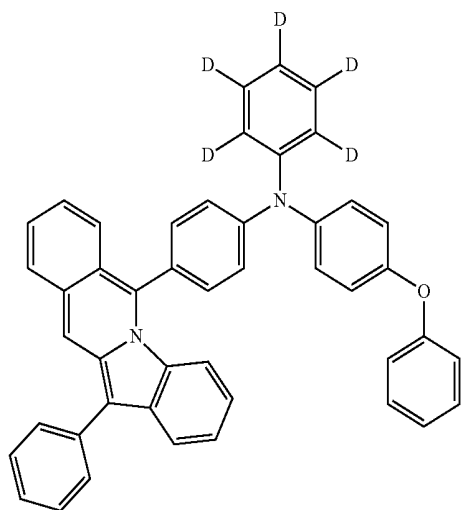
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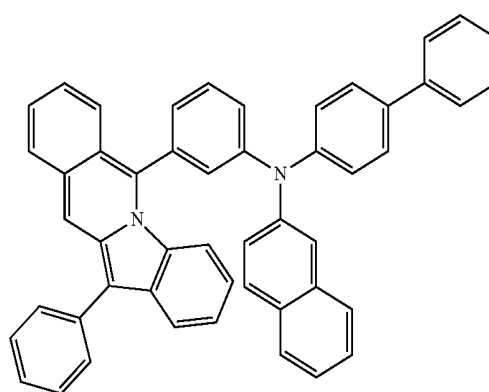
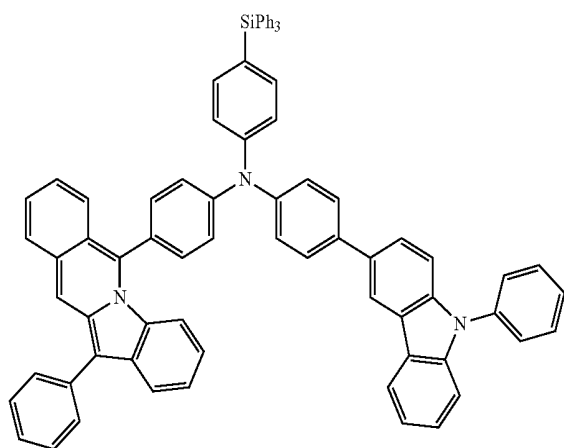
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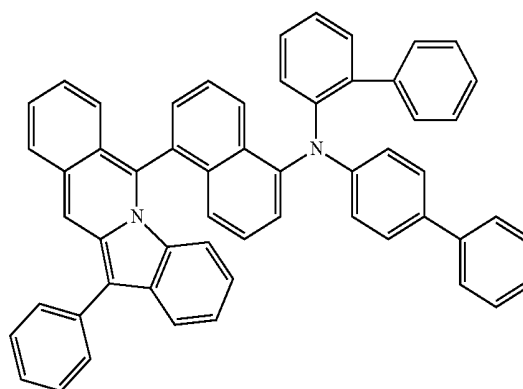
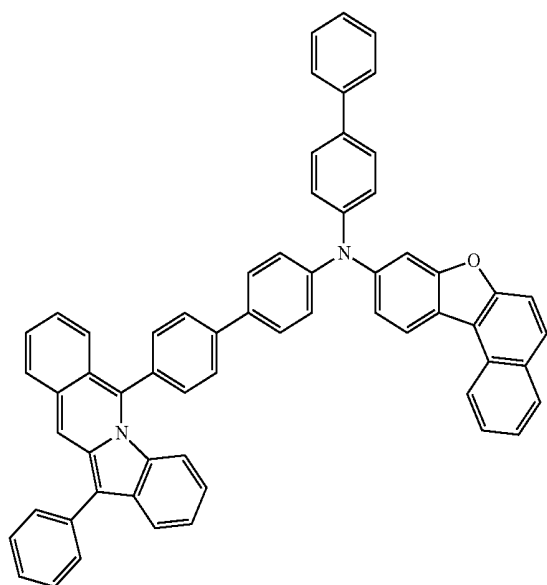
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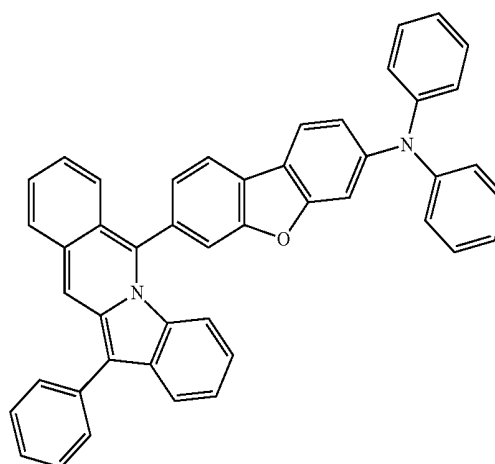
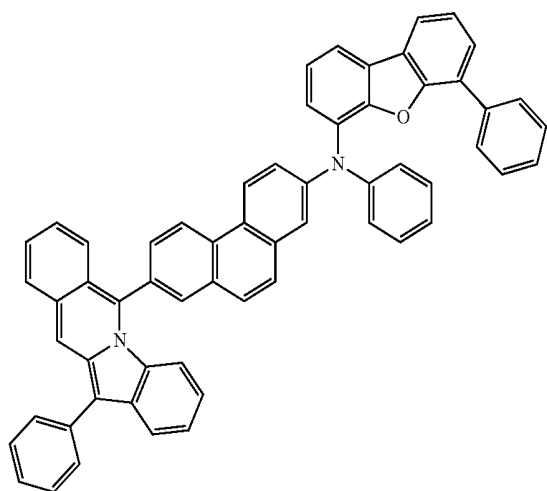
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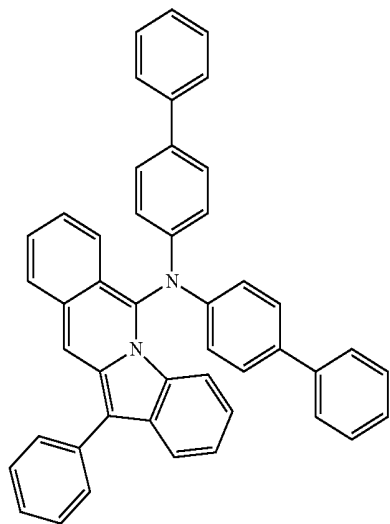
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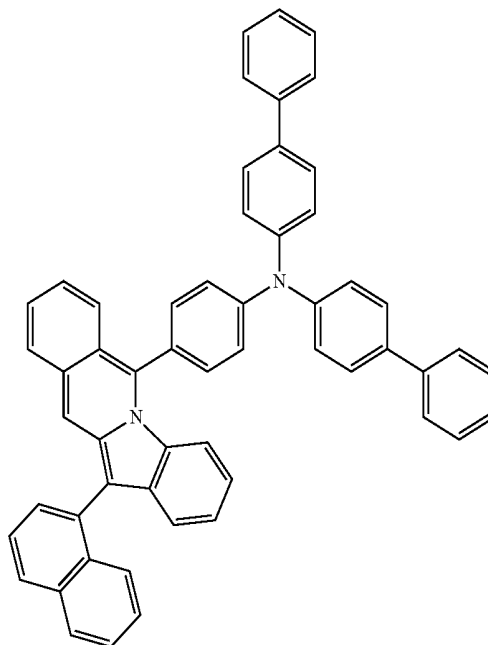


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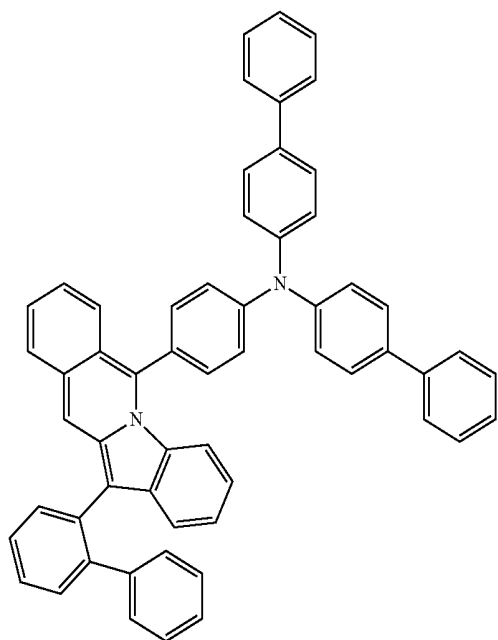
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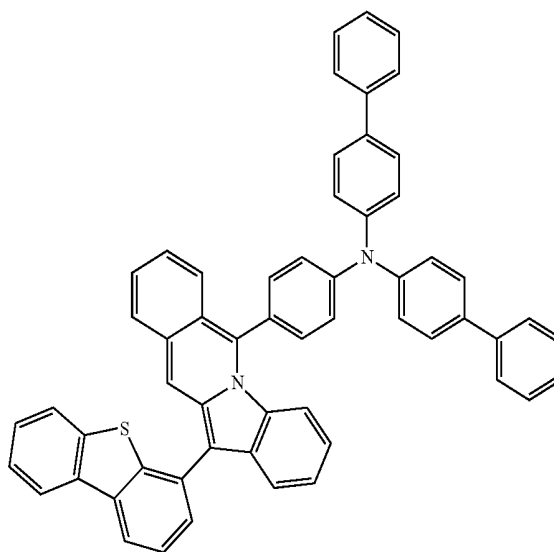
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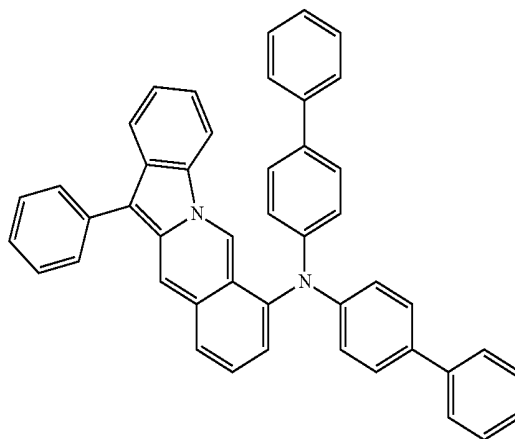
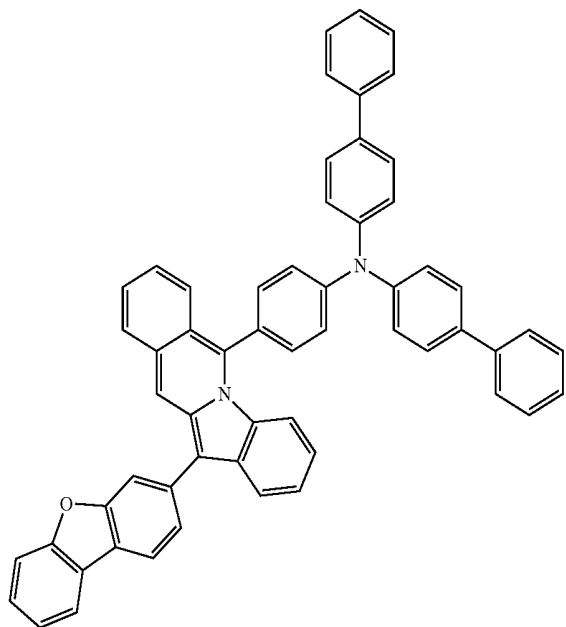


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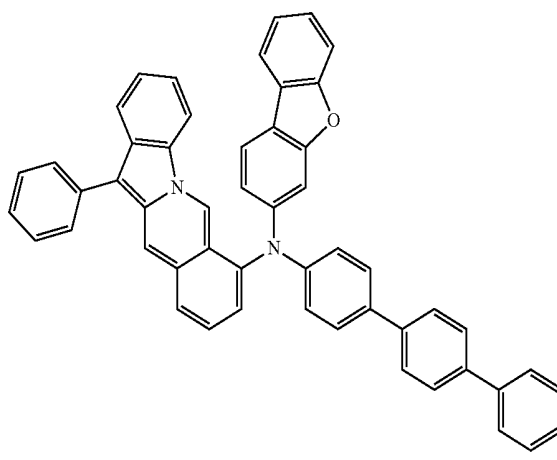
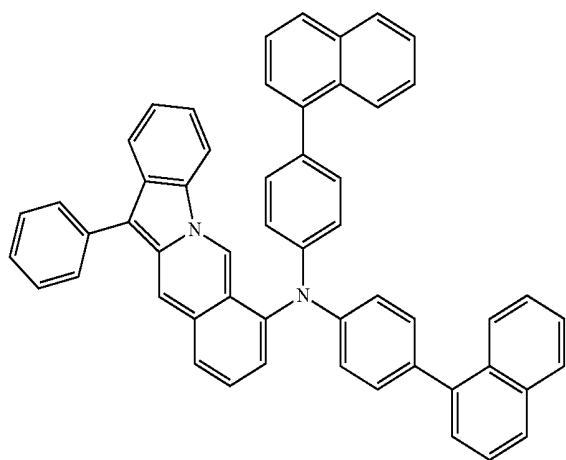
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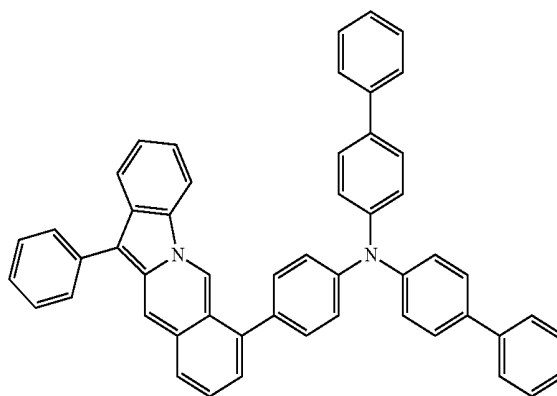
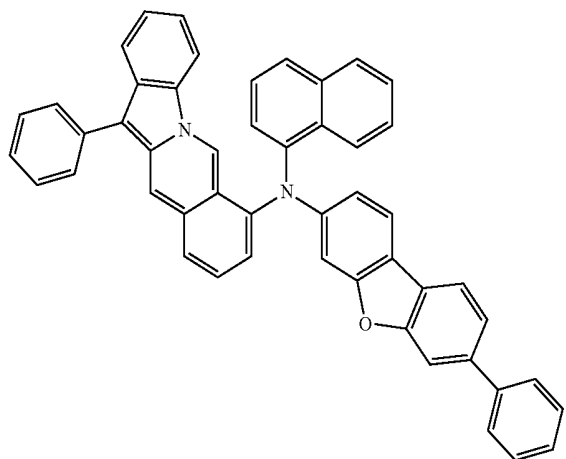
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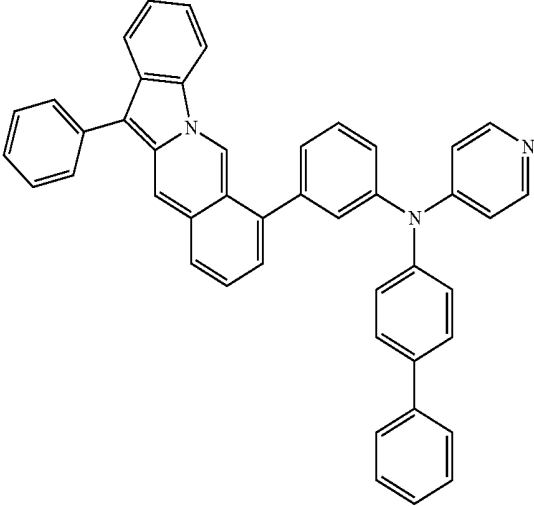


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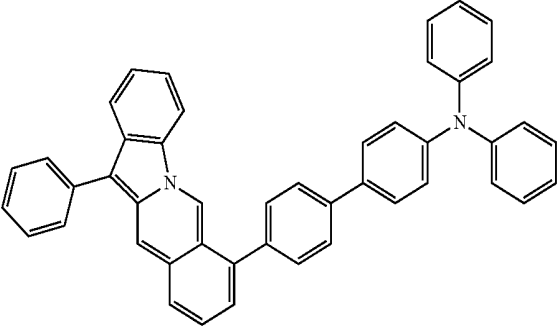
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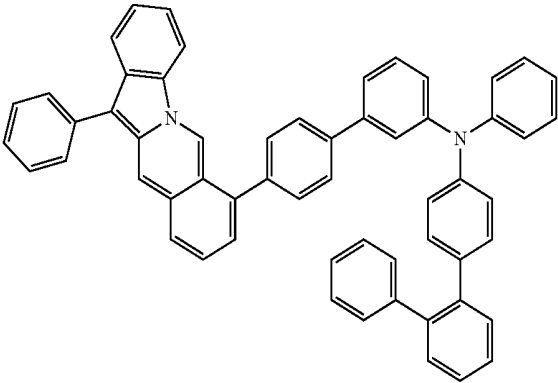
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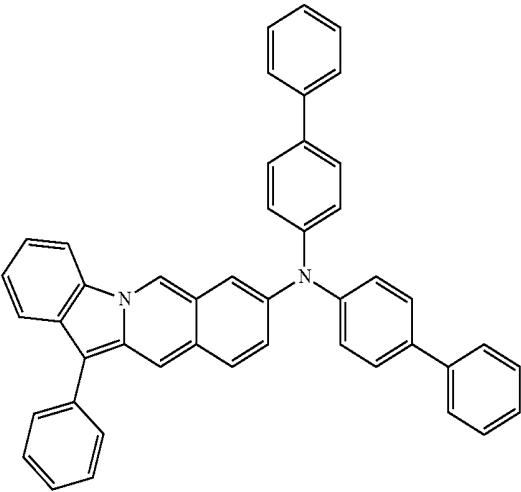
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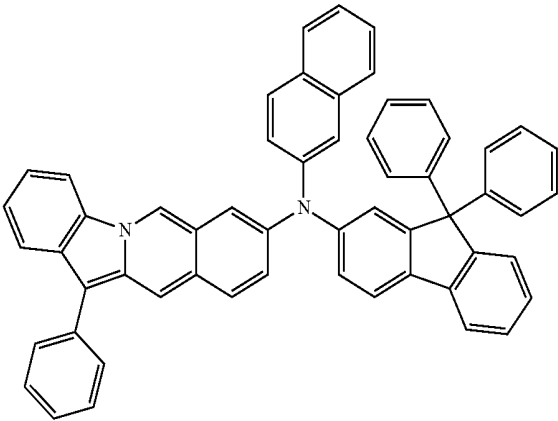
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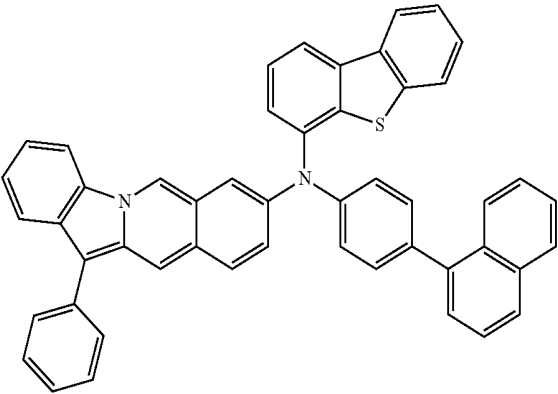
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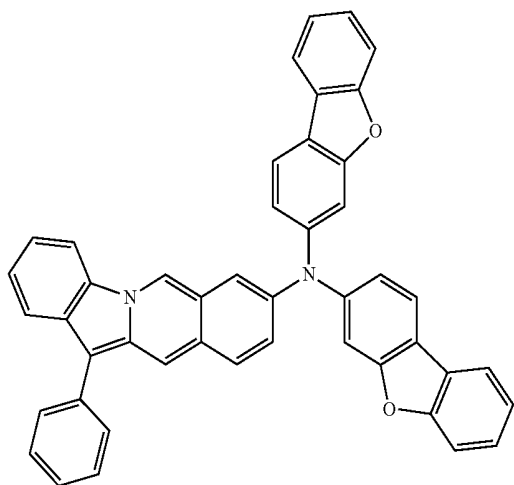
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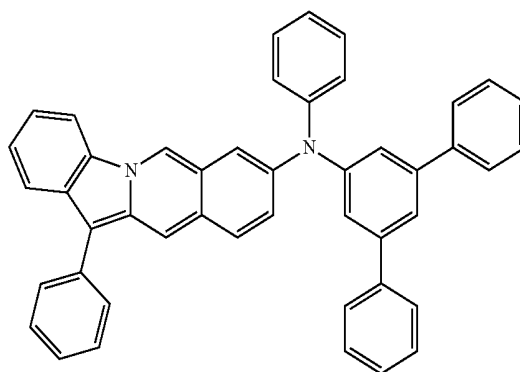
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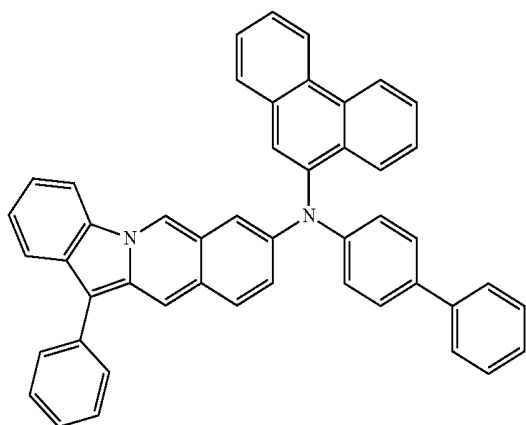
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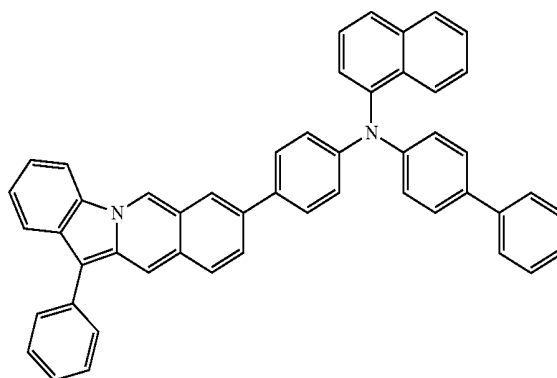
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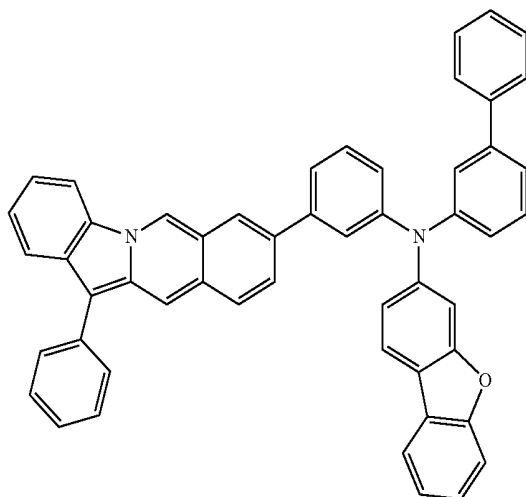
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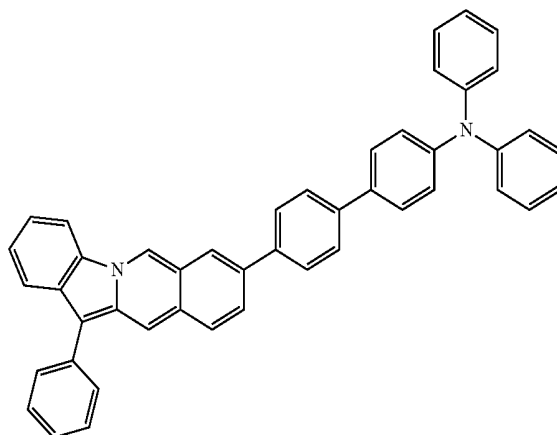
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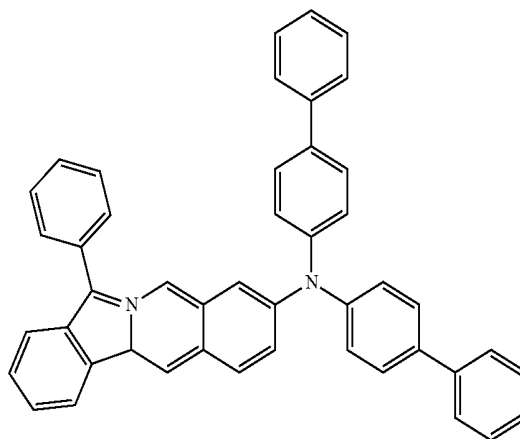
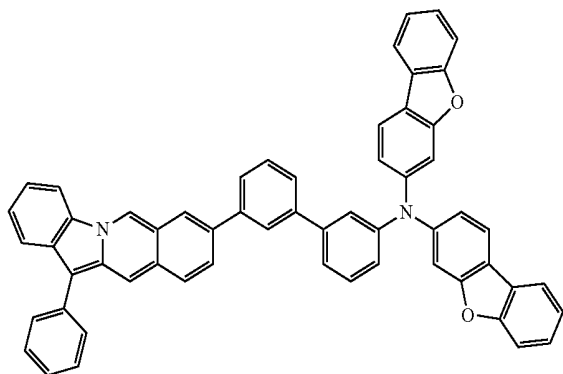
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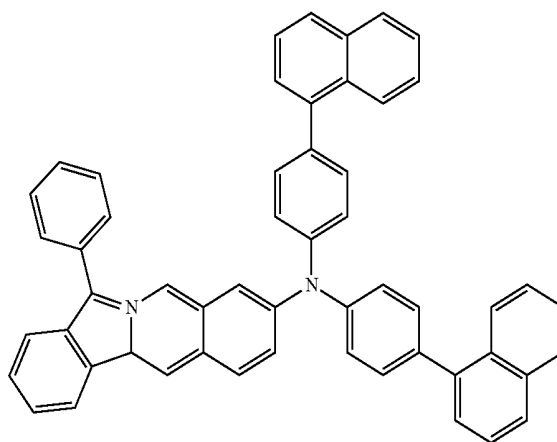
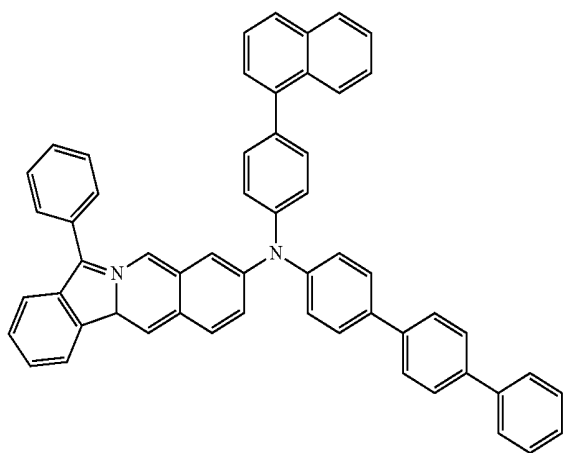
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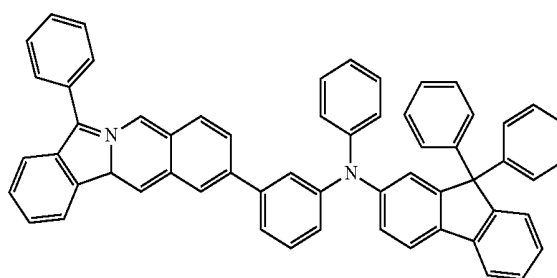
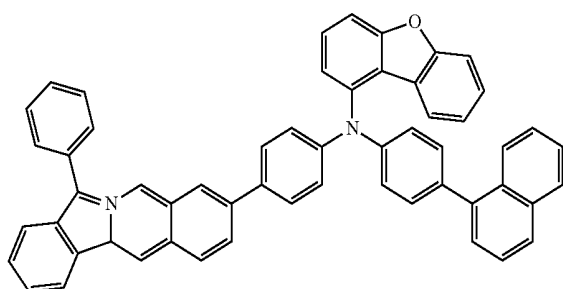
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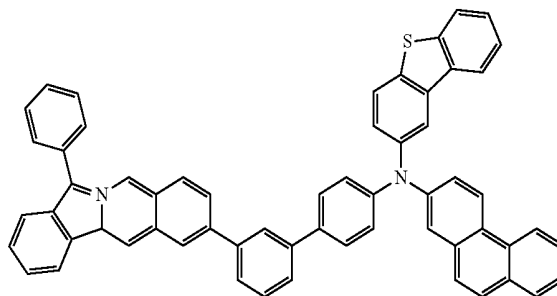
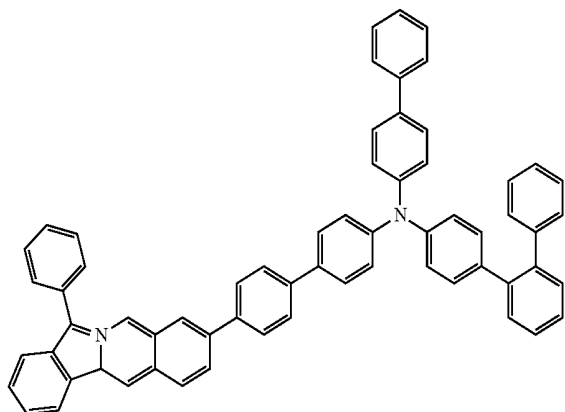
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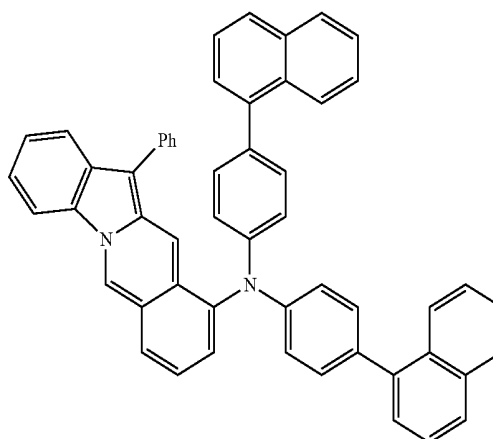
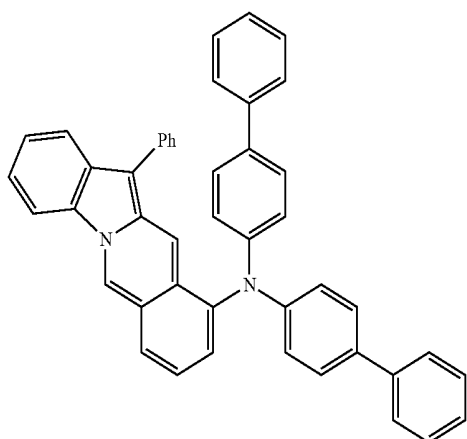
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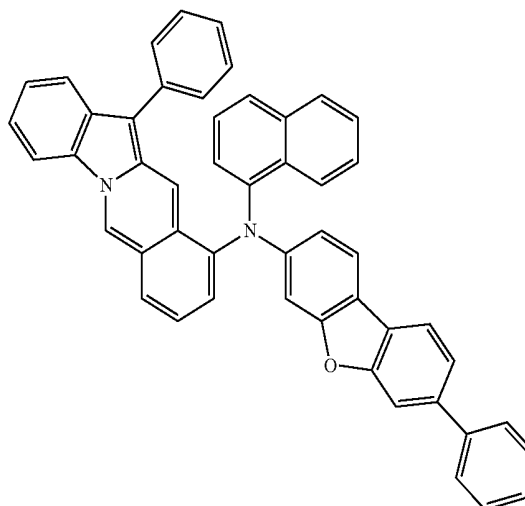
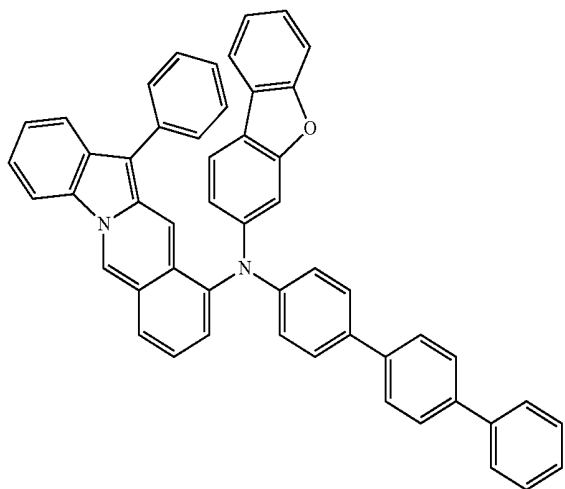
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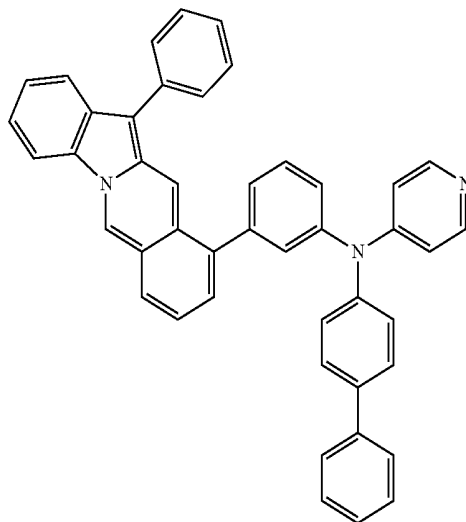
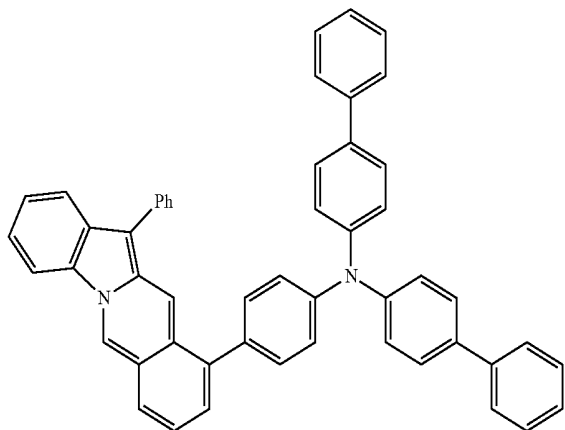
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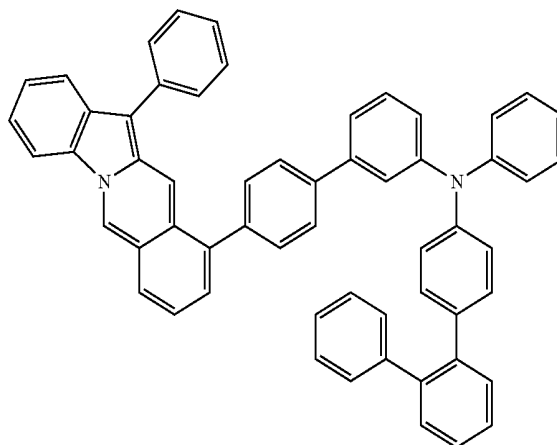
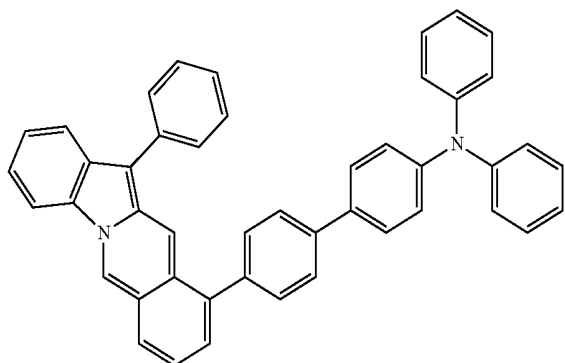
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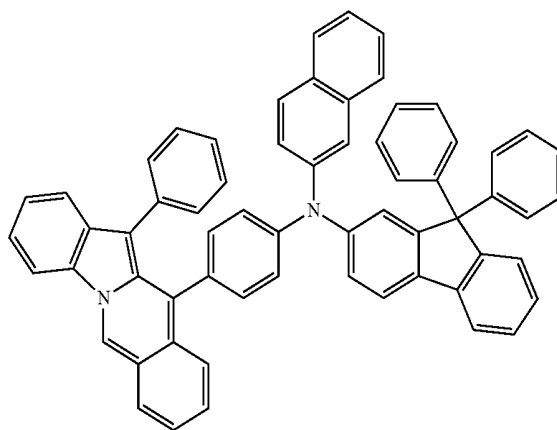
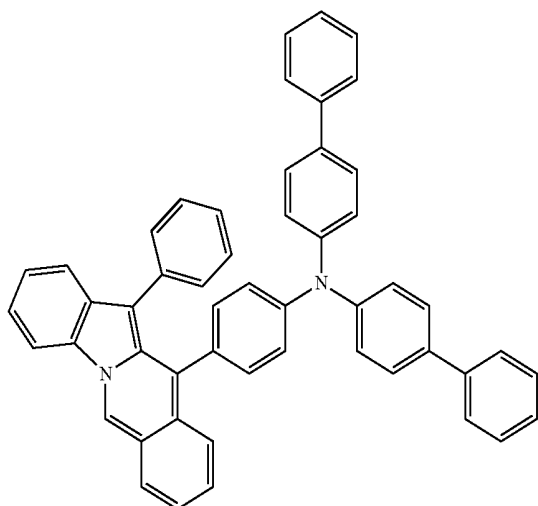
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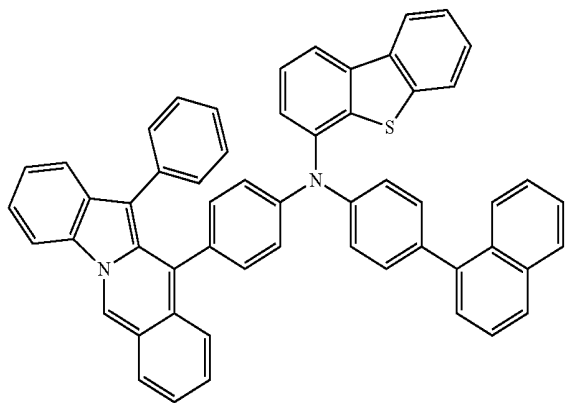


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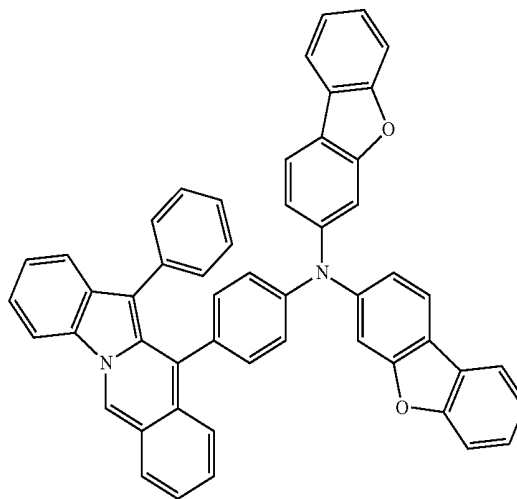
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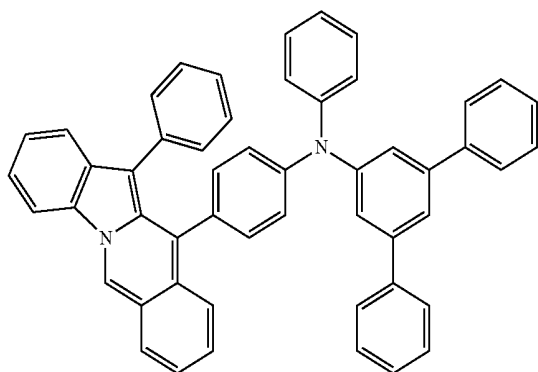
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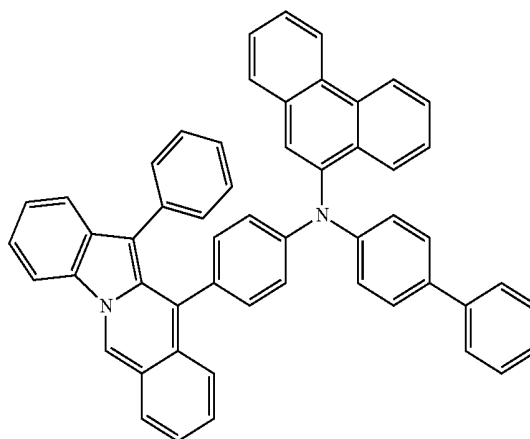
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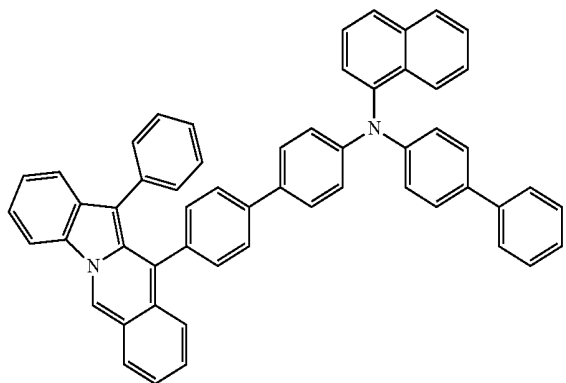
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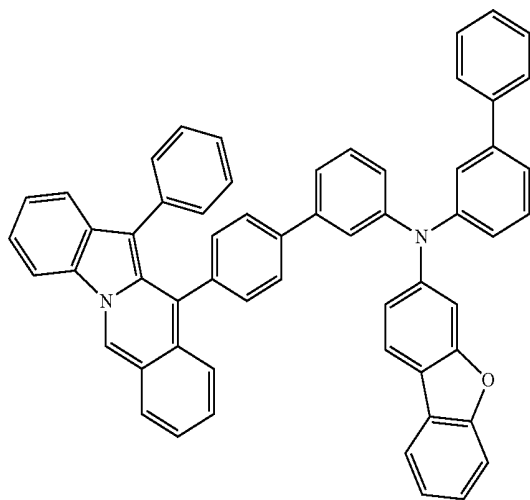
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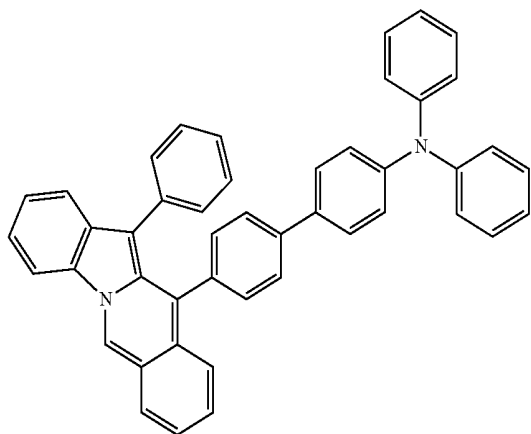


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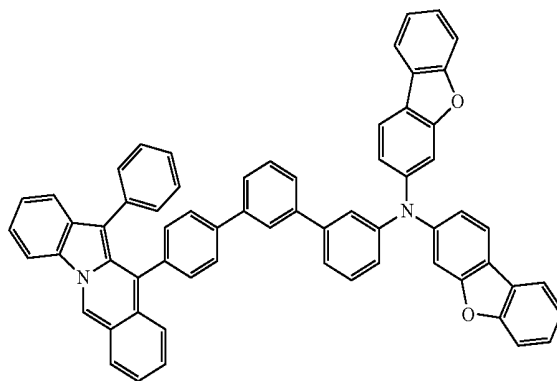


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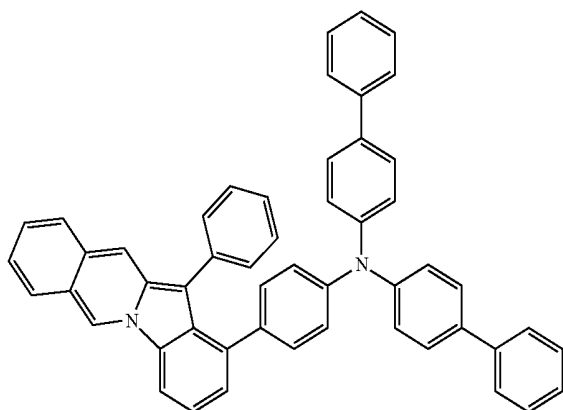
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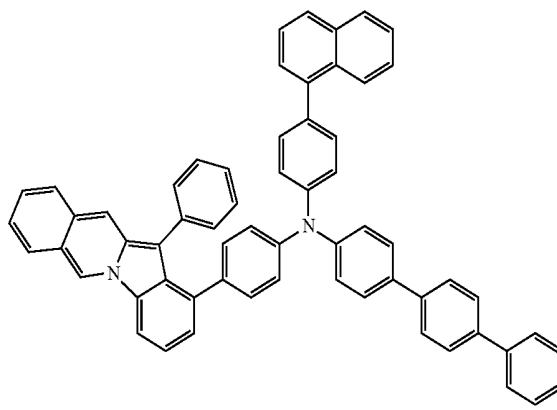
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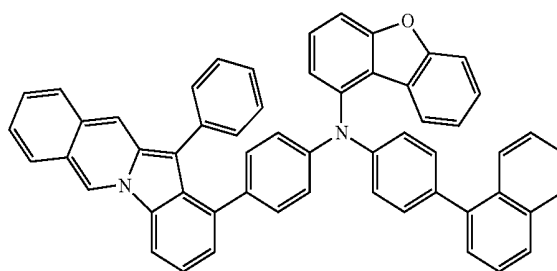
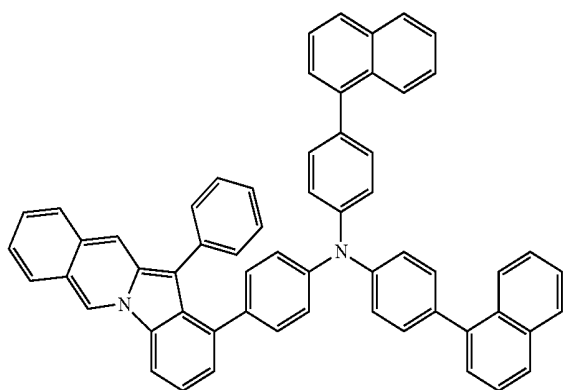
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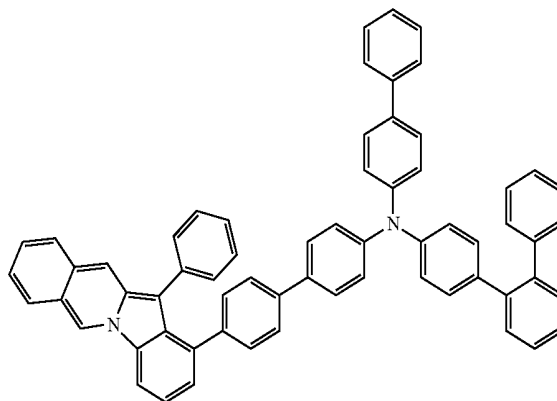
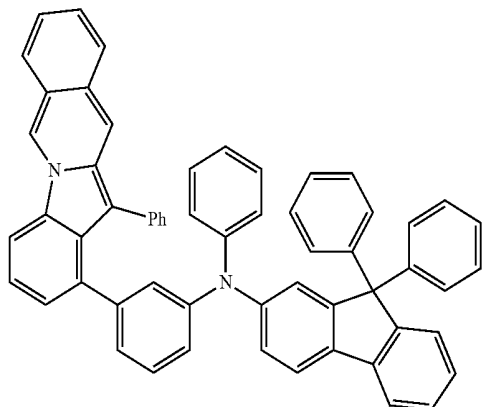
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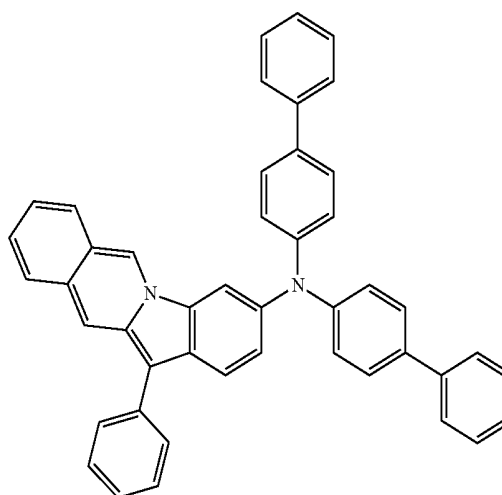
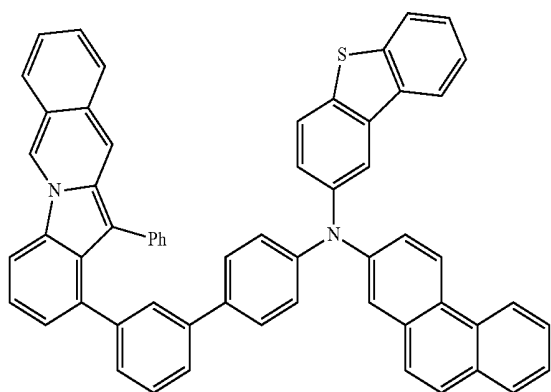
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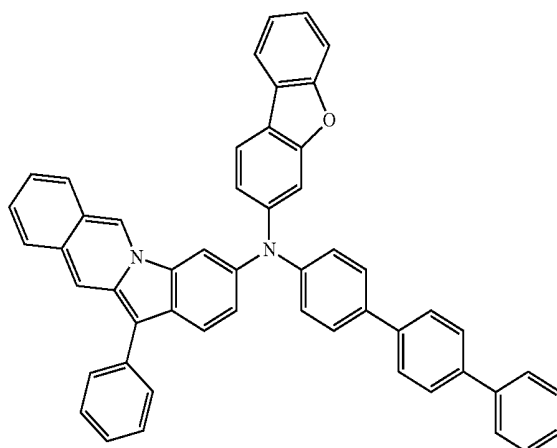
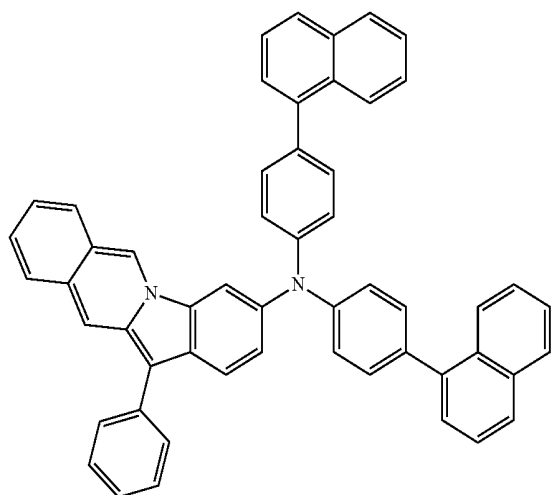
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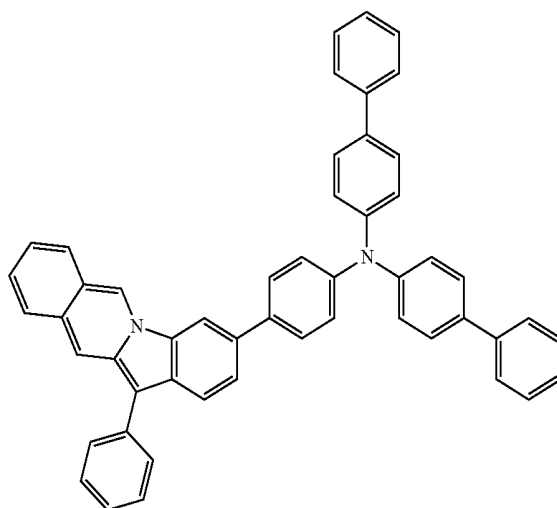
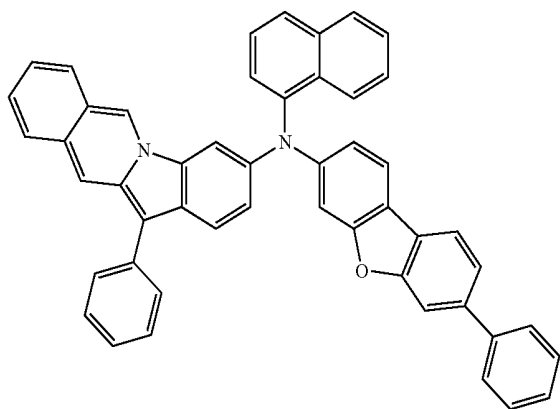
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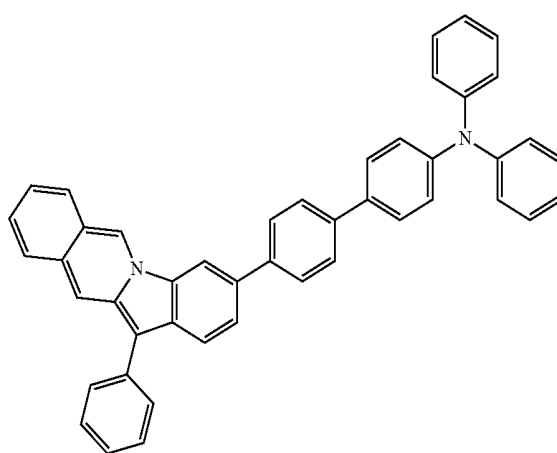
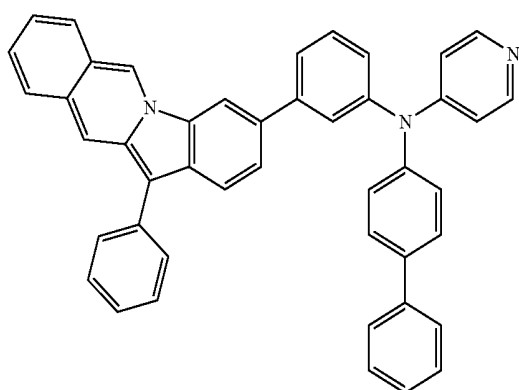
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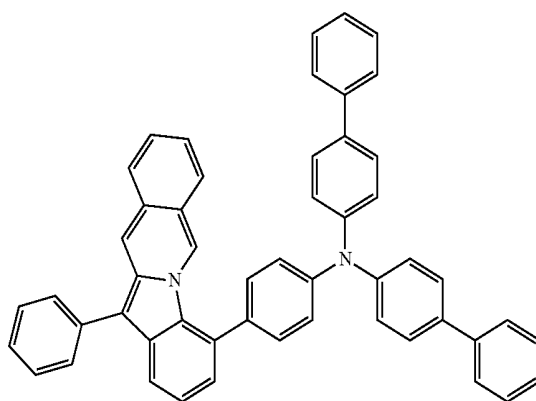
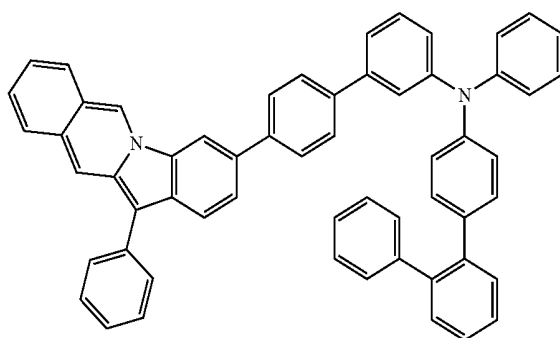
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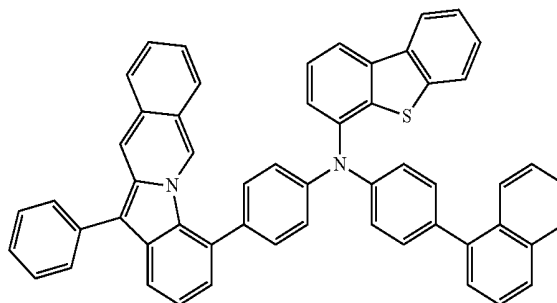
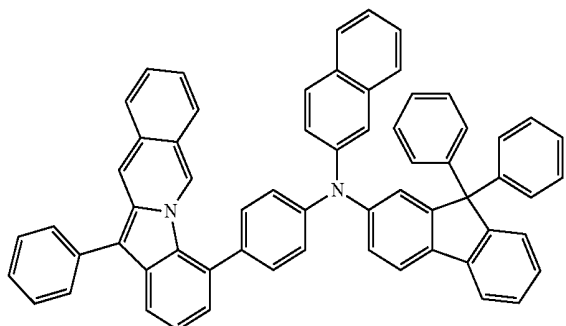
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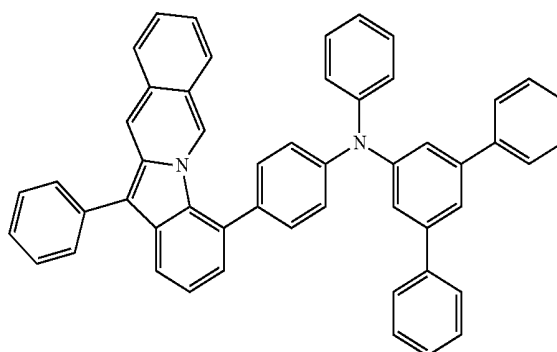
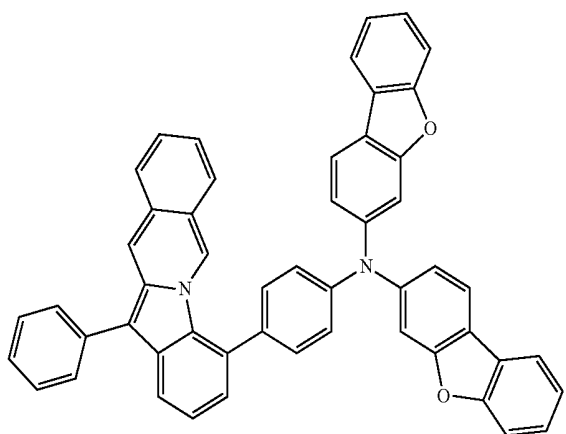
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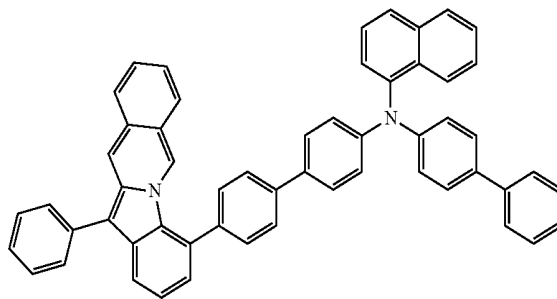
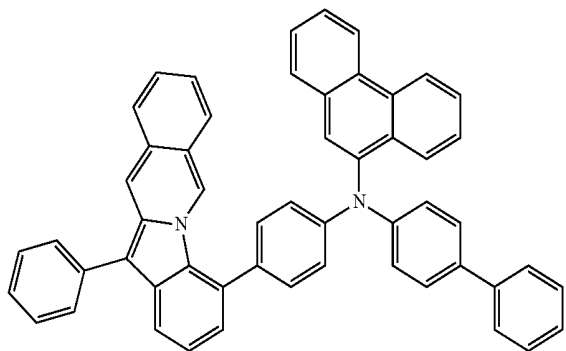
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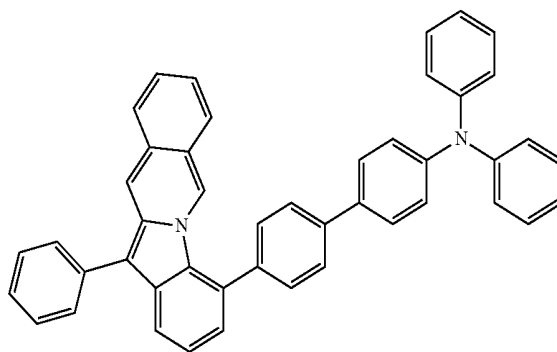
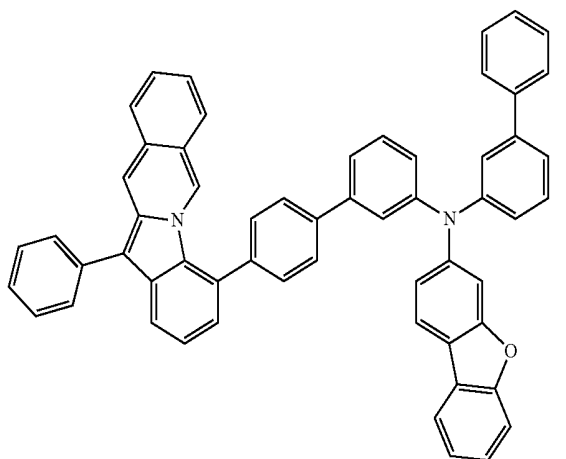
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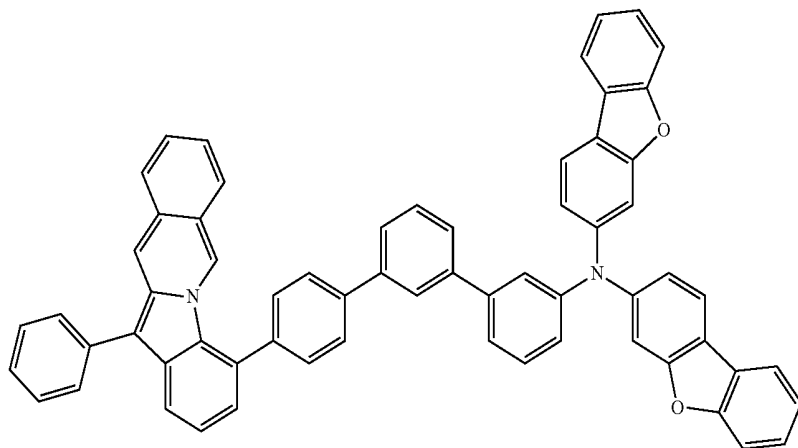
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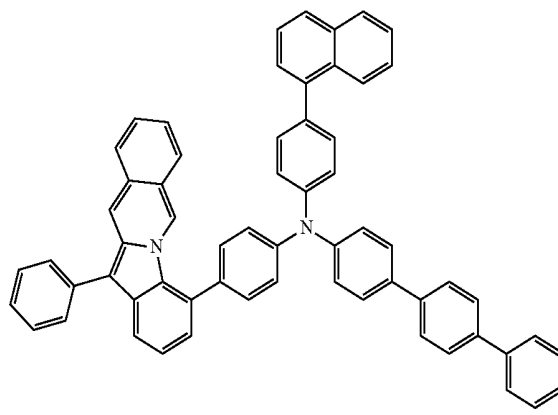
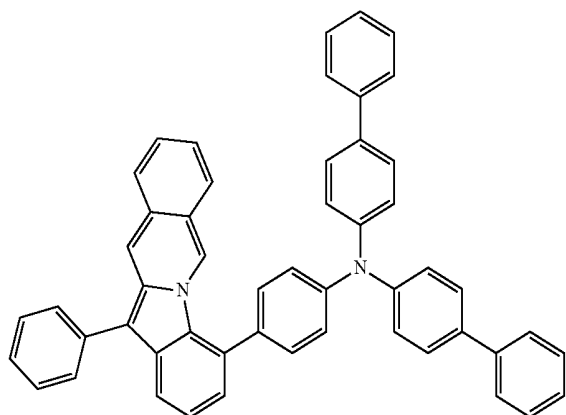
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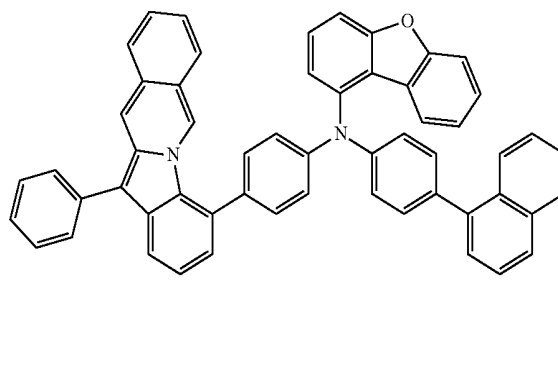
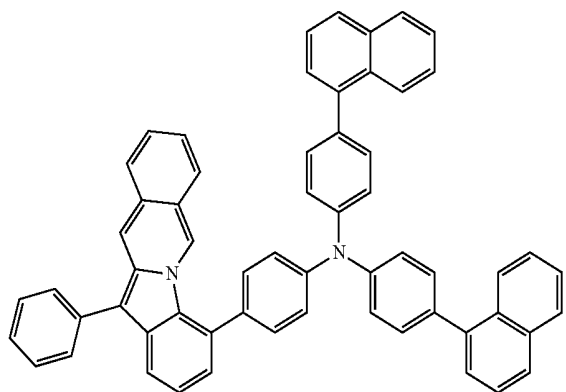
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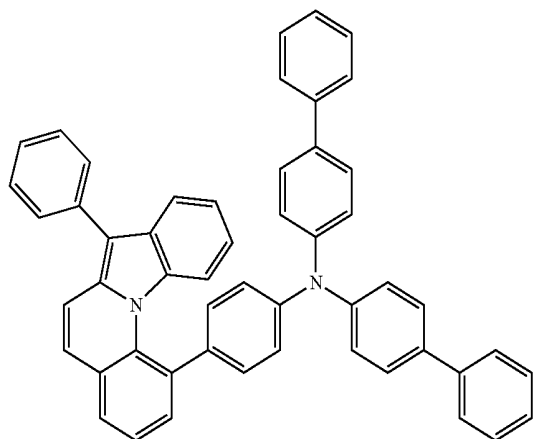


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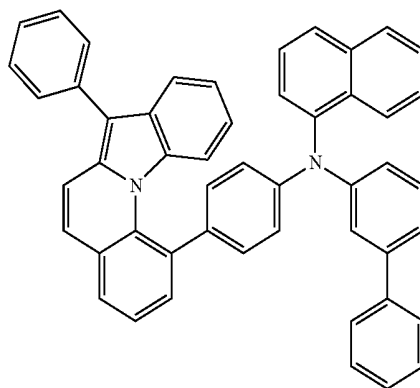


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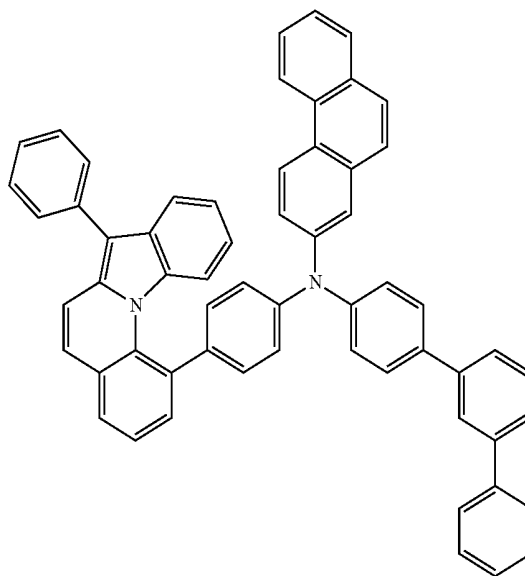
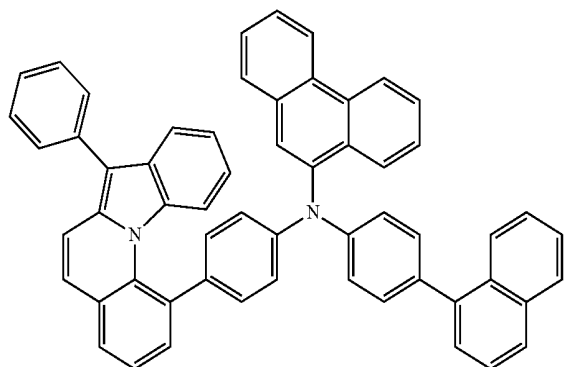
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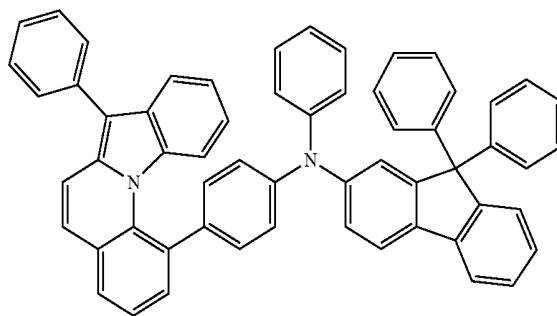
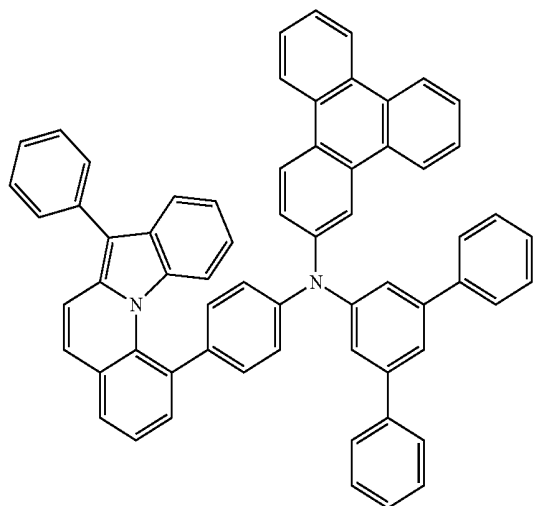
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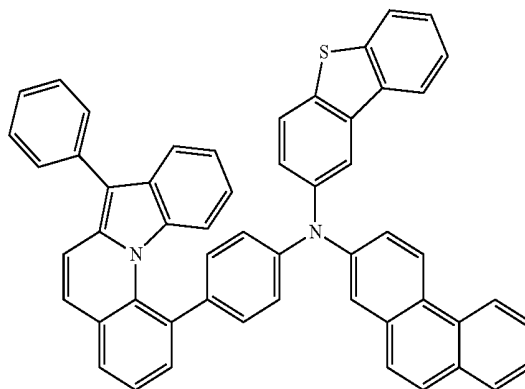
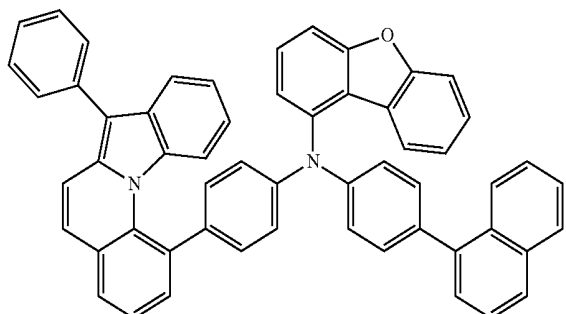
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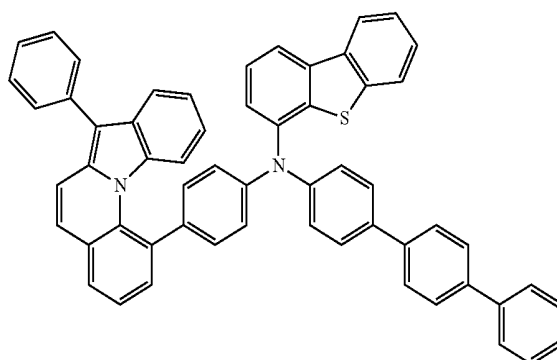
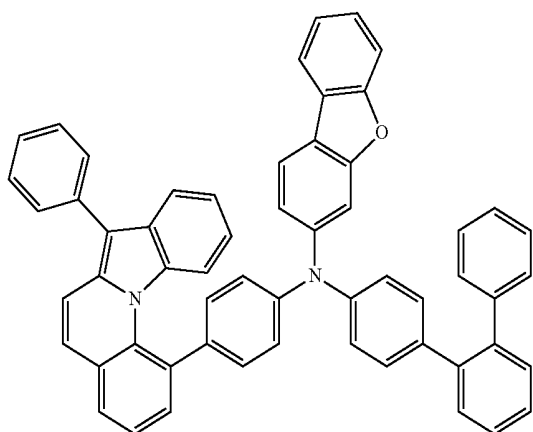
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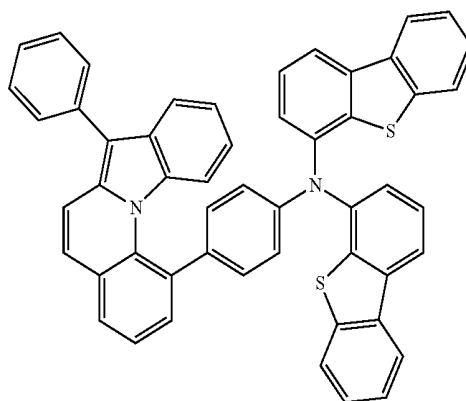
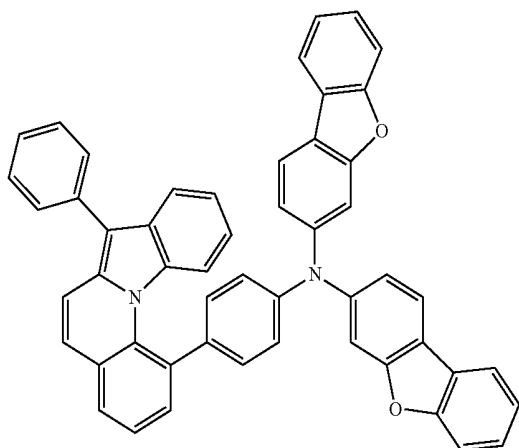
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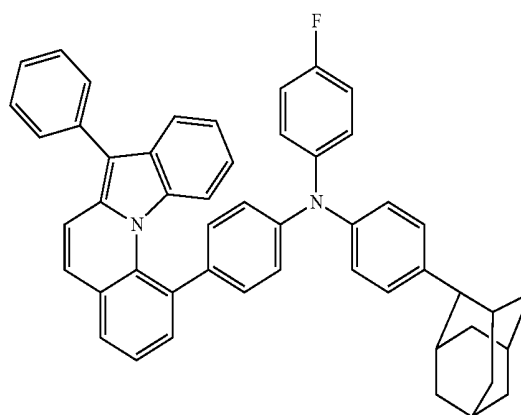
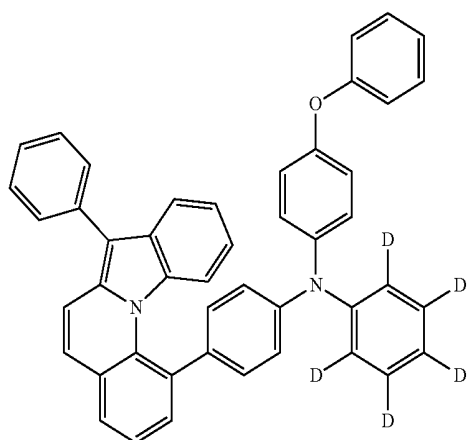


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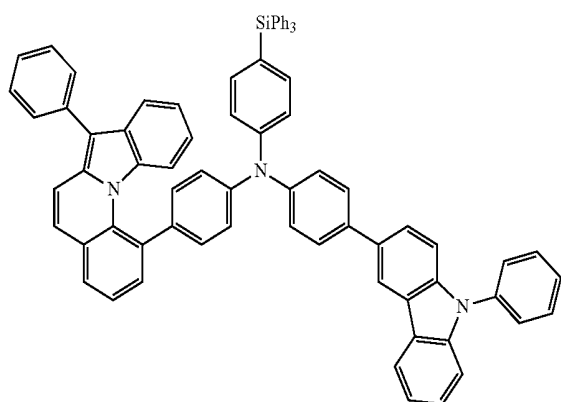
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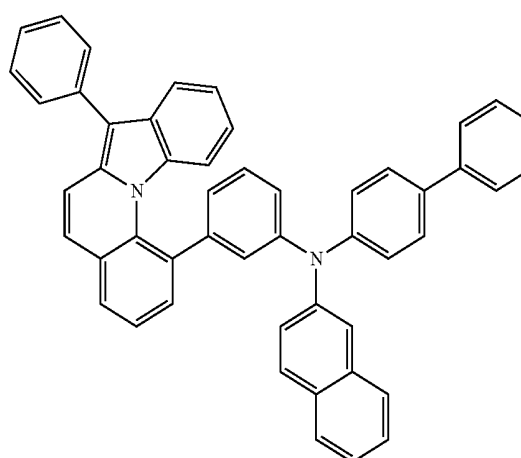
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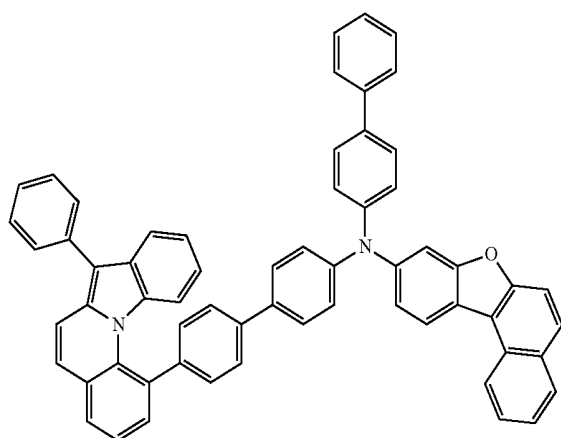
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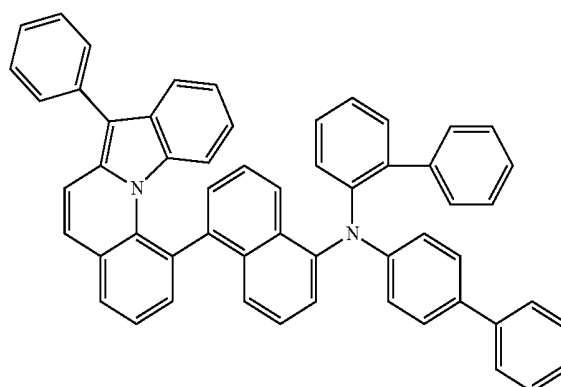
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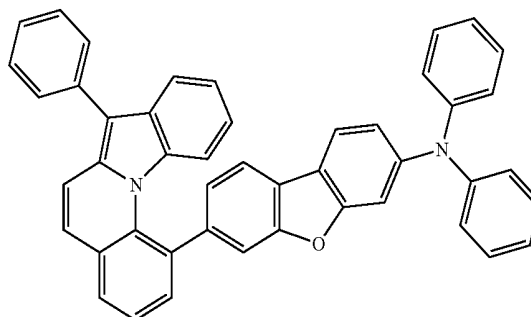
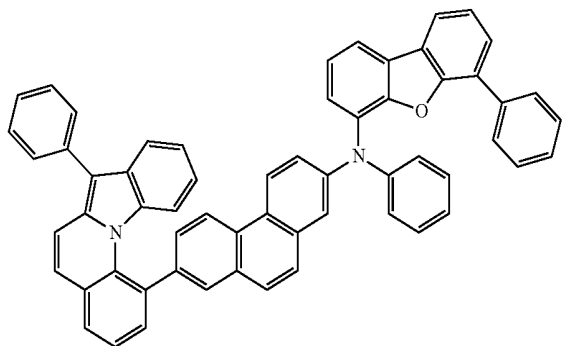
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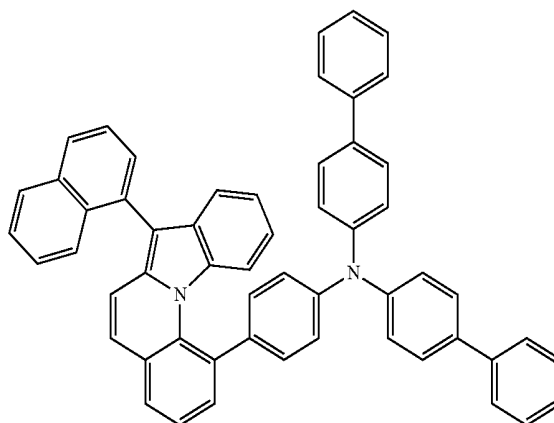
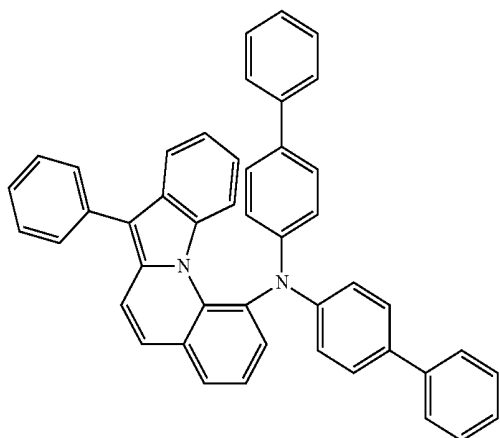
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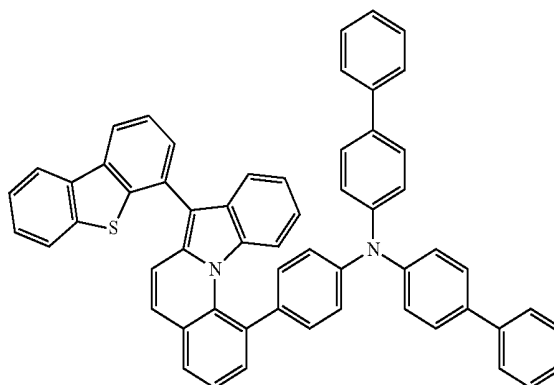
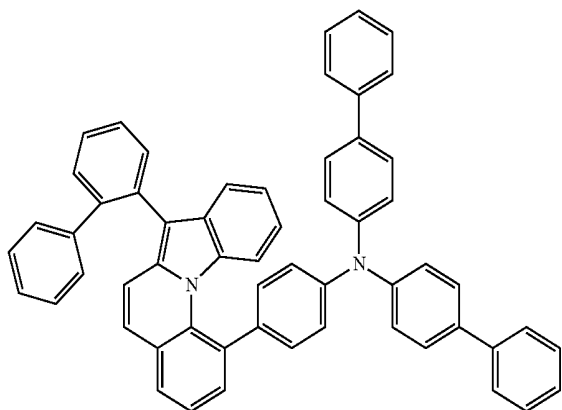
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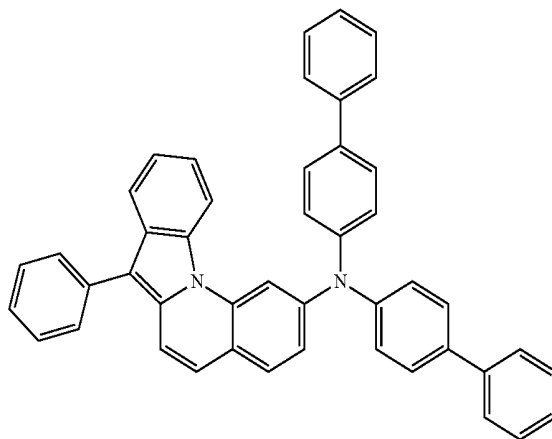
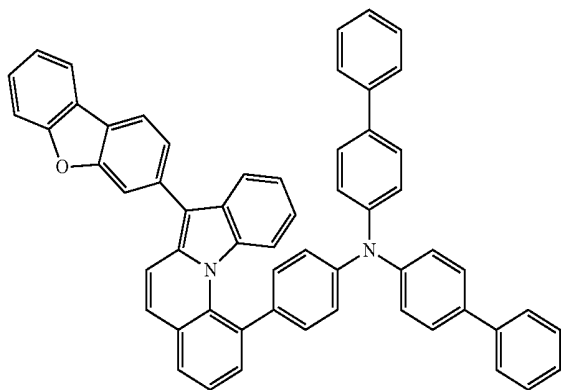
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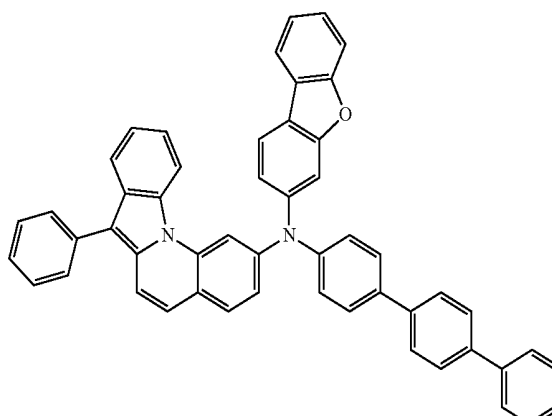
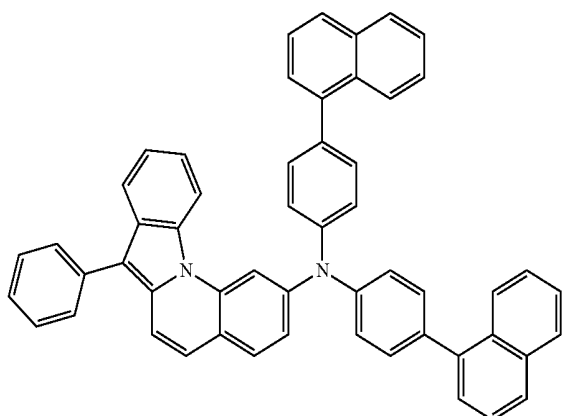
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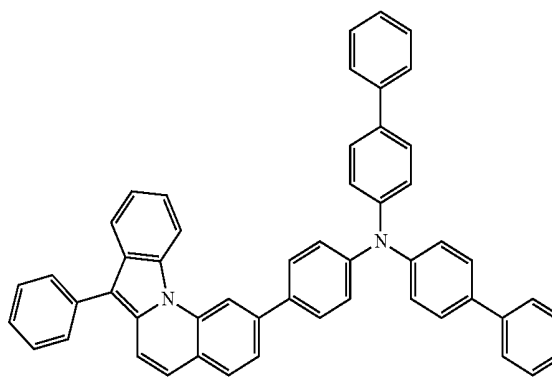
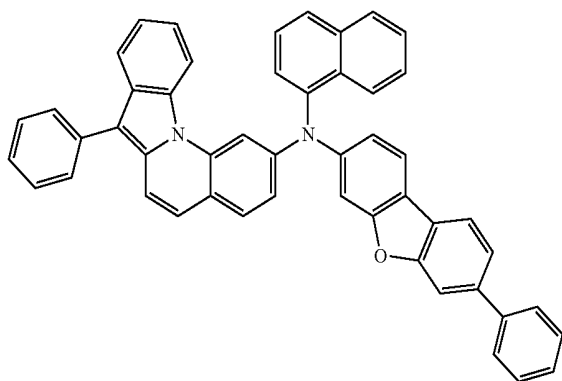
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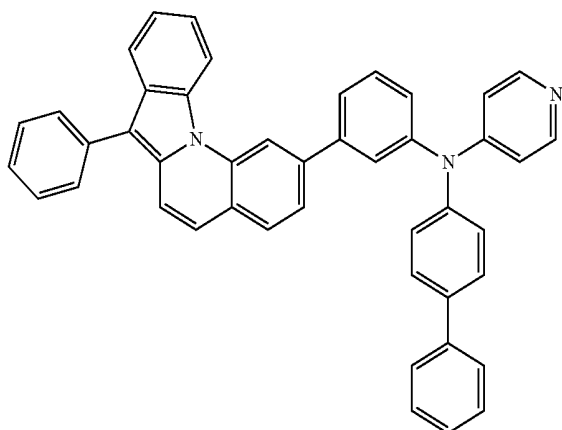


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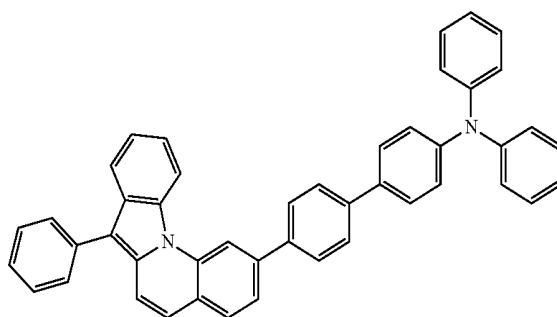
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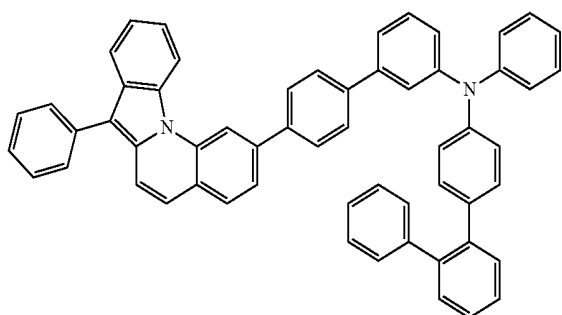
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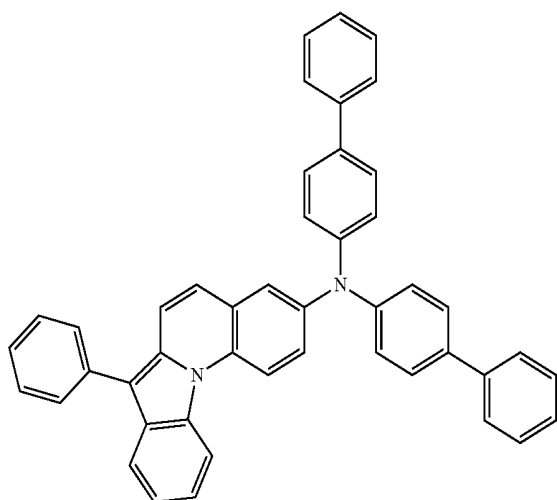
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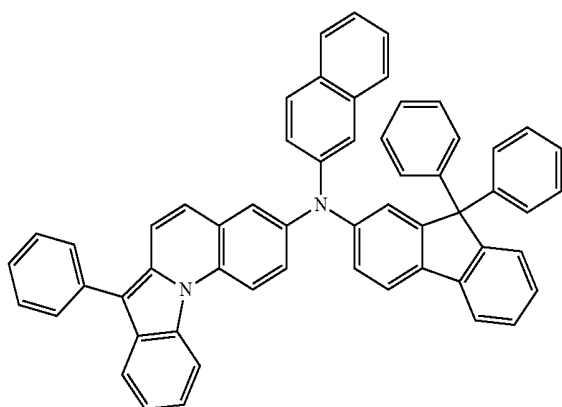
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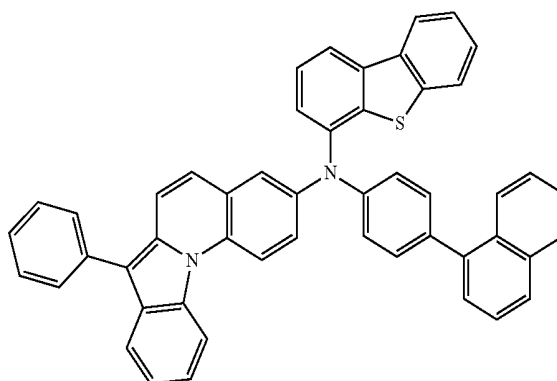
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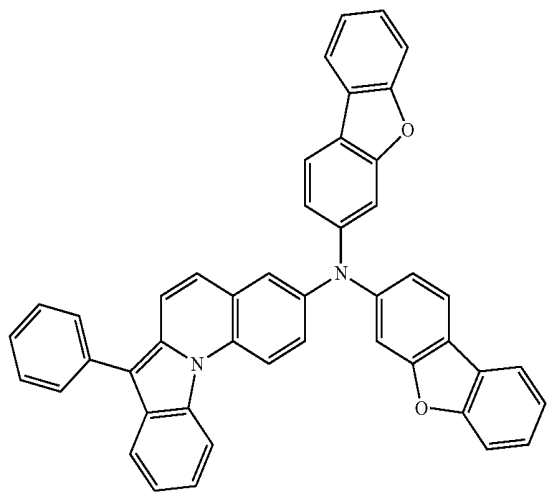


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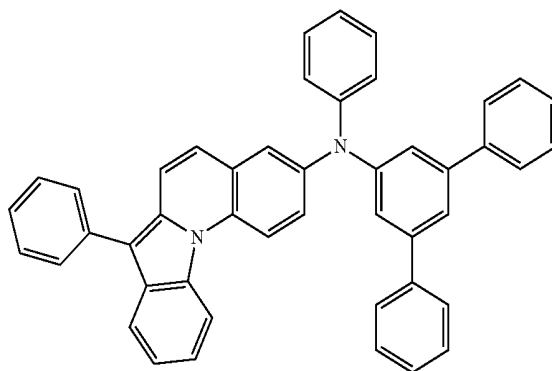


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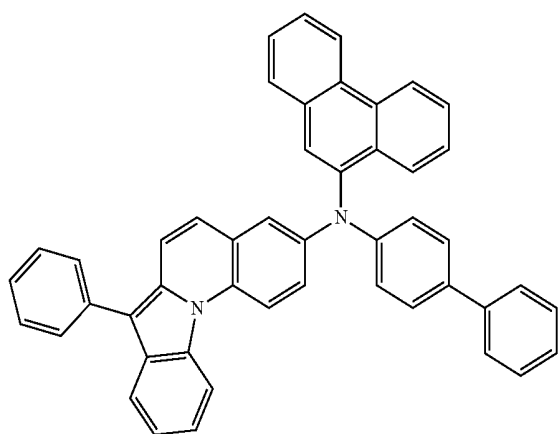
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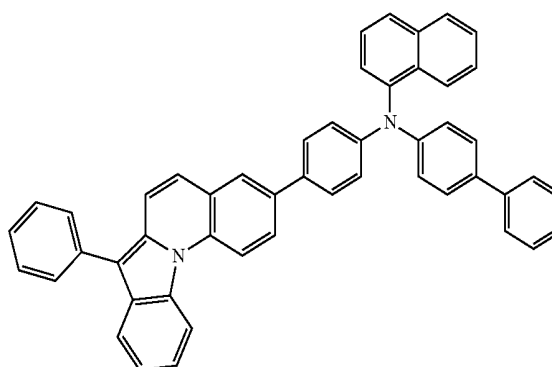
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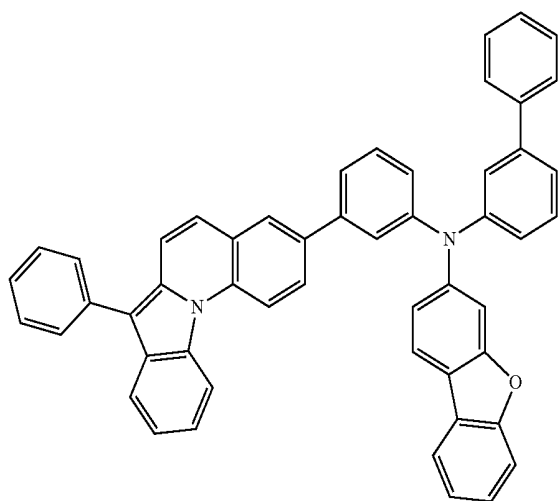
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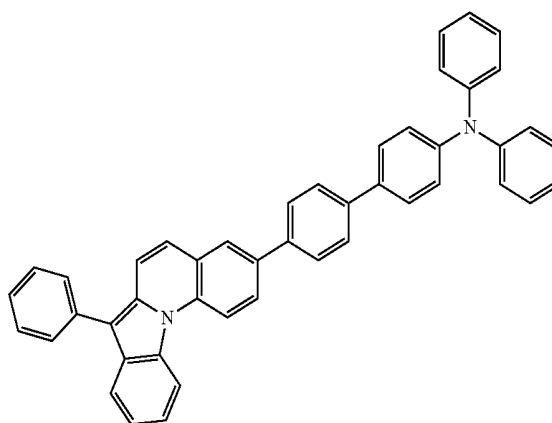
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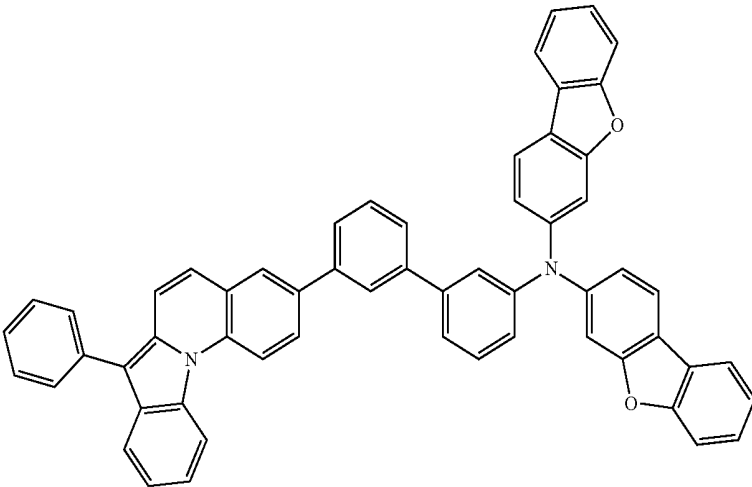


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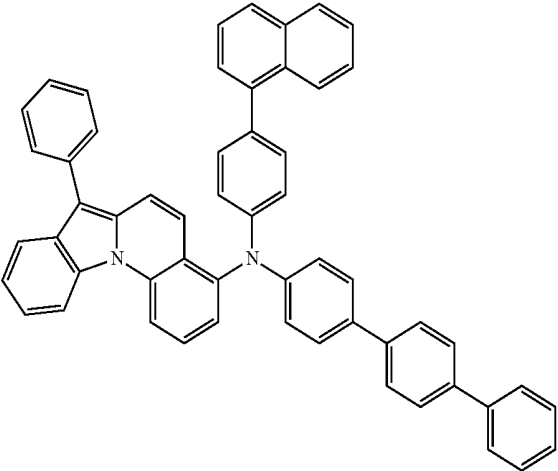
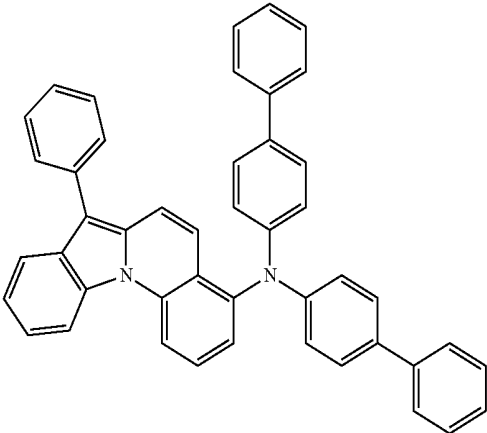
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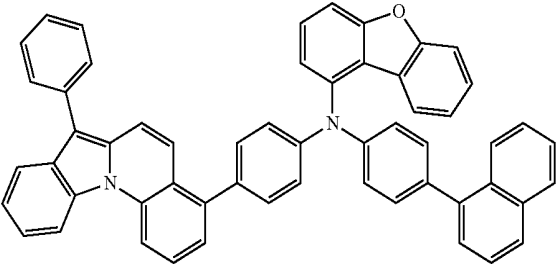
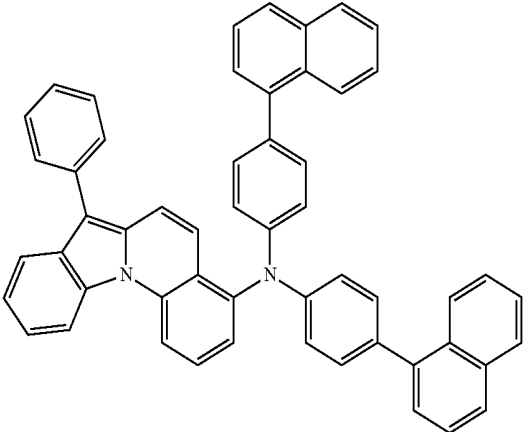
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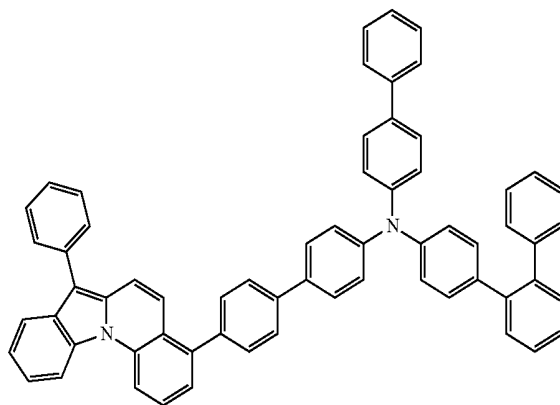
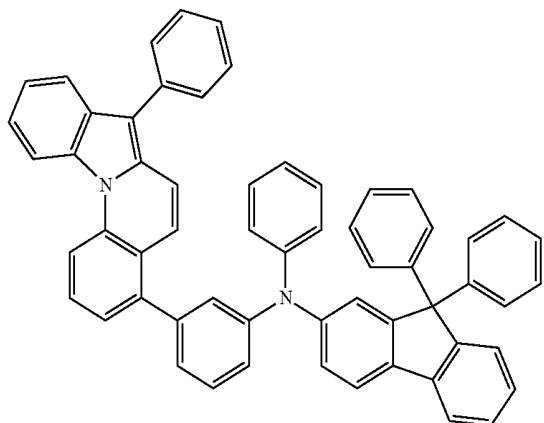
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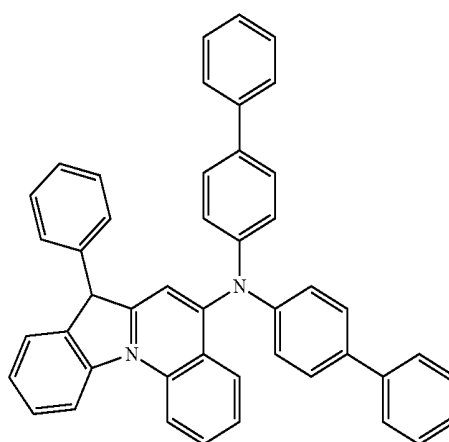
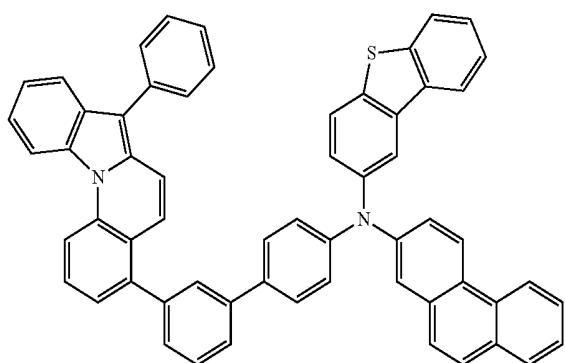
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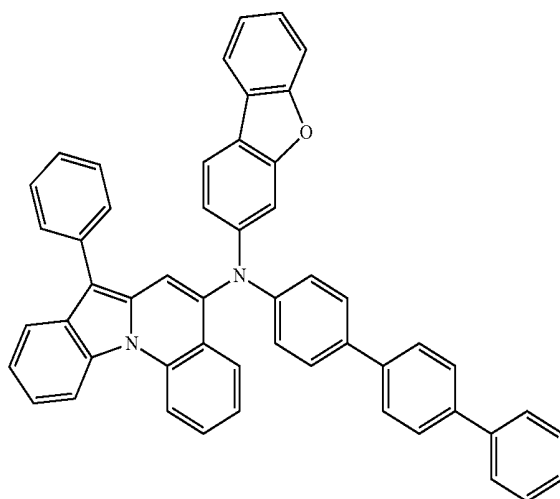
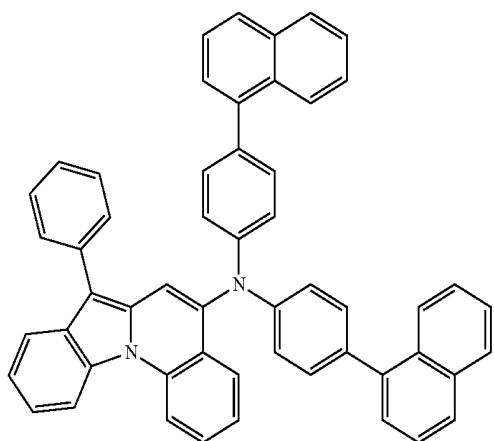
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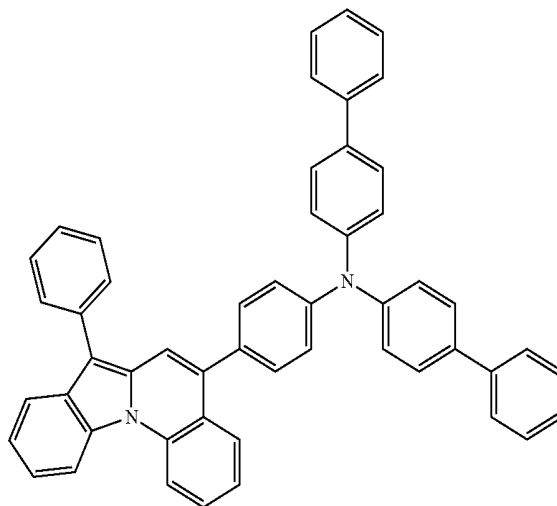
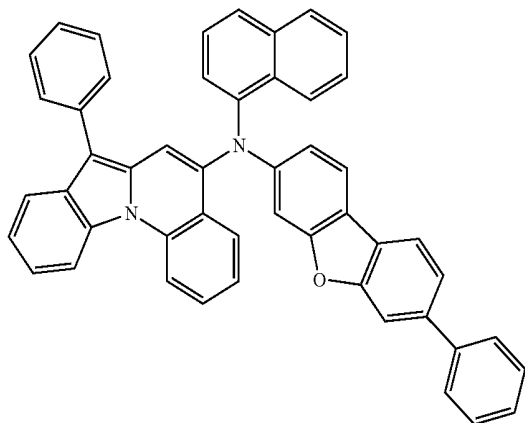
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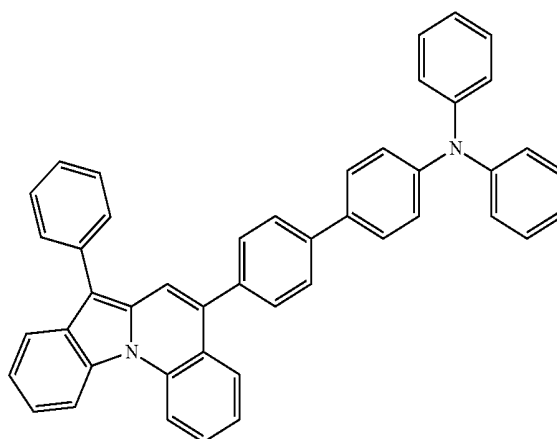
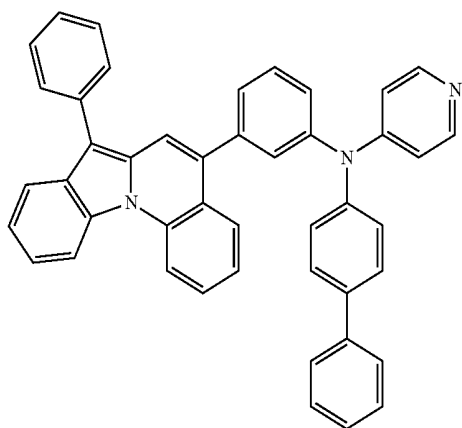
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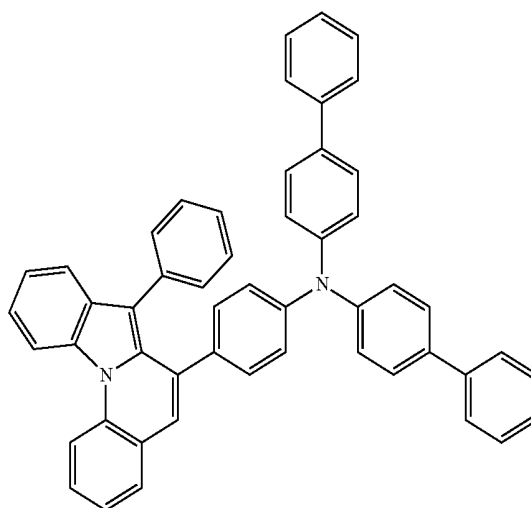
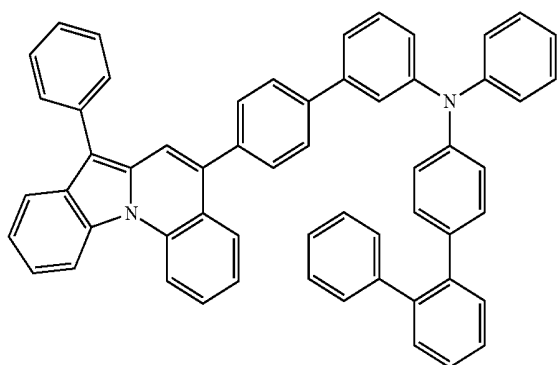
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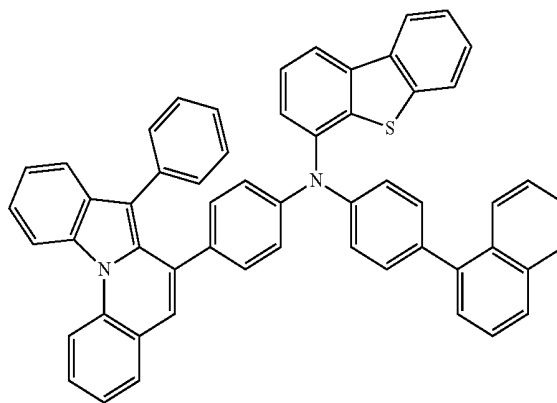
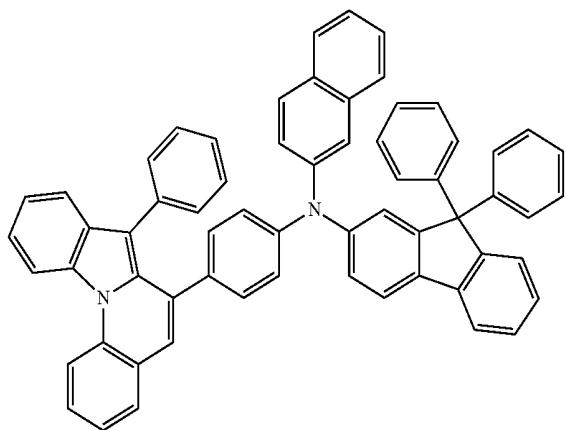
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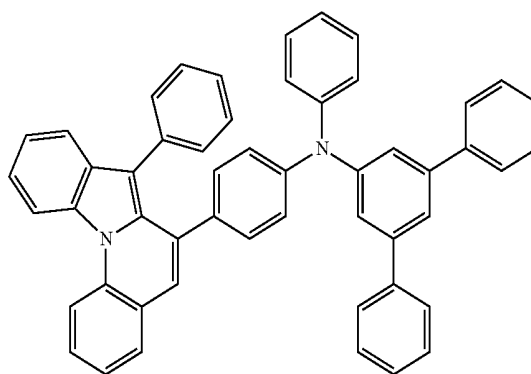
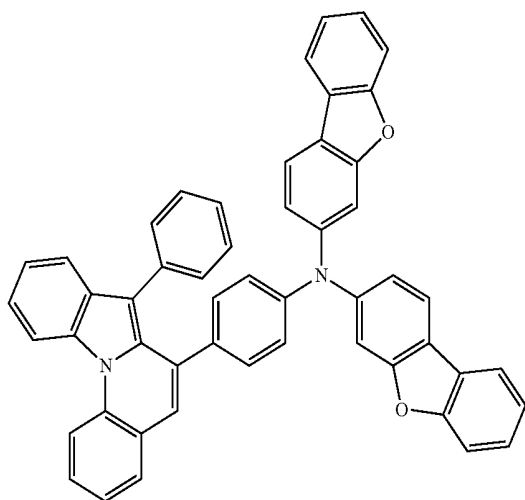
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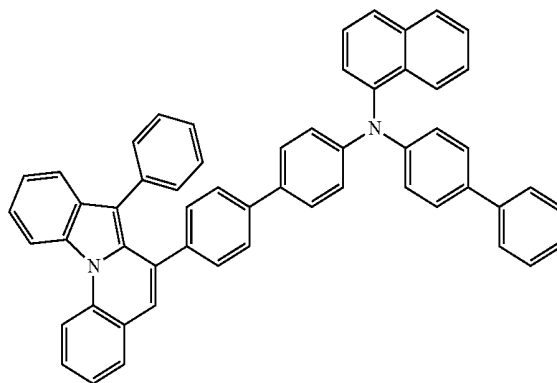
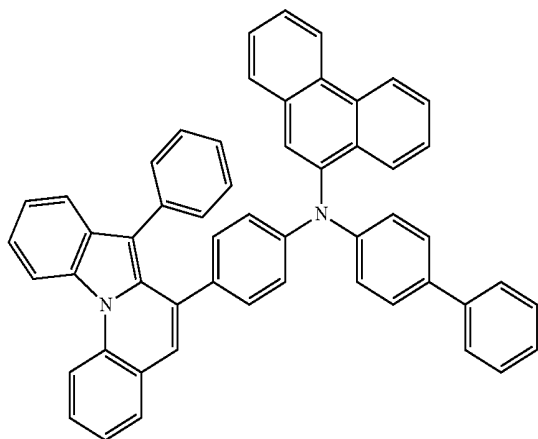
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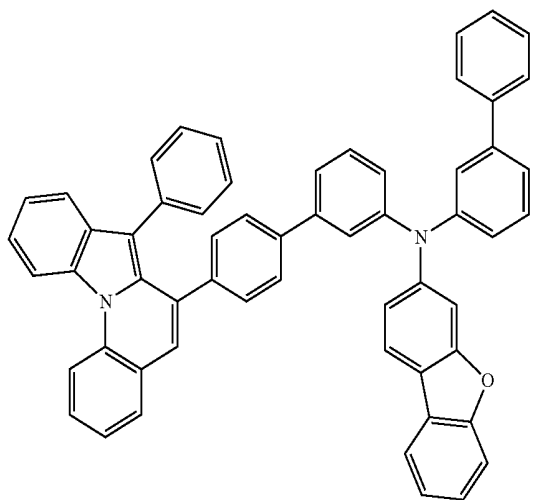
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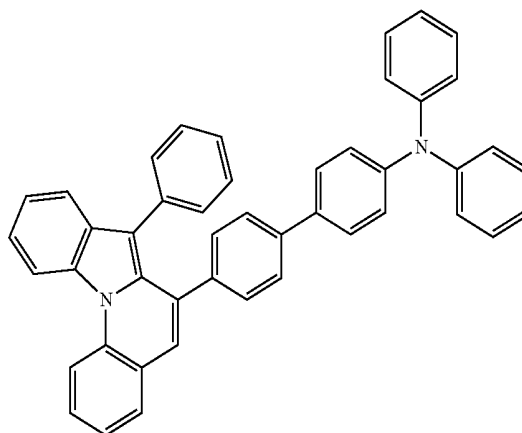


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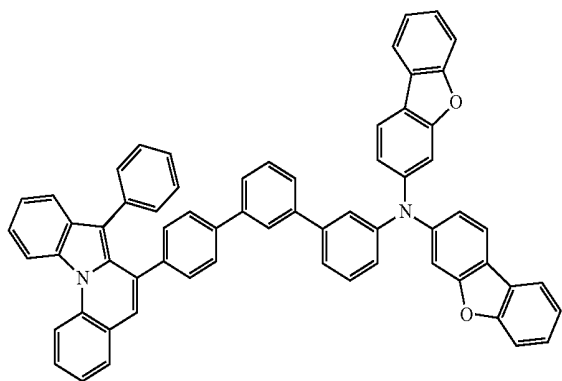
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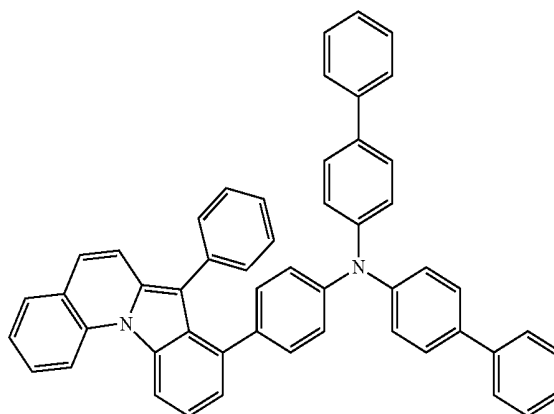
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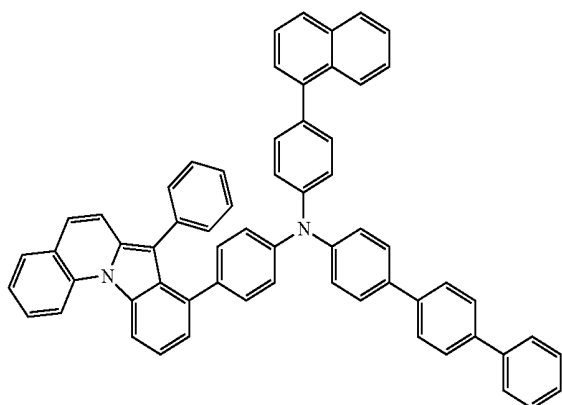
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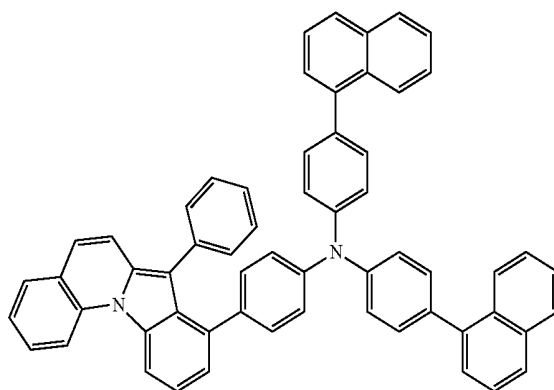
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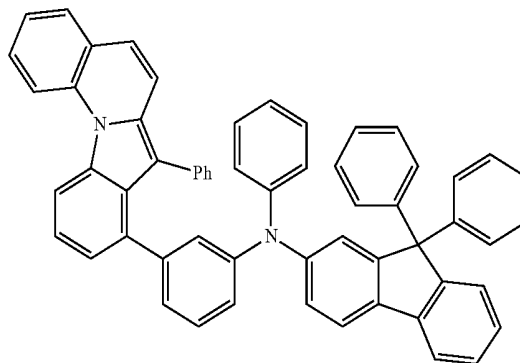
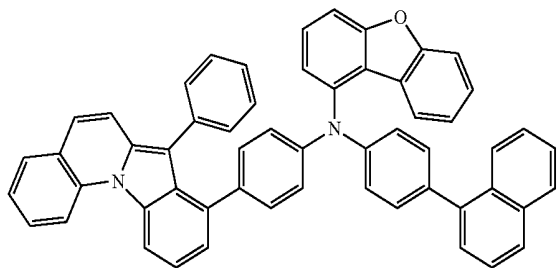
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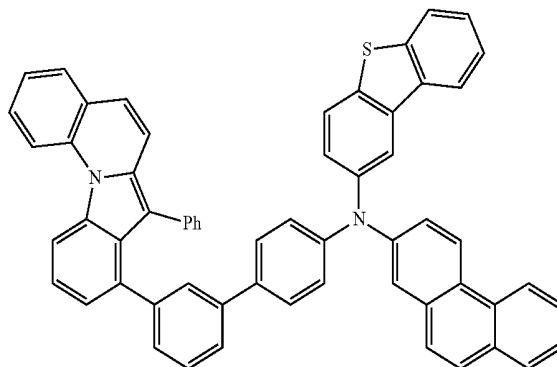
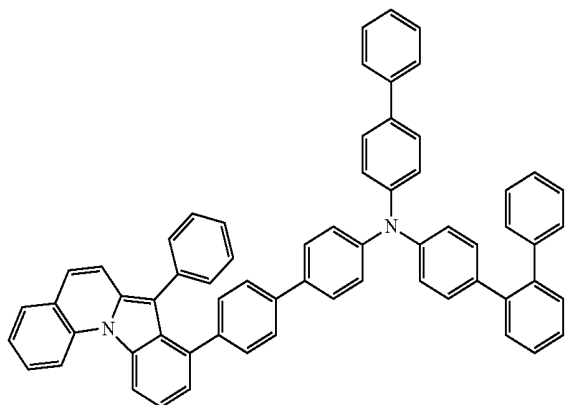
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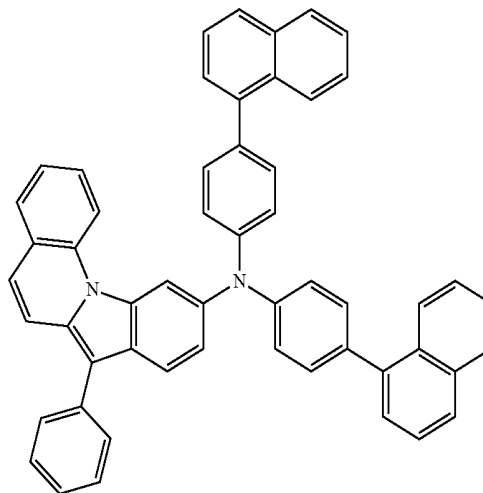
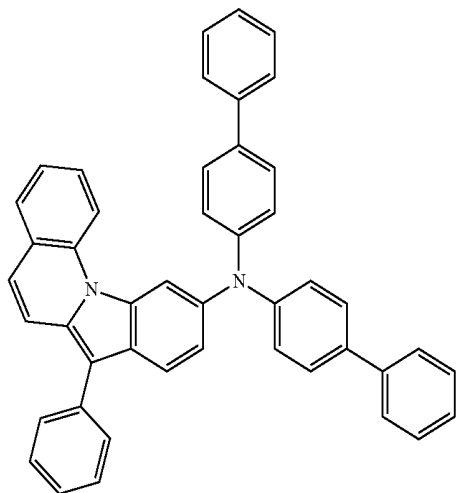
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C75



C76

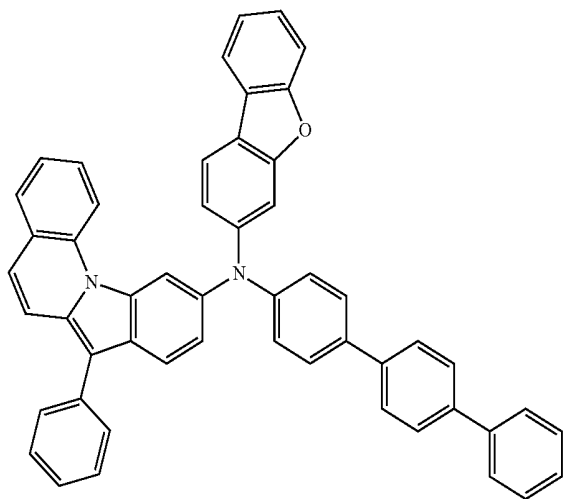
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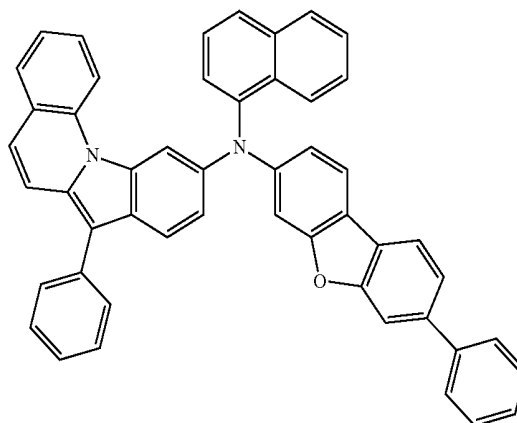
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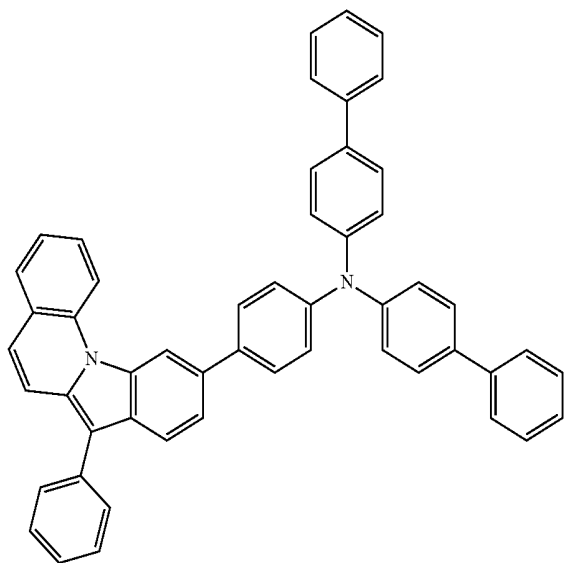
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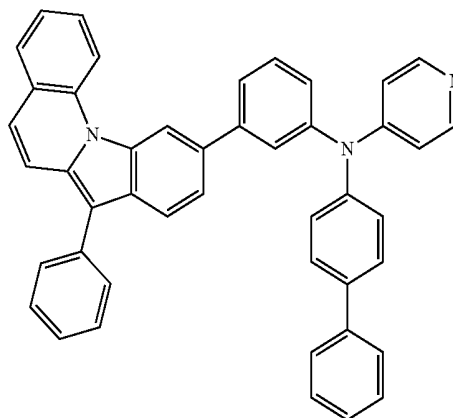
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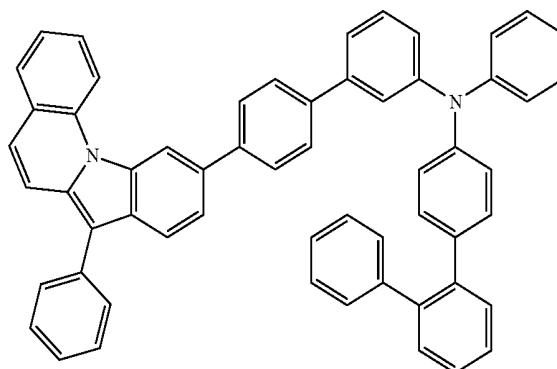
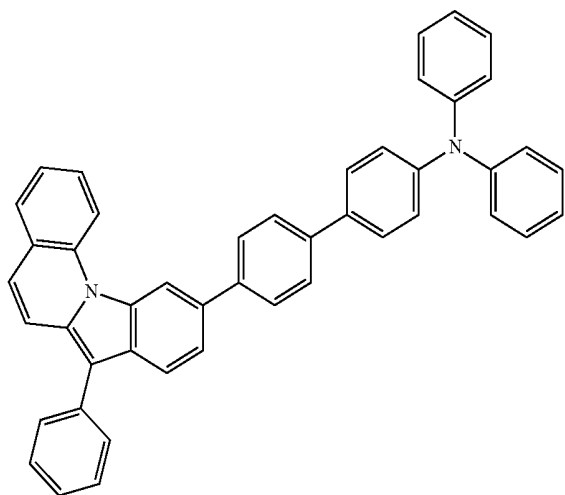
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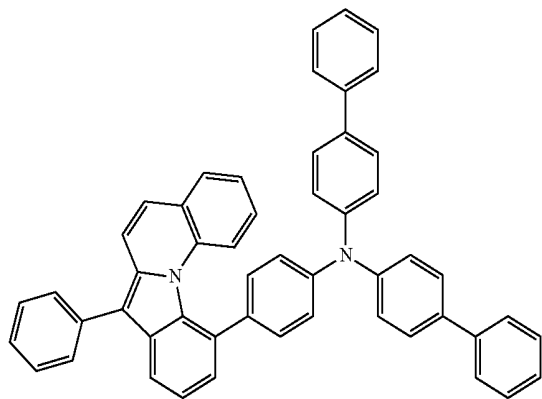


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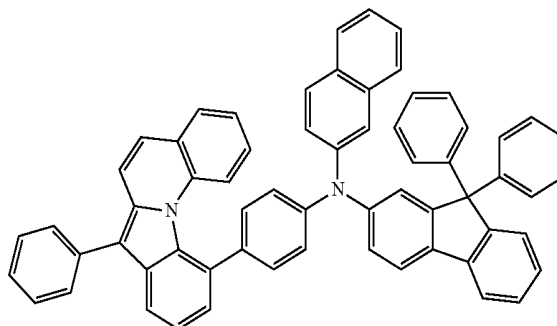


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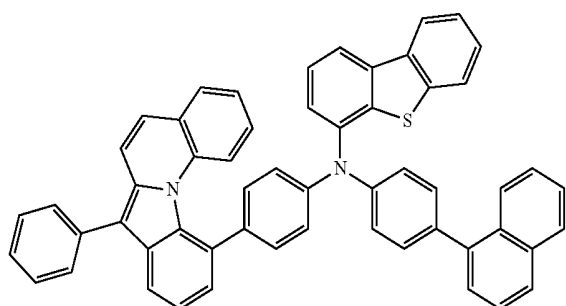
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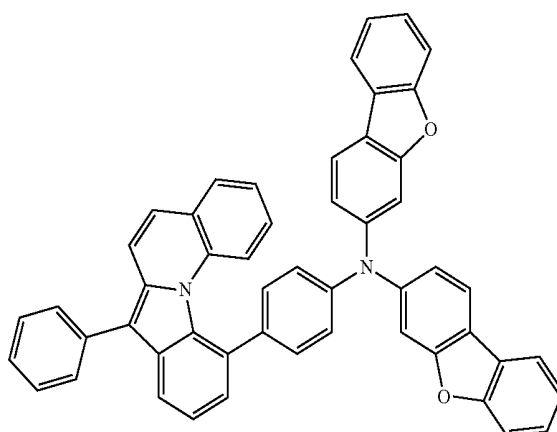
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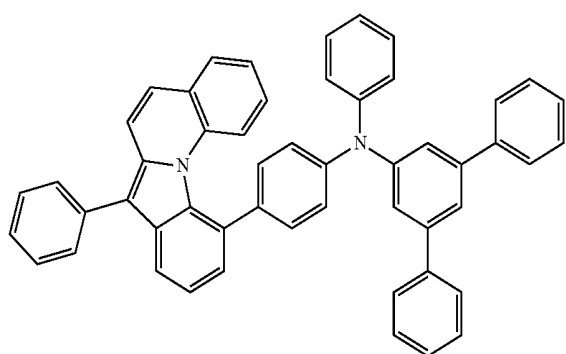
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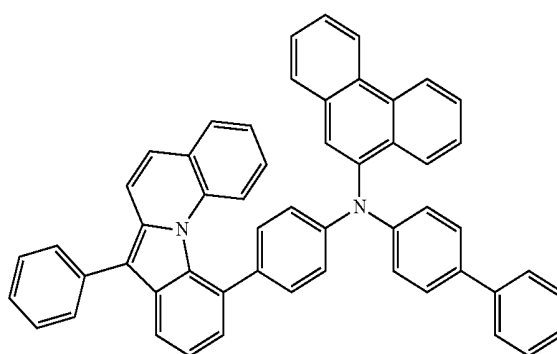
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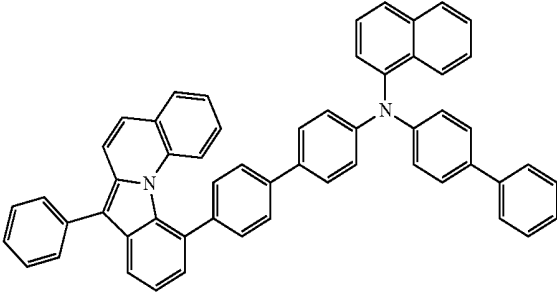
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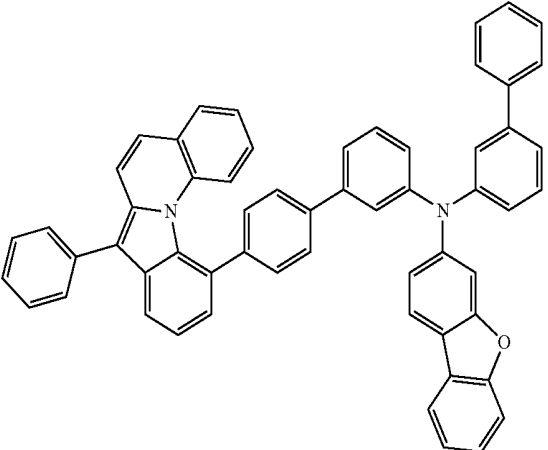
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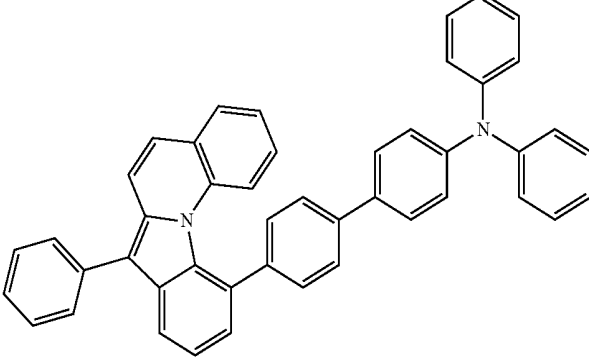
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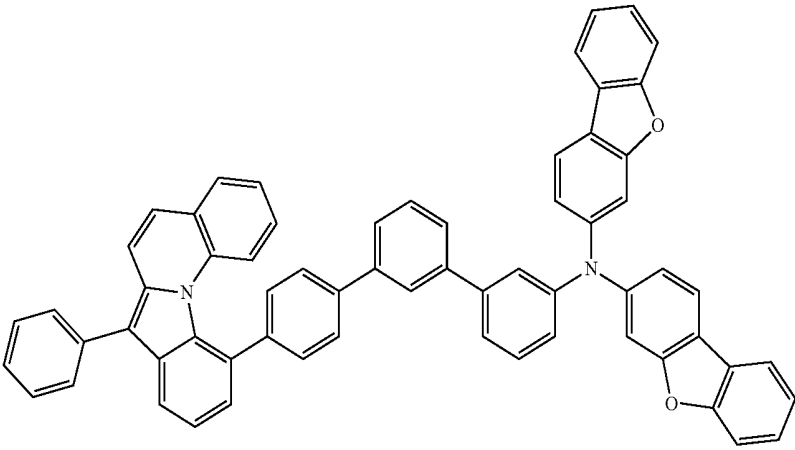
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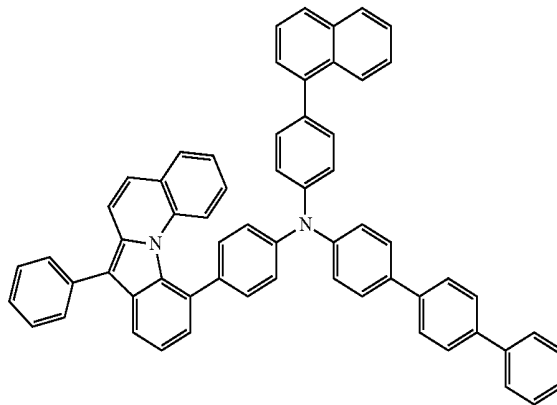
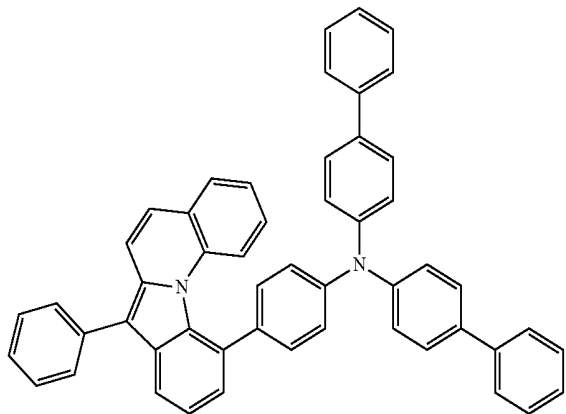


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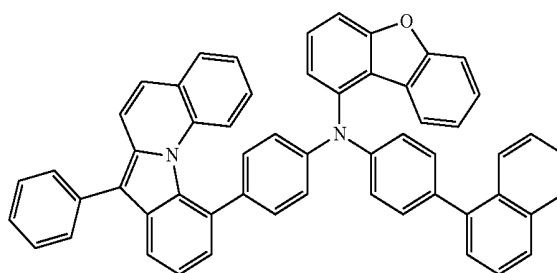
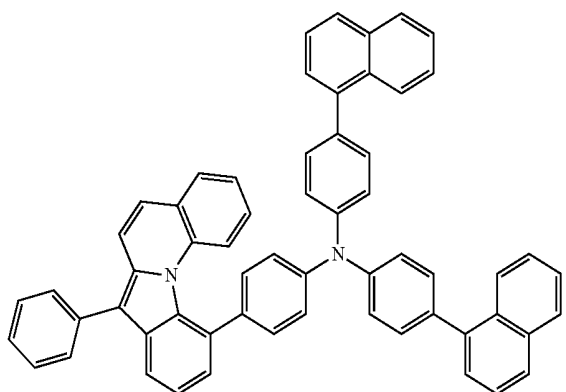
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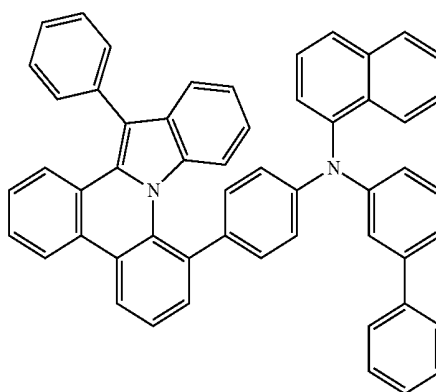
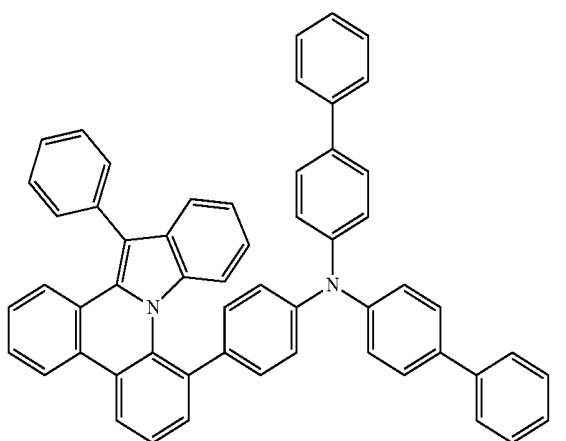
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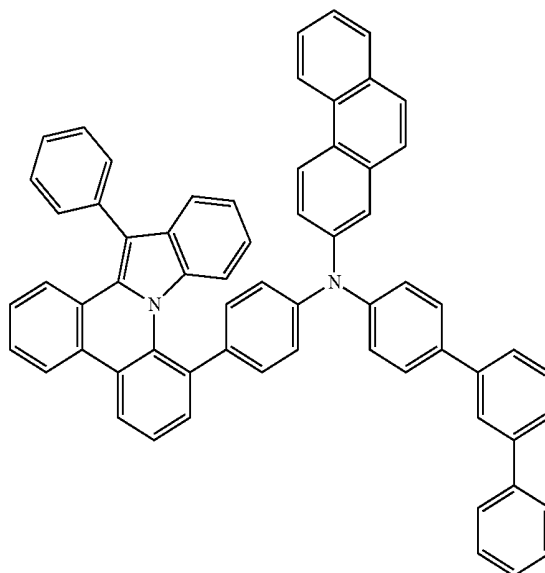
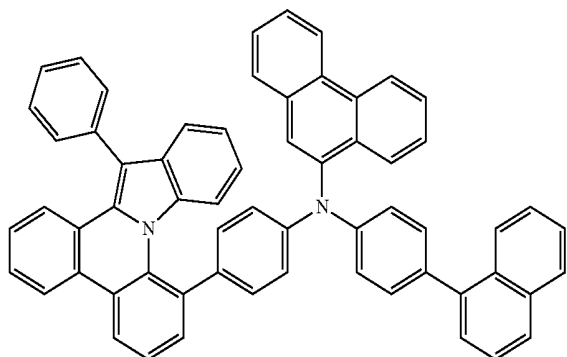
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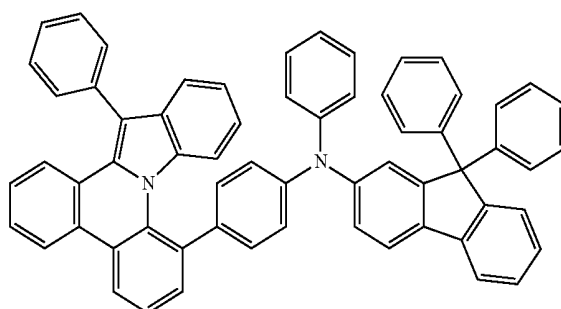
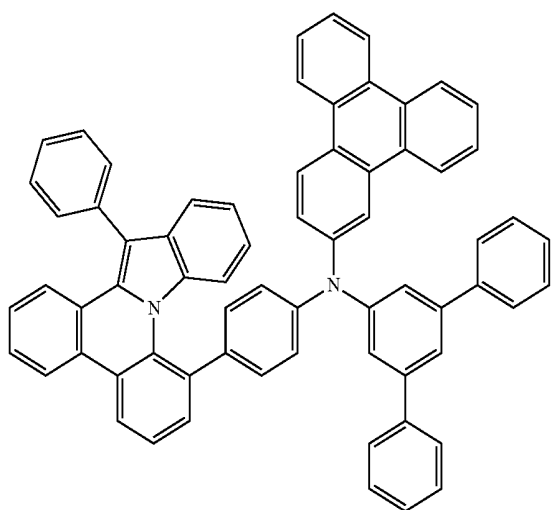
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D4



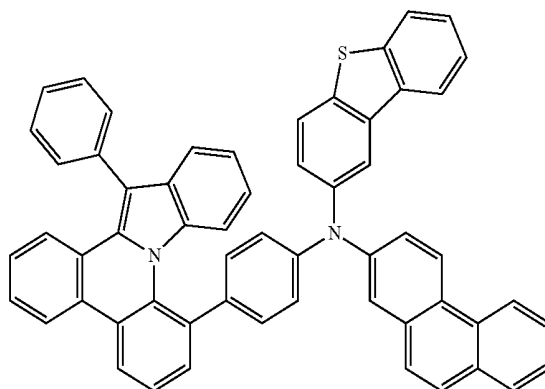
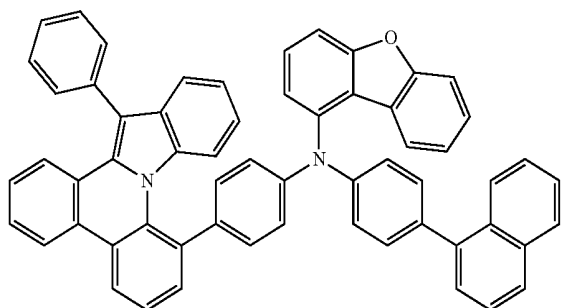
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D6



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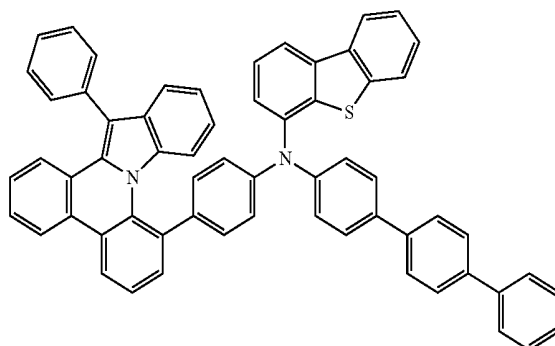
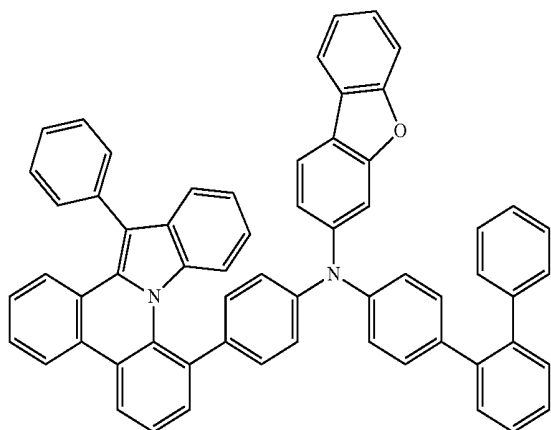
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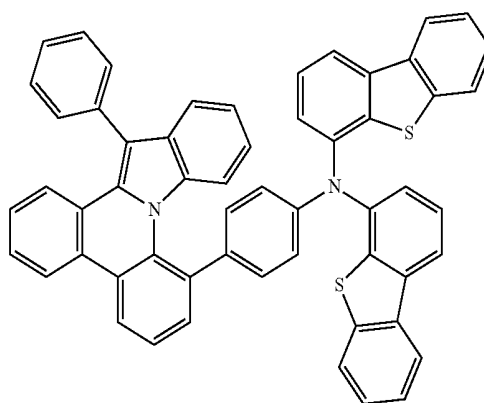
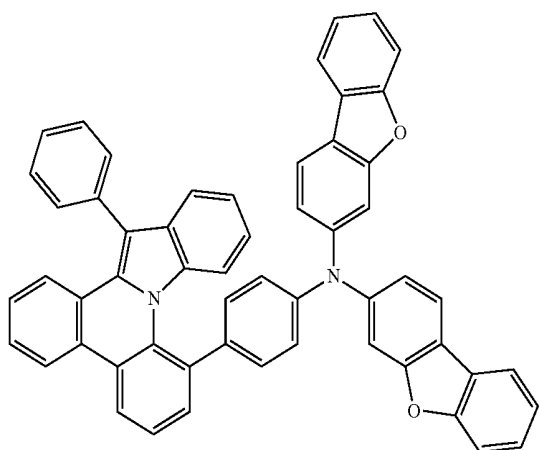
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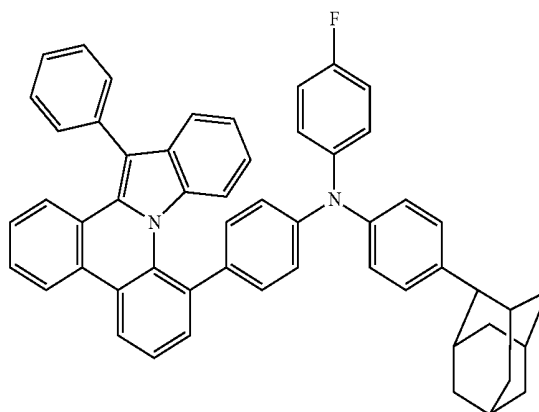
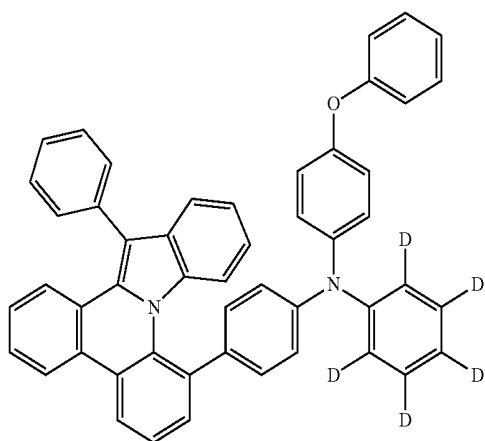
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D12



D14

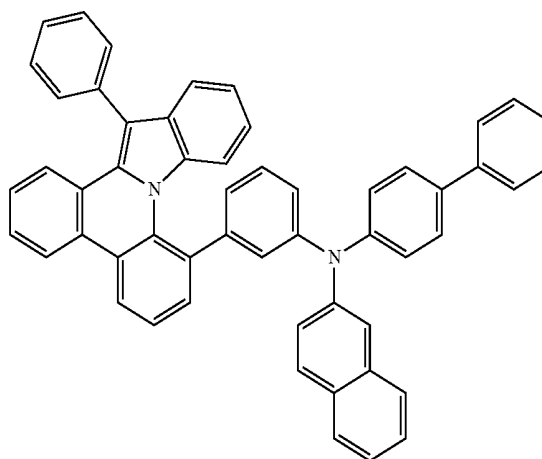
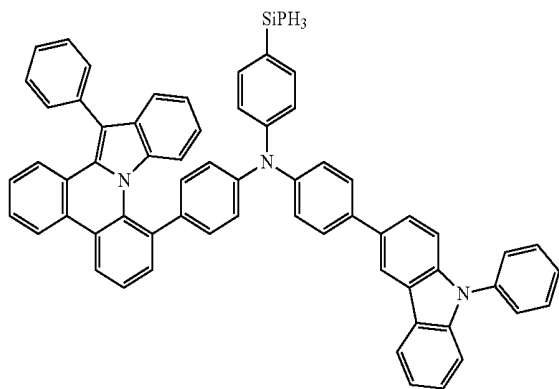
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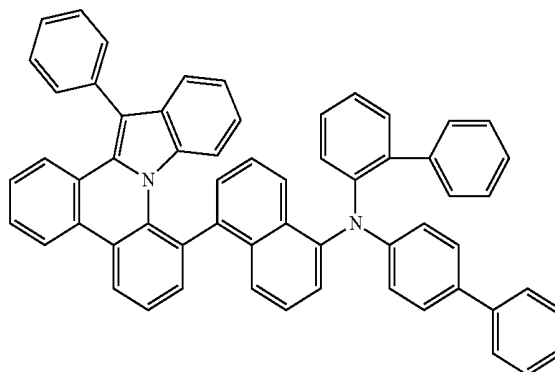
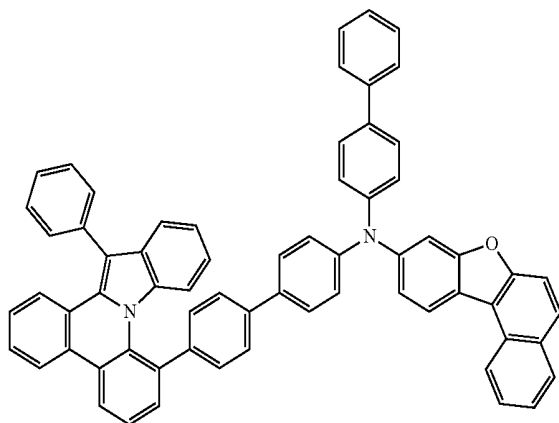
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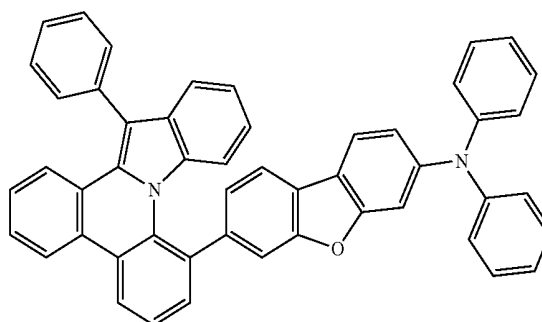
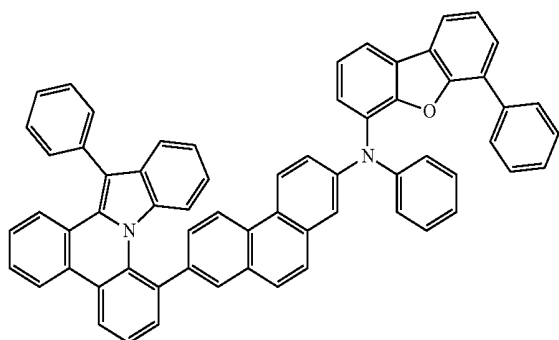
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D19

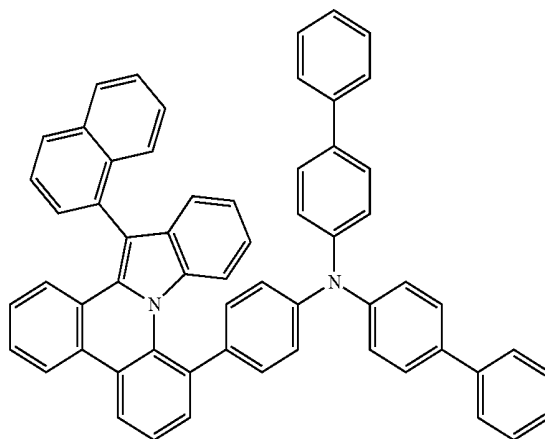
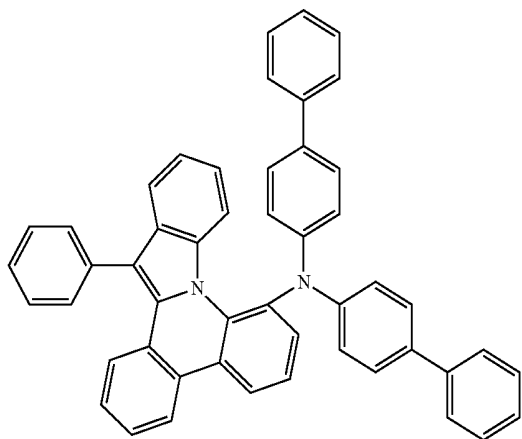
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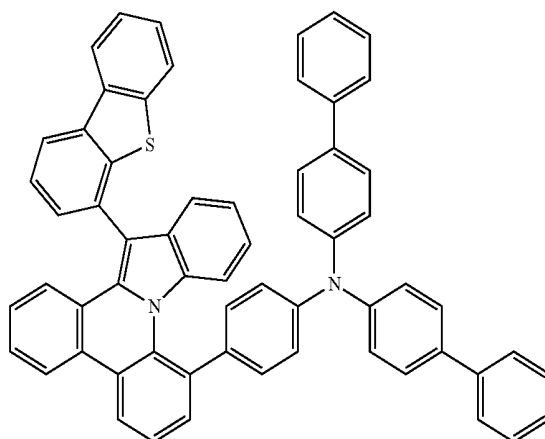
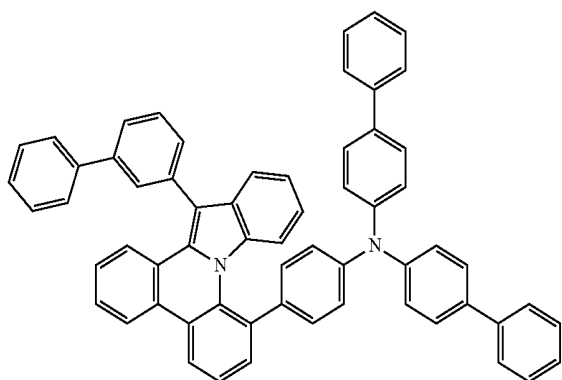
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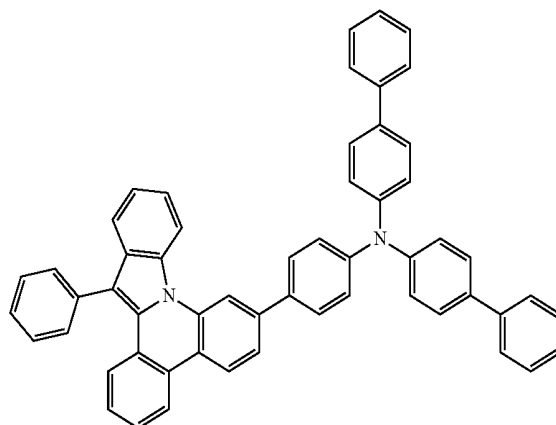
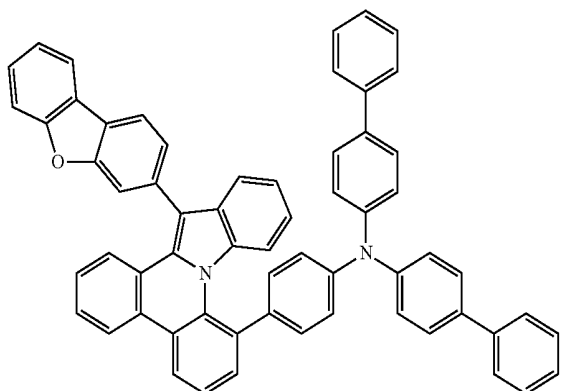
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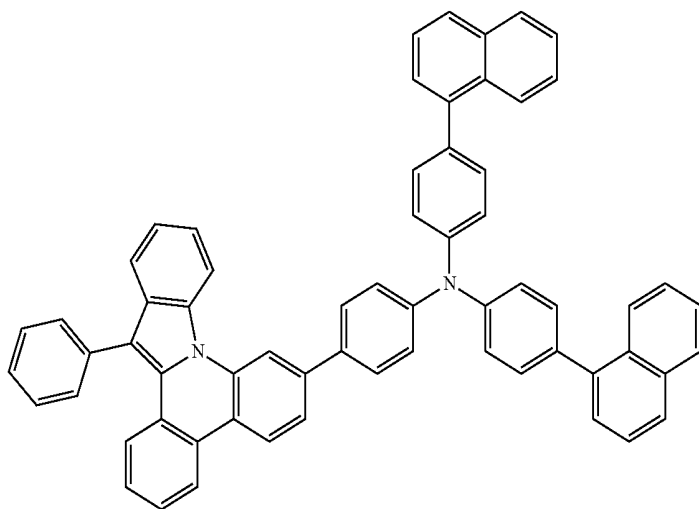
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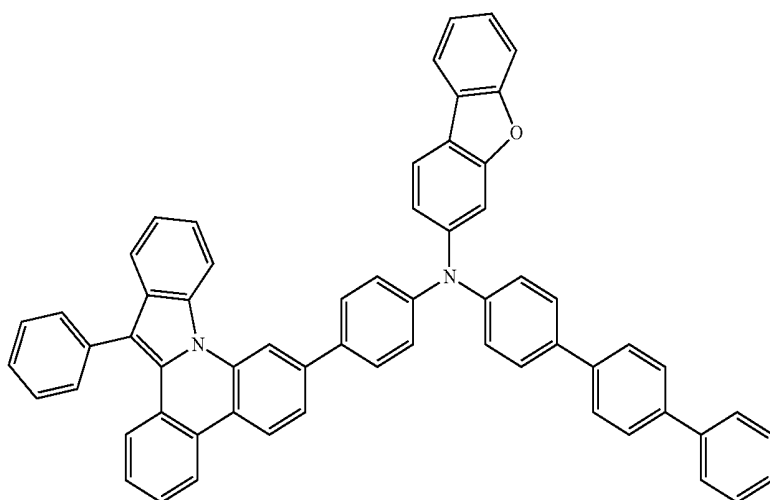


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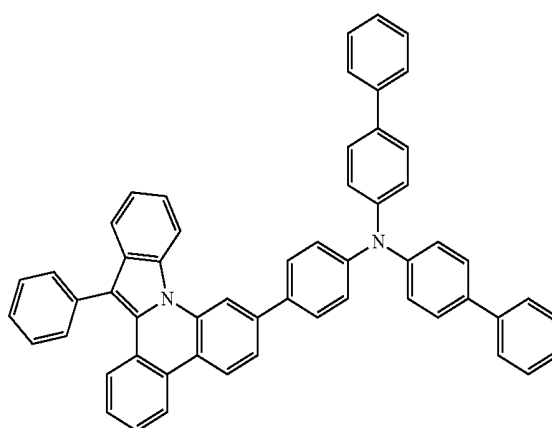
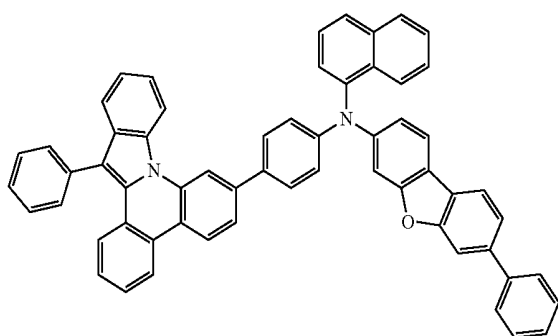


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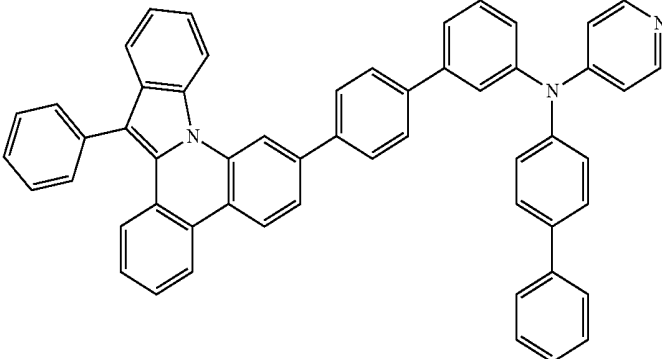
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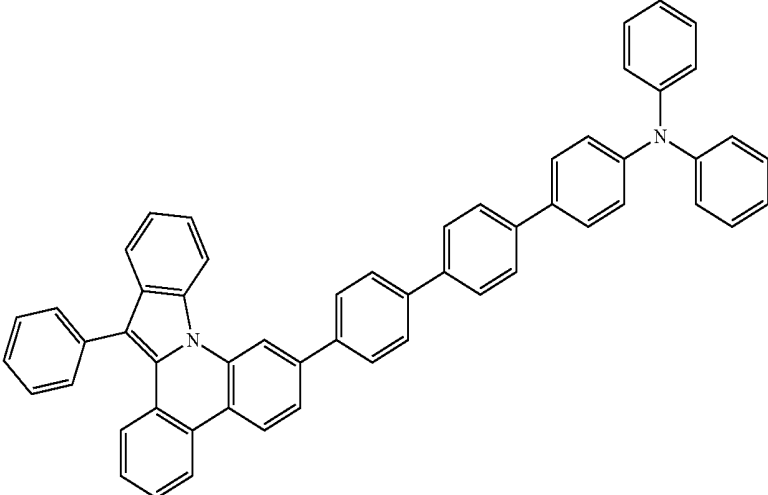


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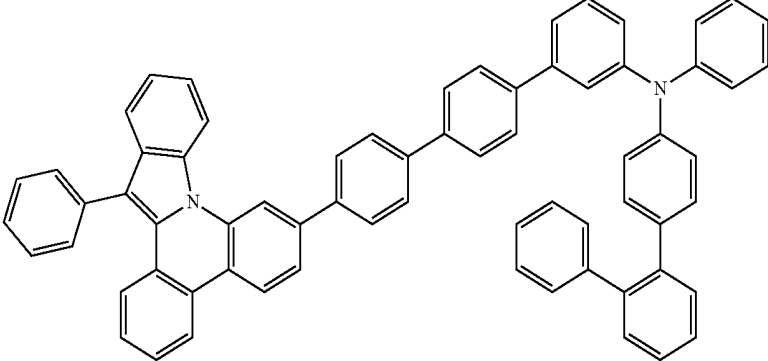
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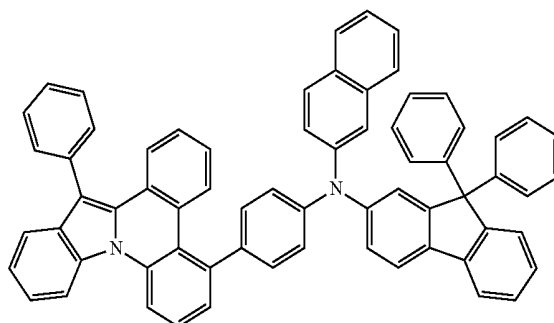
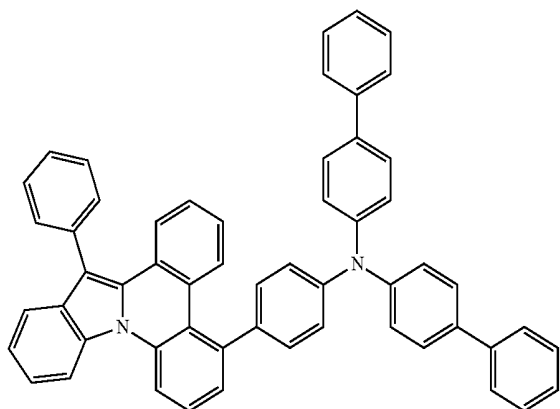
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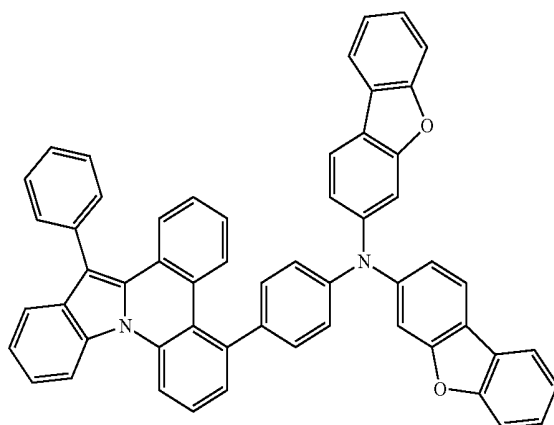
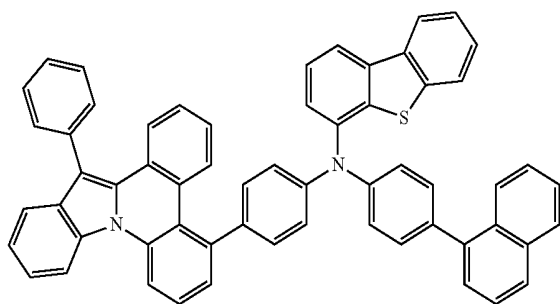
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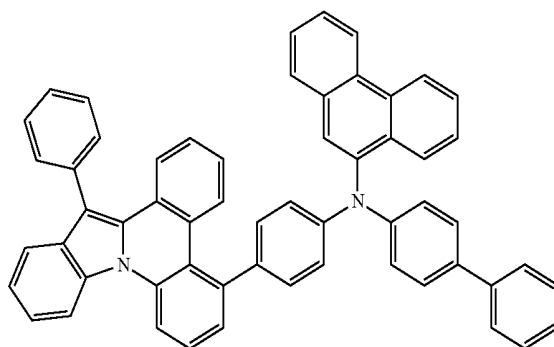
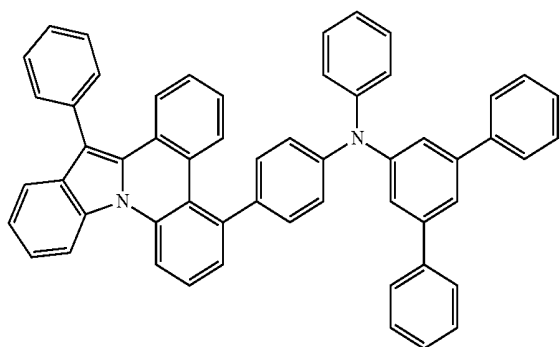
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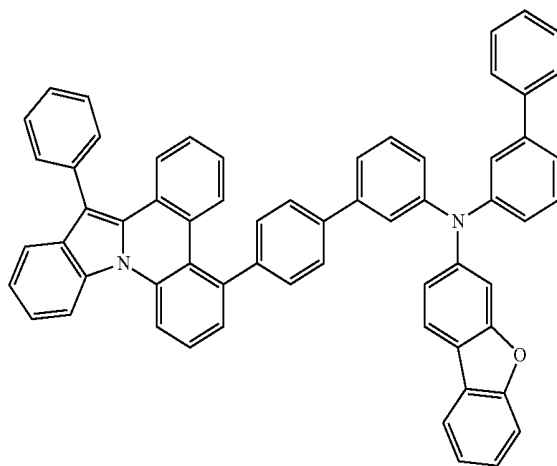
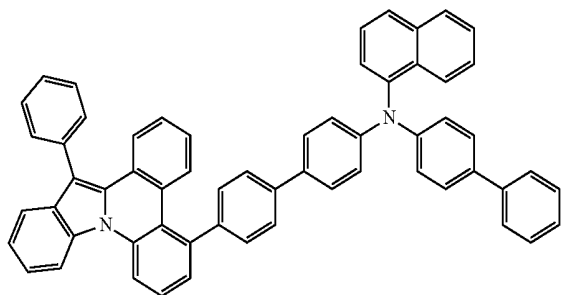


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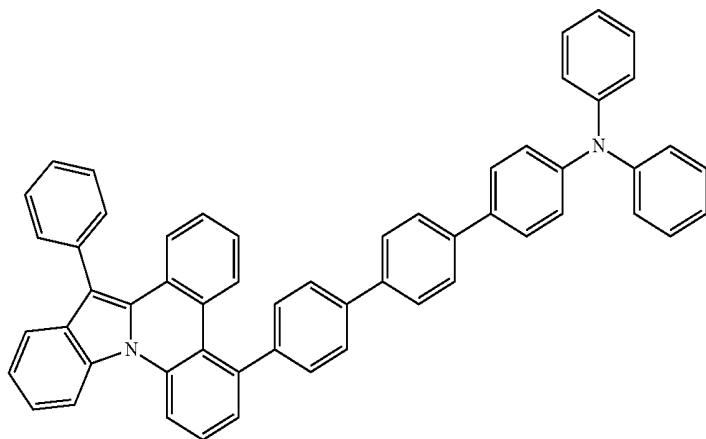
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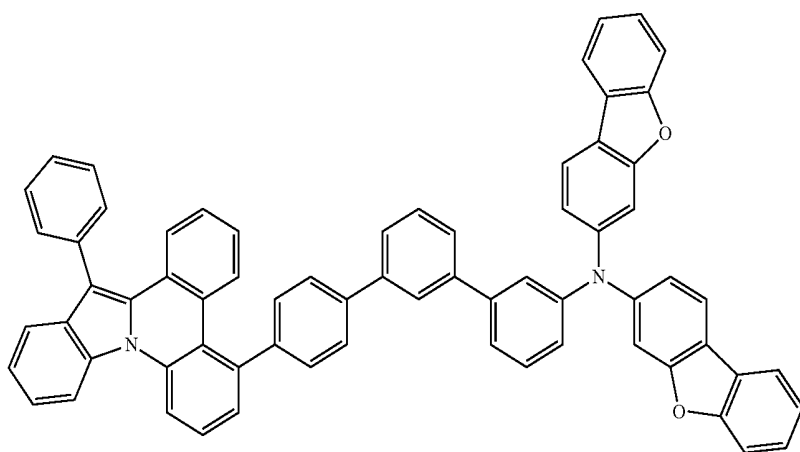
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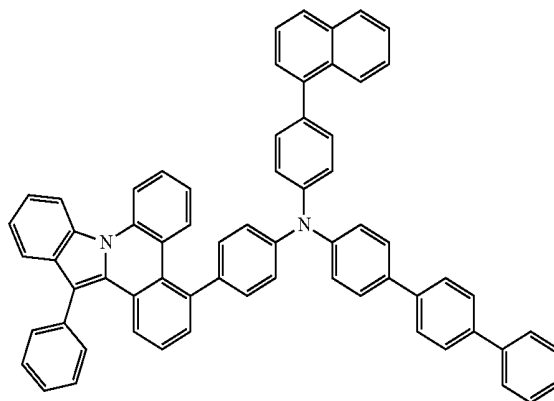
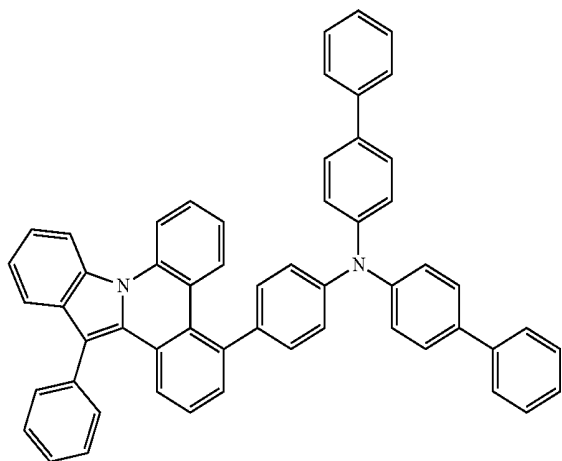
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D43

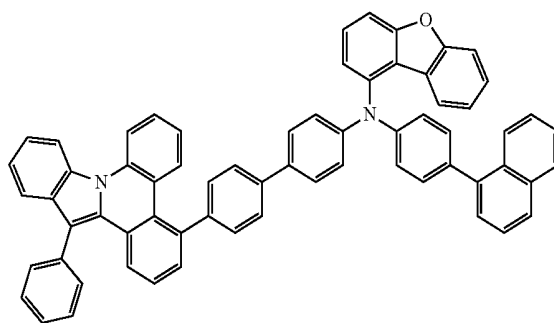
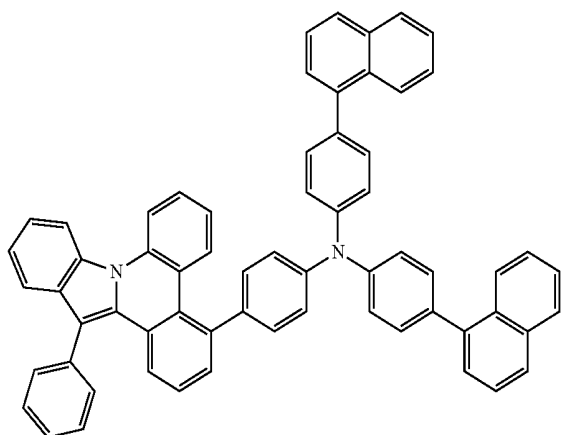
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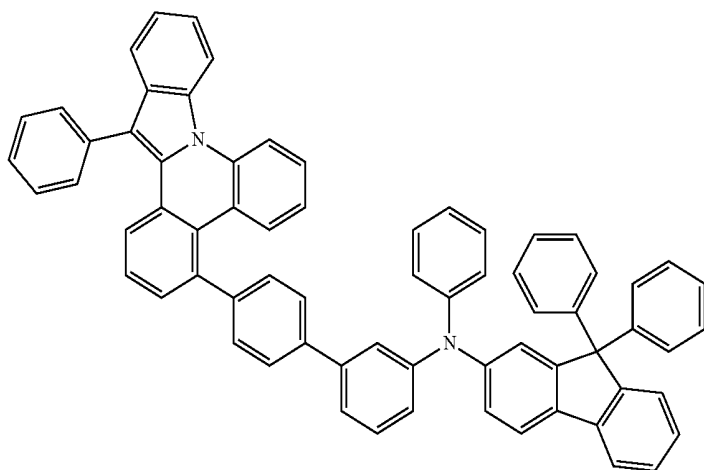


D46

D47

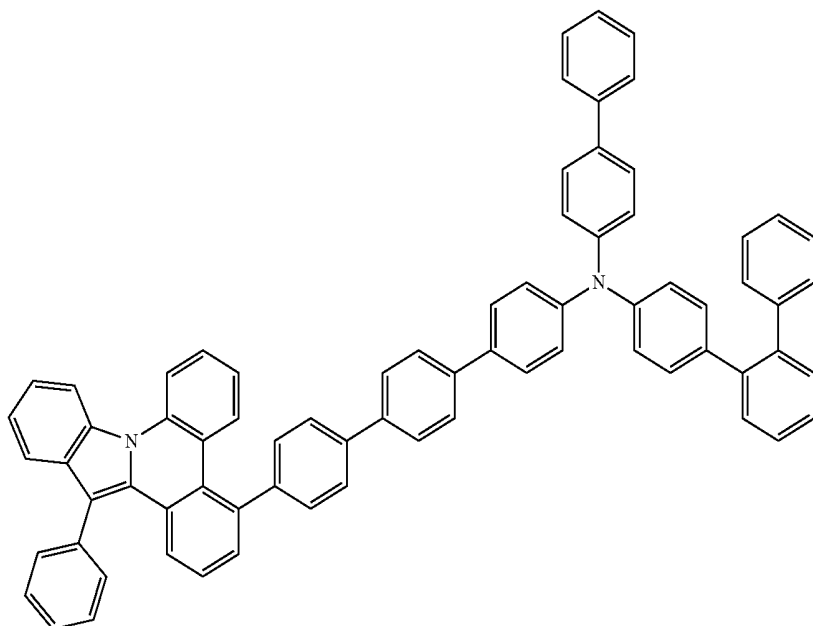


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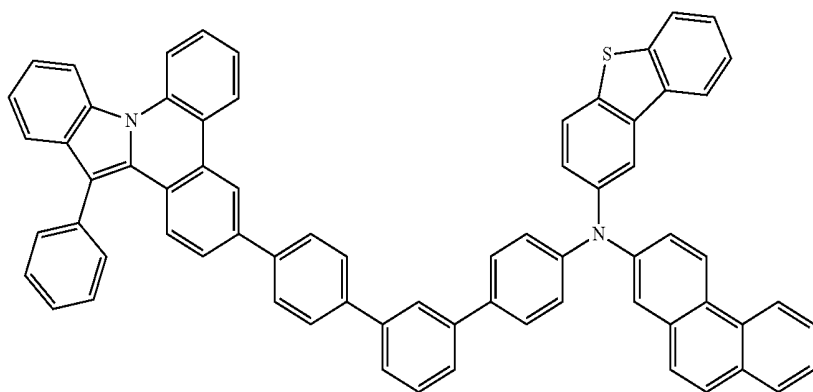


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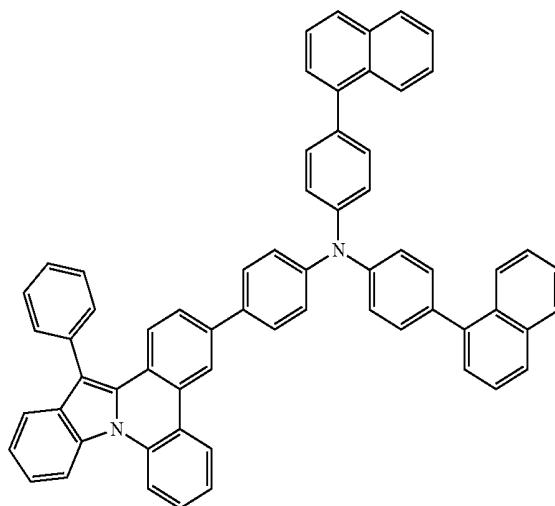
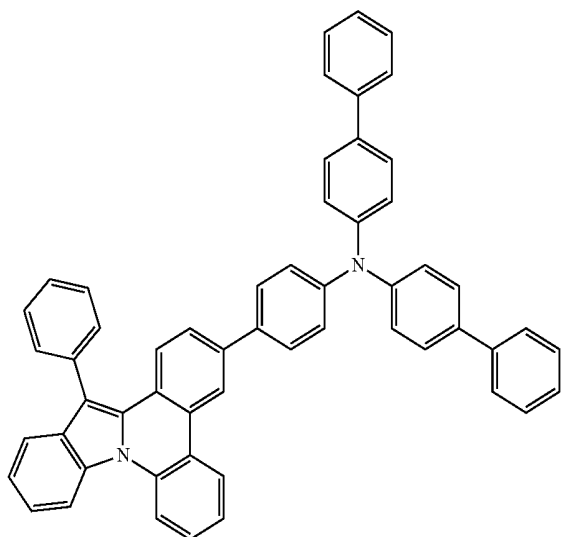


D50



D51

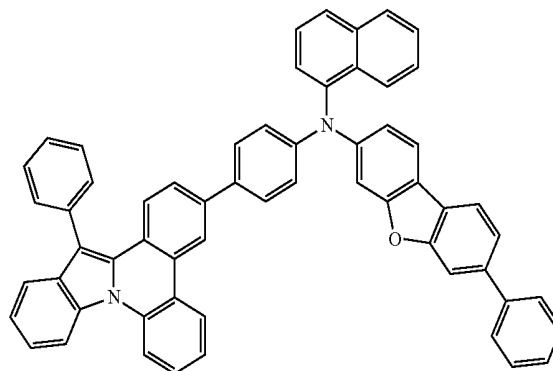
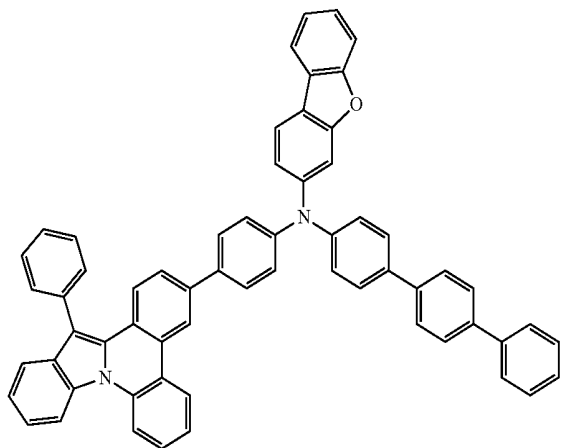
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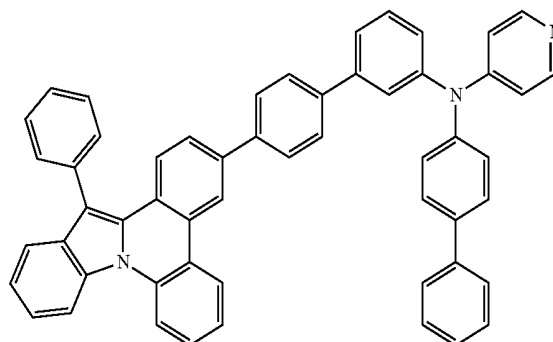
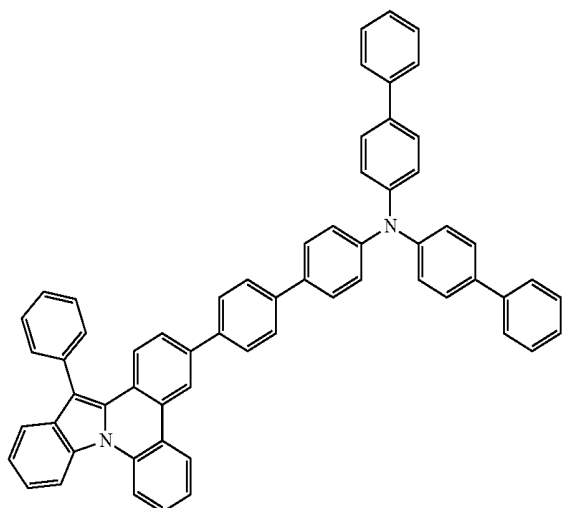
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D54



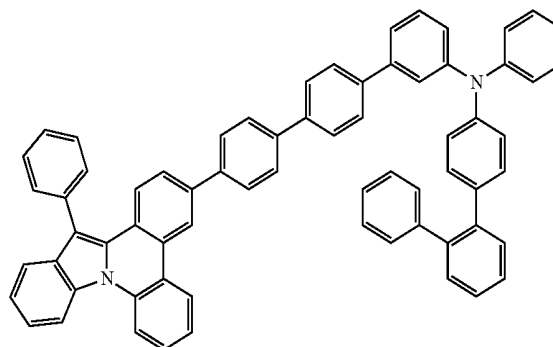
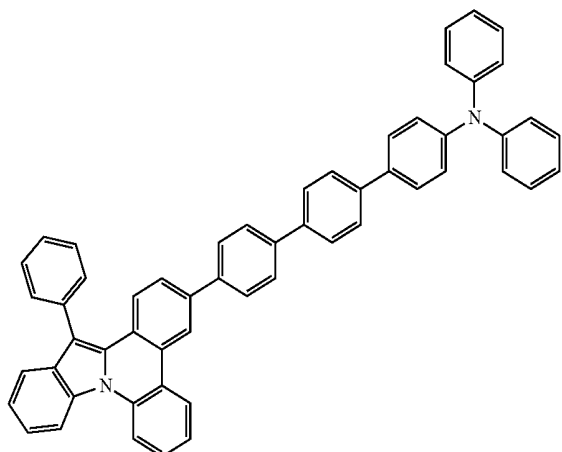
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D56



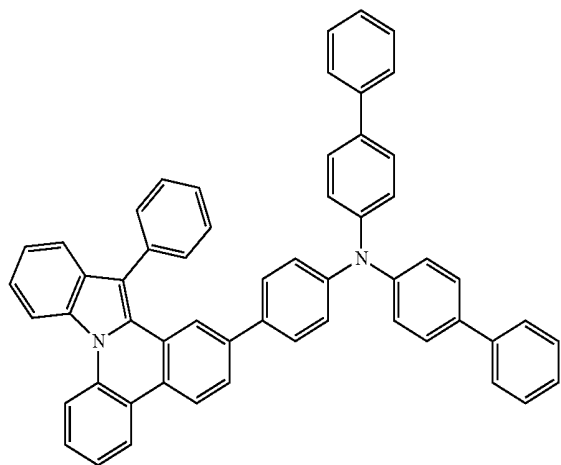
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D58

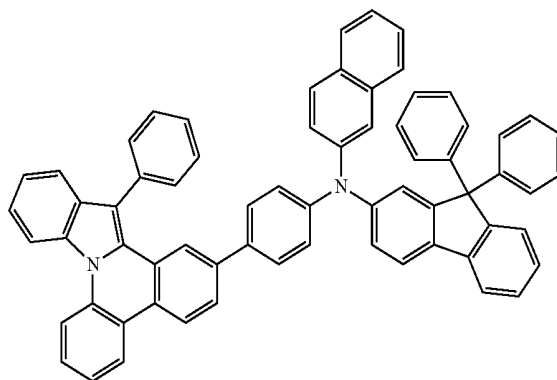


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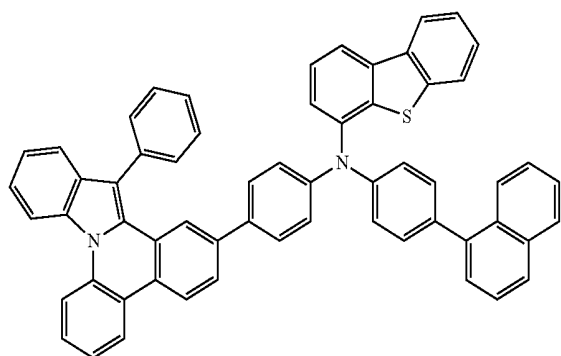
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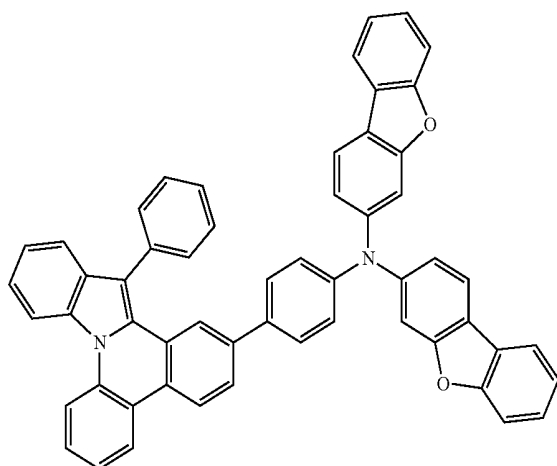
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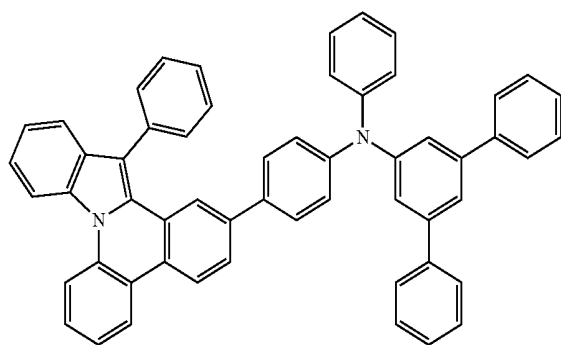
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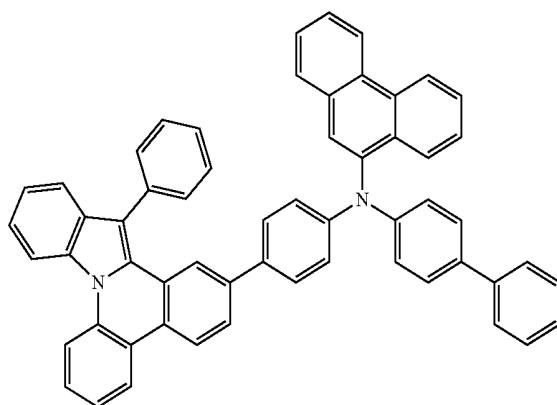
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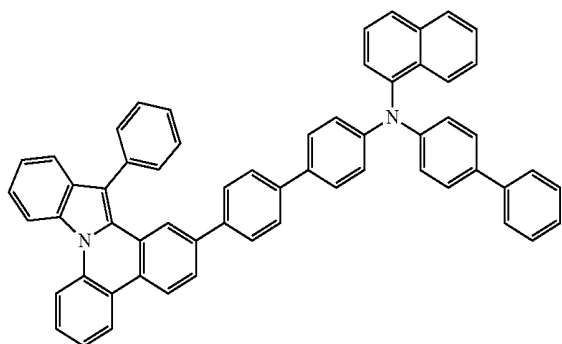
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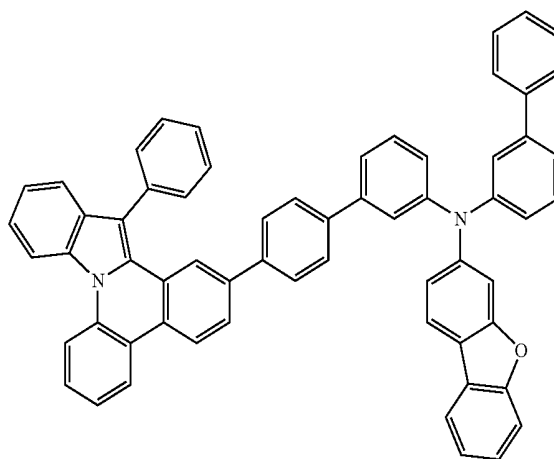
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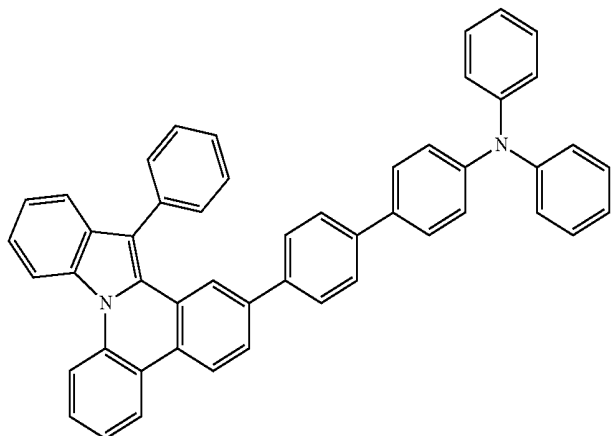
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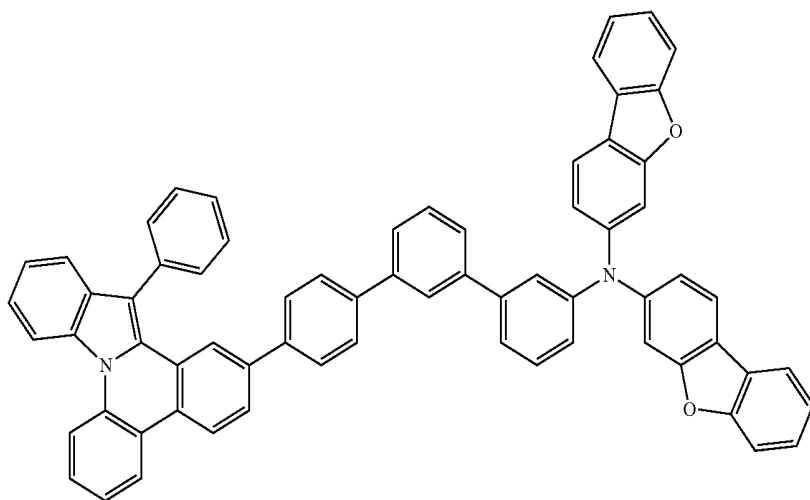
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D67

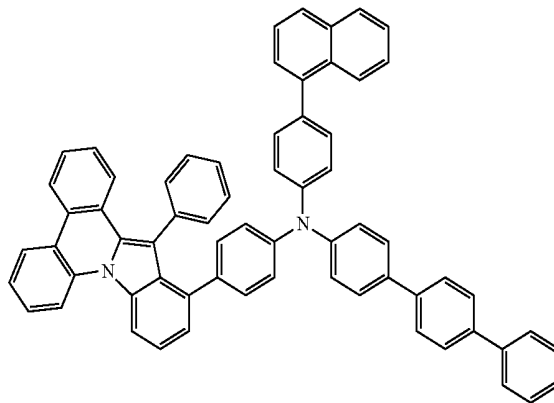
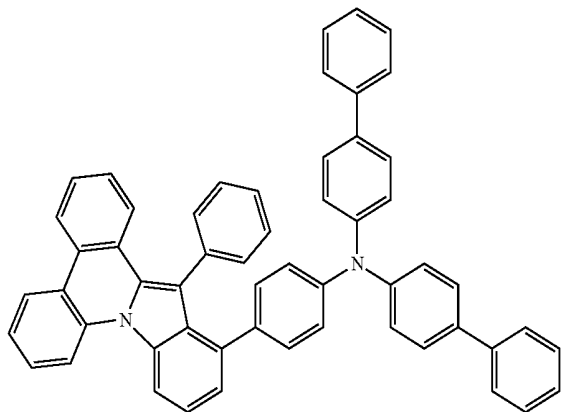


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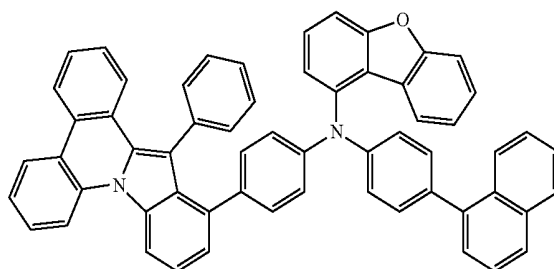
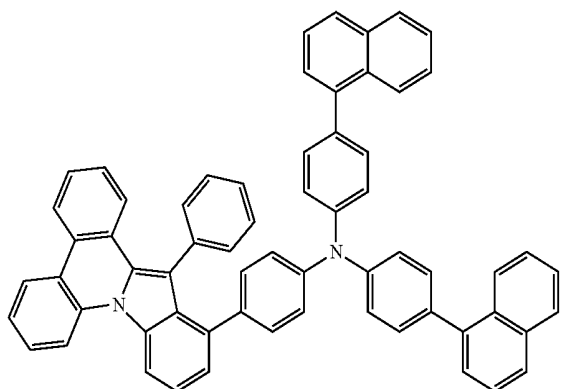
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D70



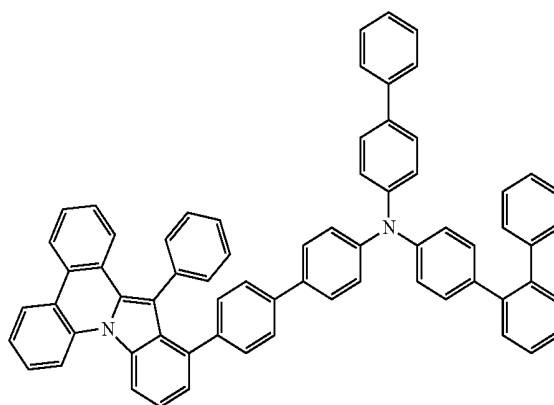
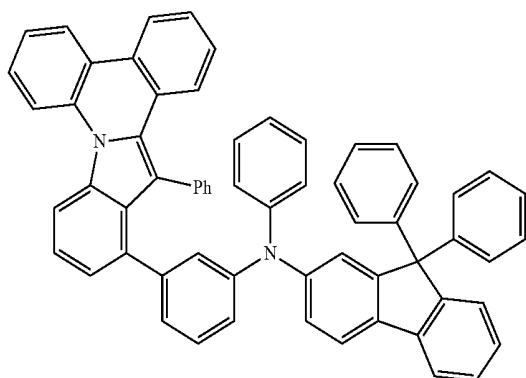
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D72



D73

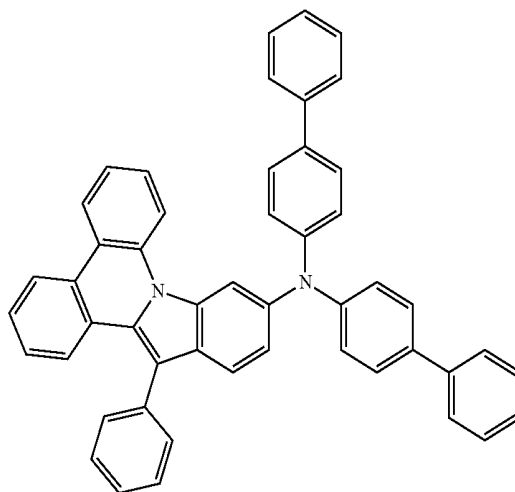
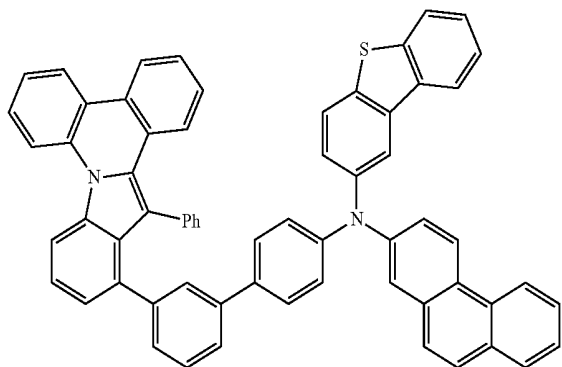
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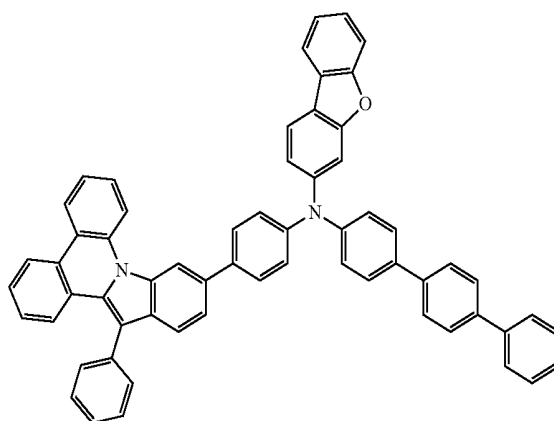
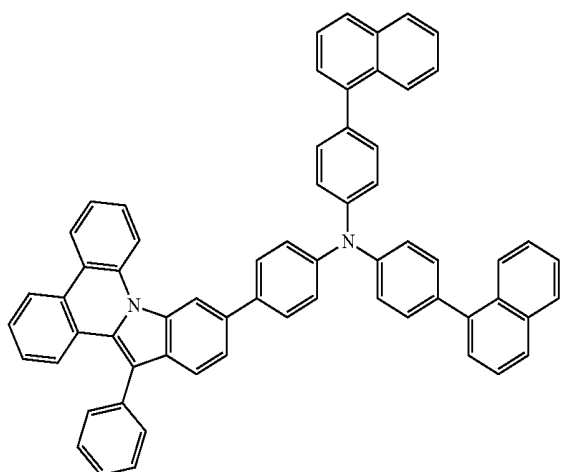
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D76



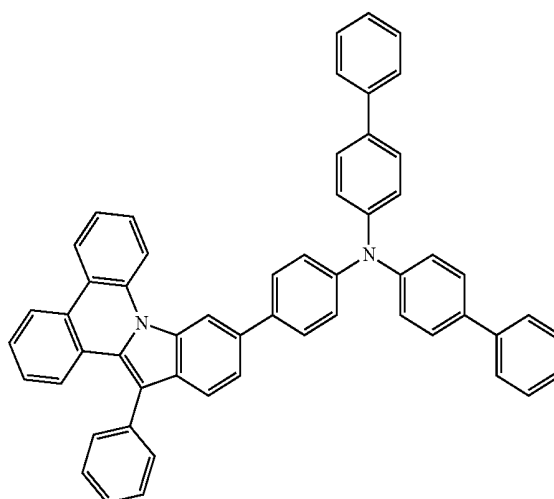
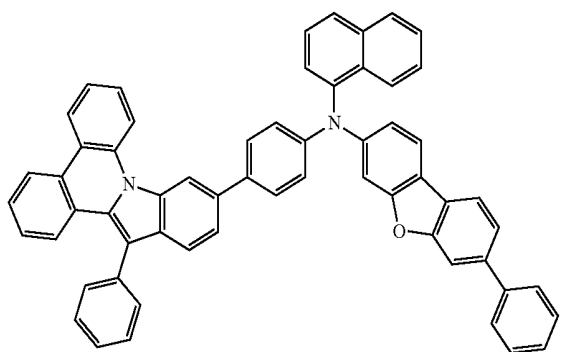
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D78



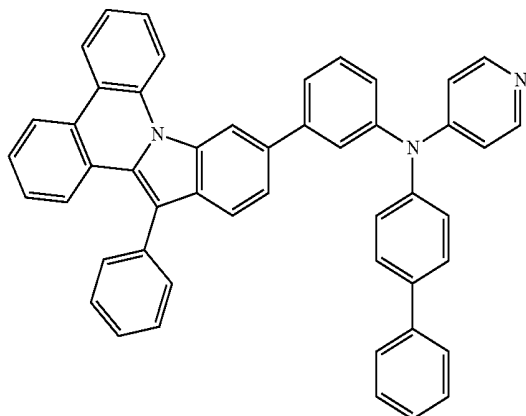
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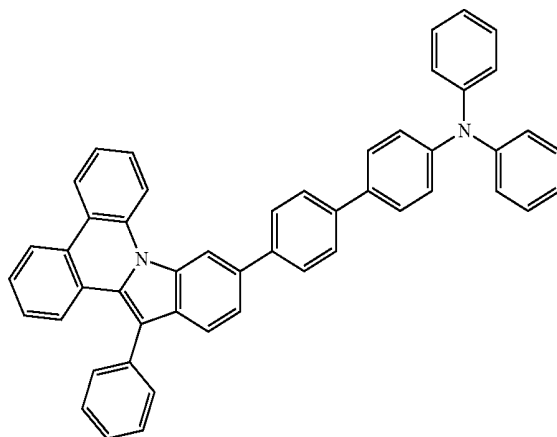


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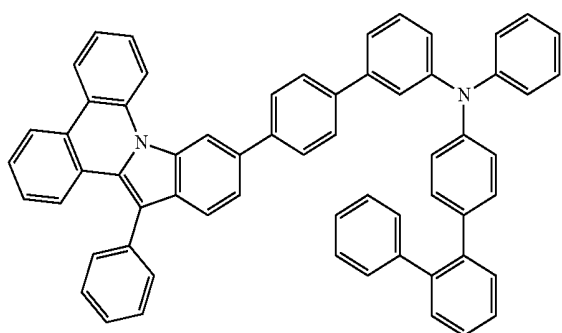
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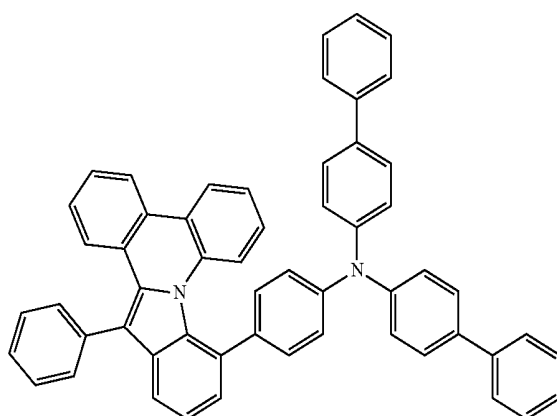
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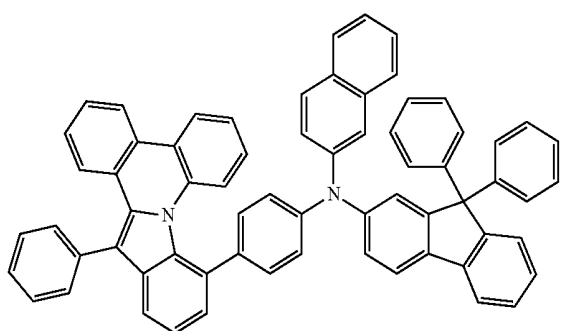
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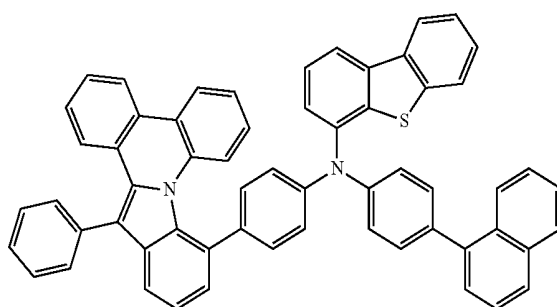
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D85

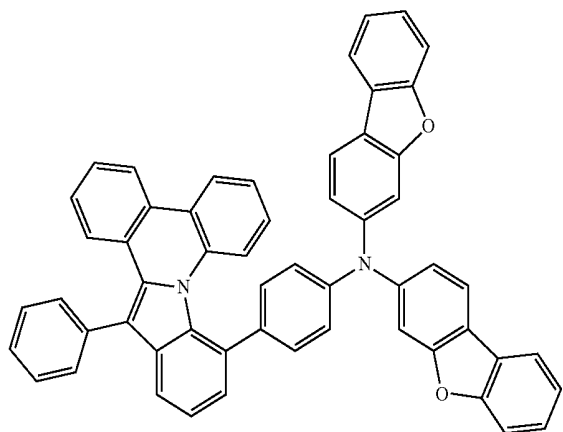


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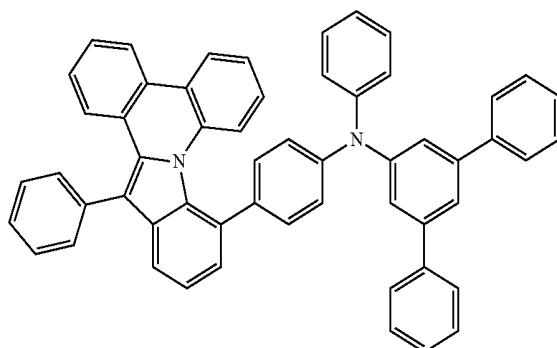


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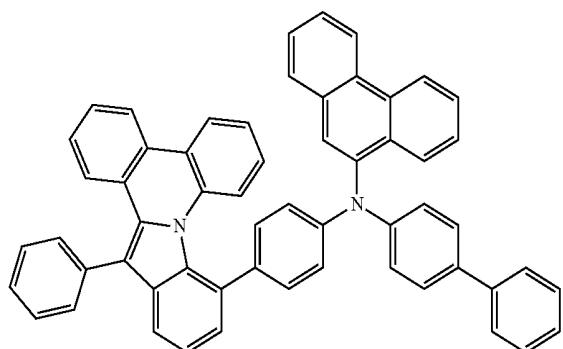
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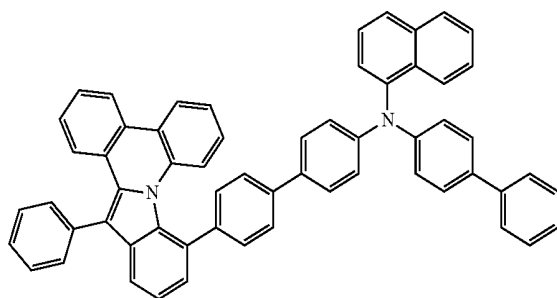
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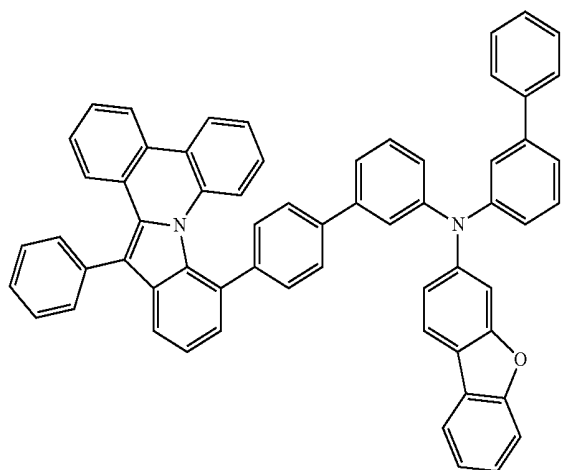
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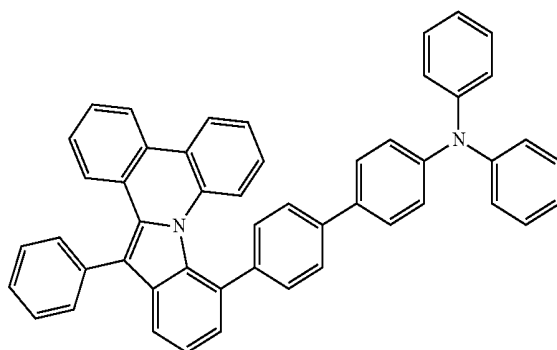
D90



D91



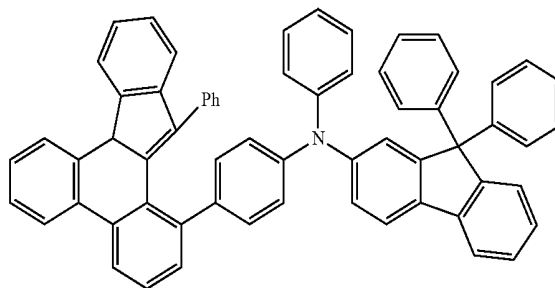
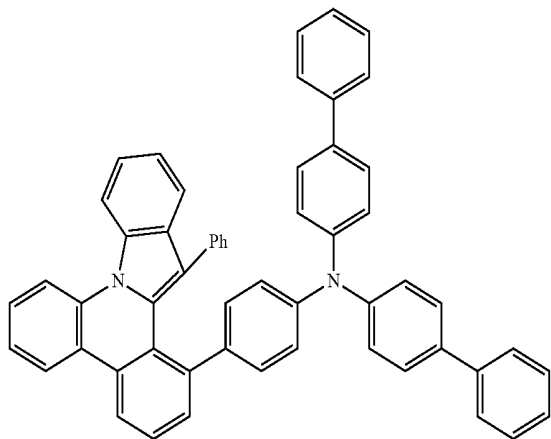
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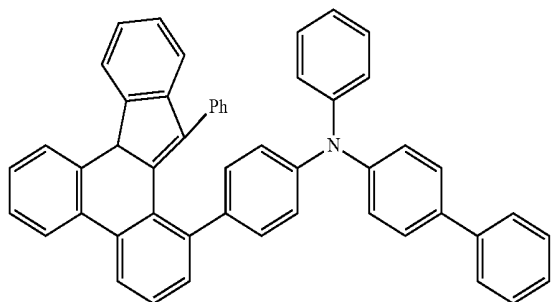
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D98

D99



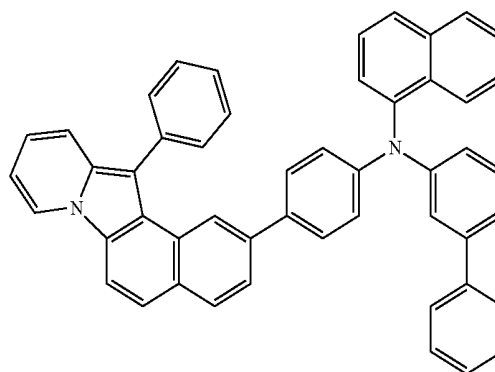
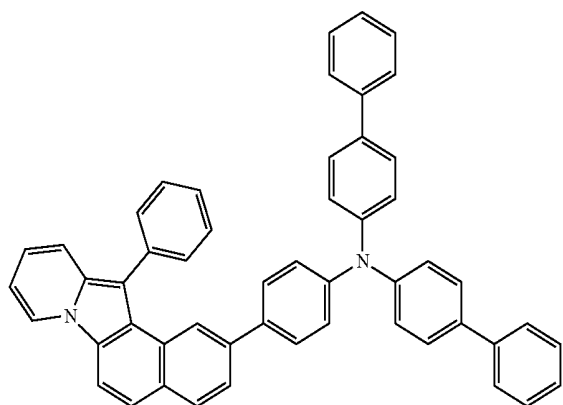
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Compound Group 2

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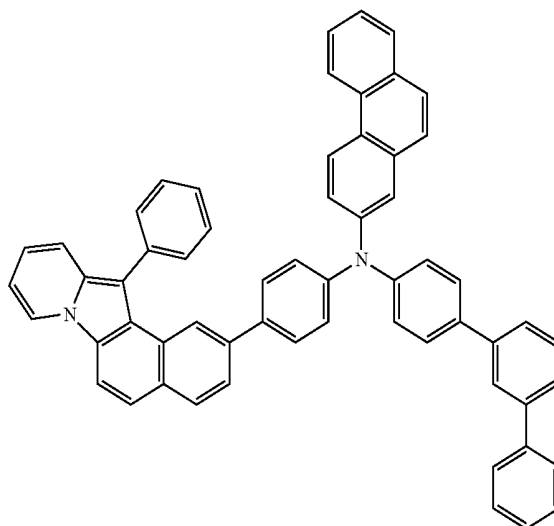
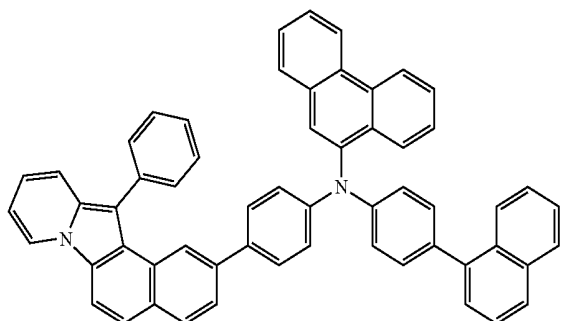
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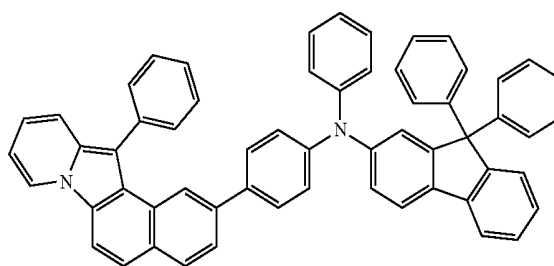
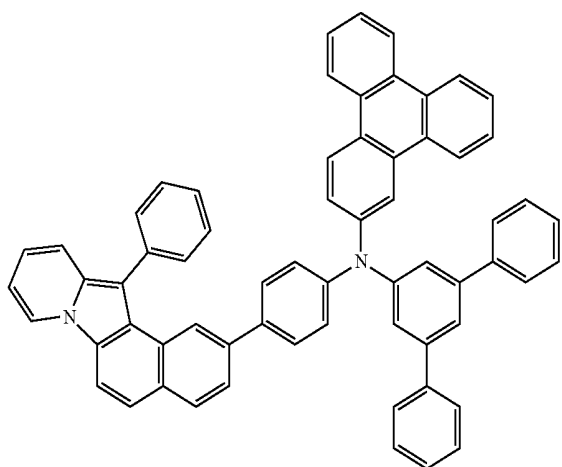
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E4



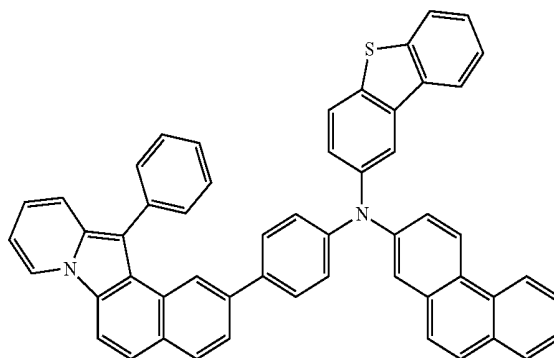
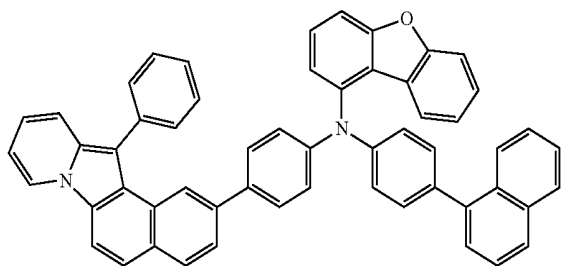
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E6



E7

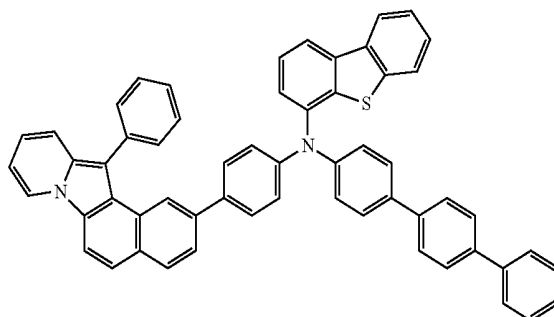
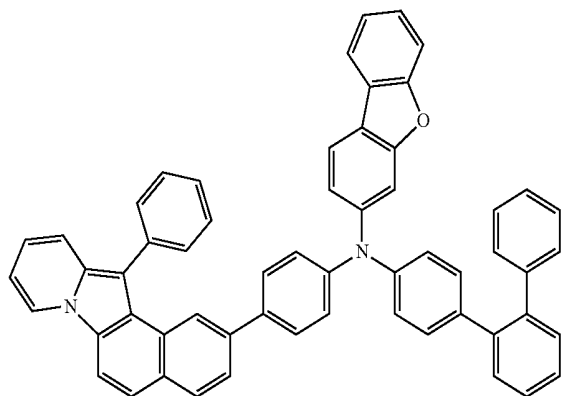
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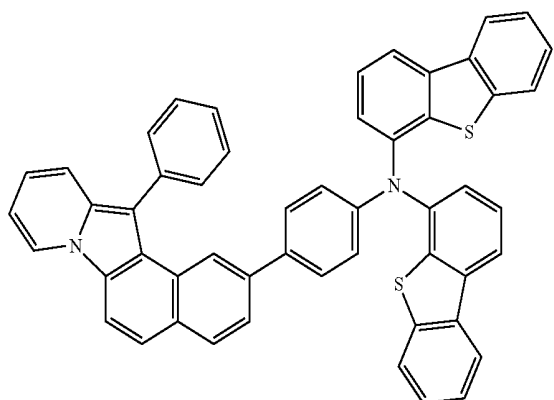
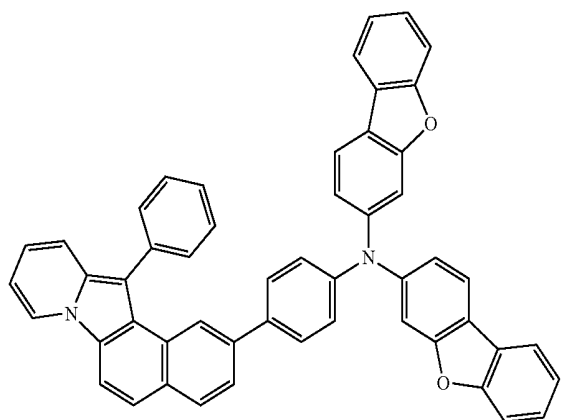
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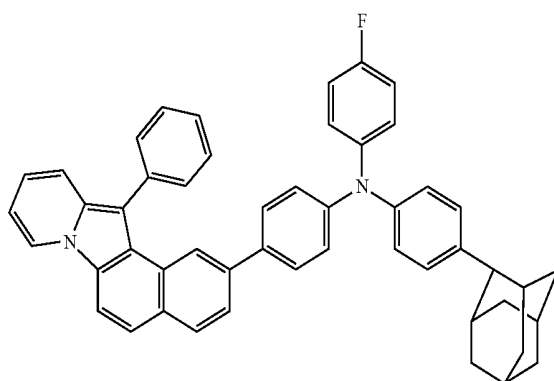
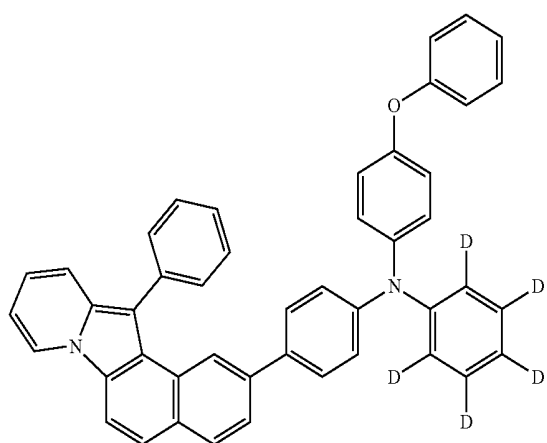
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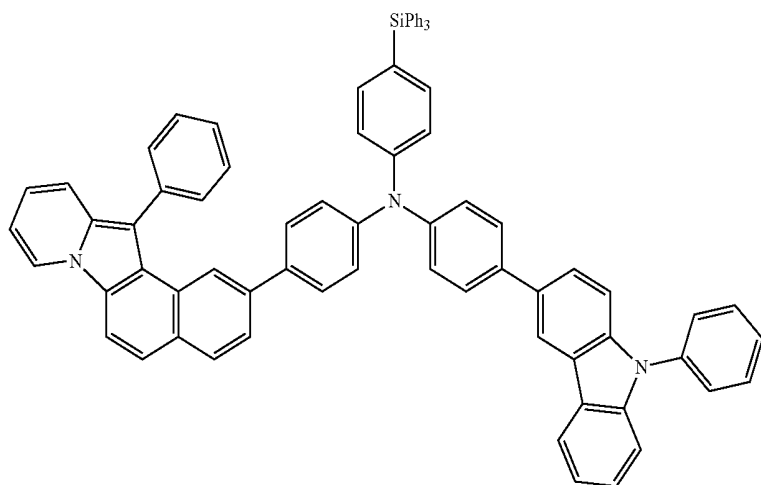
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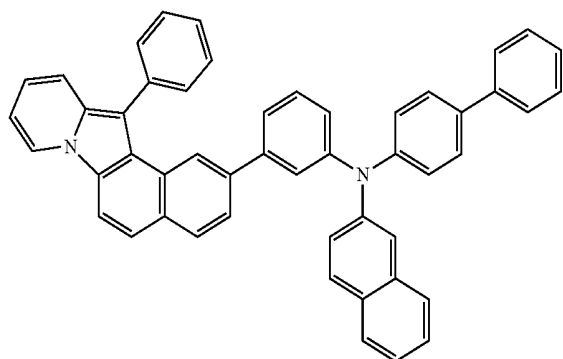


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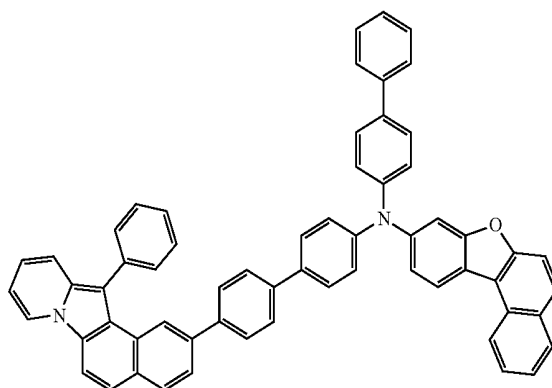
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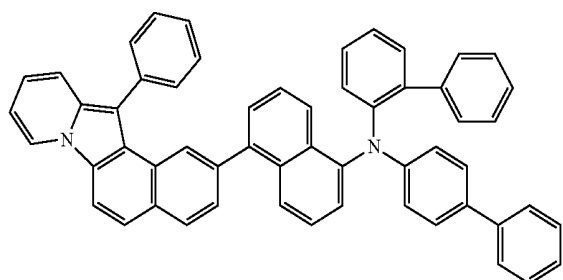
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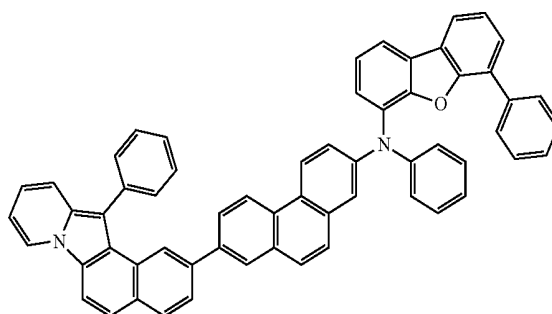
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E18

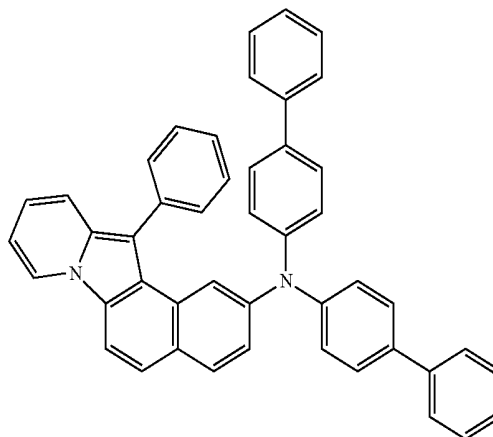
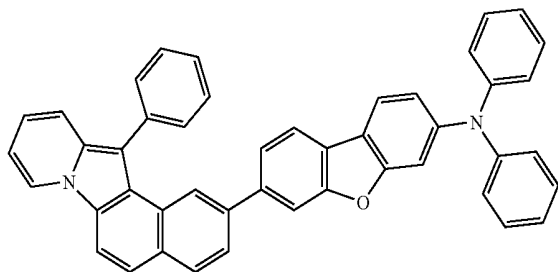


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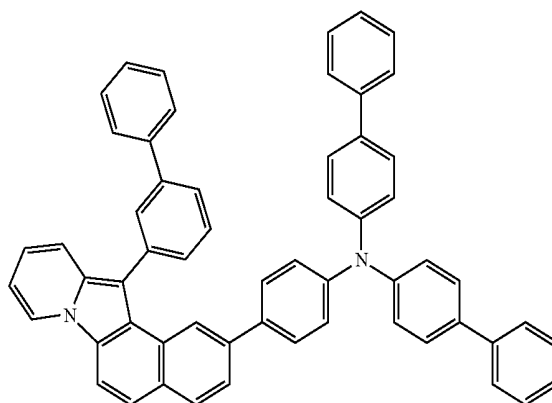
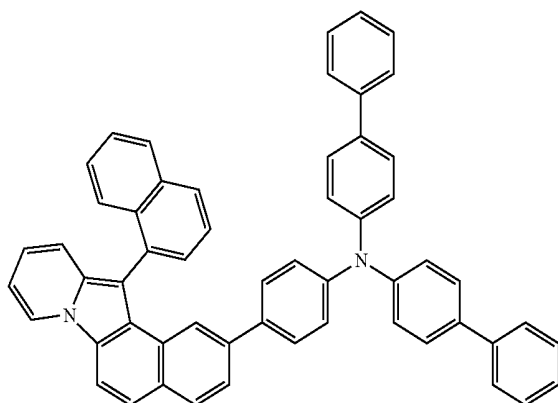
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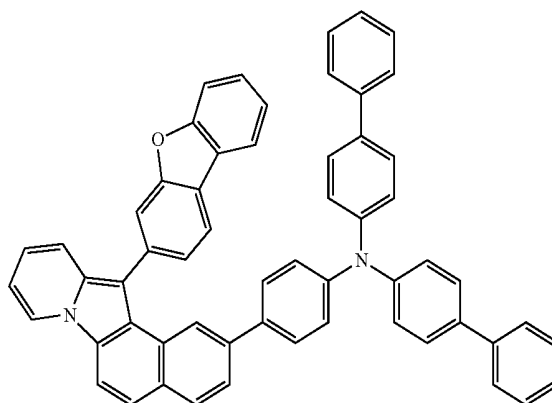
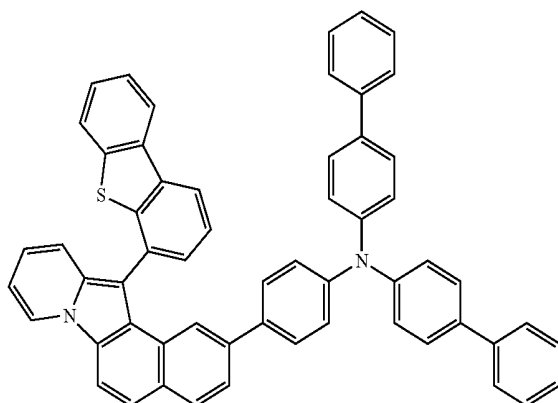
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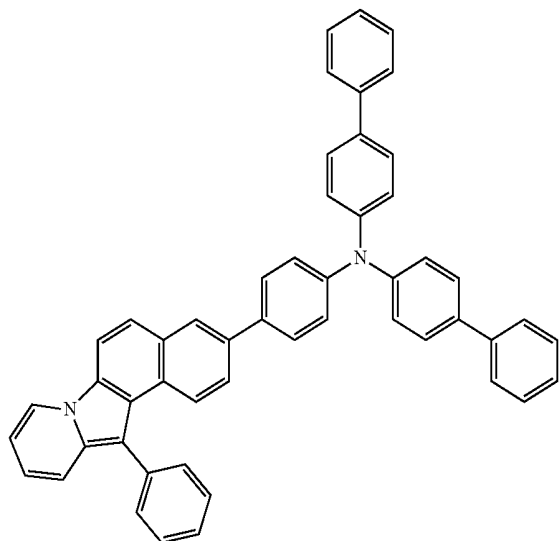


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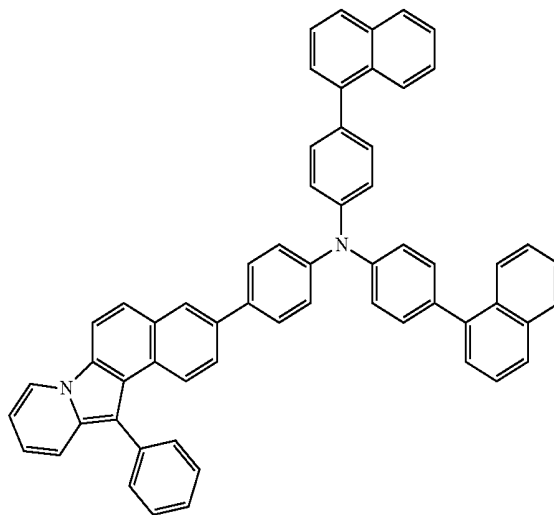
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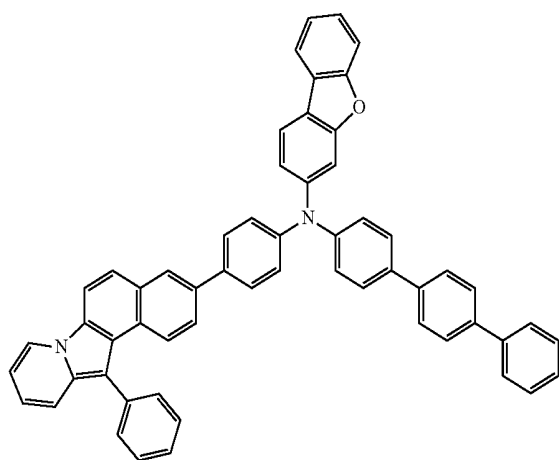
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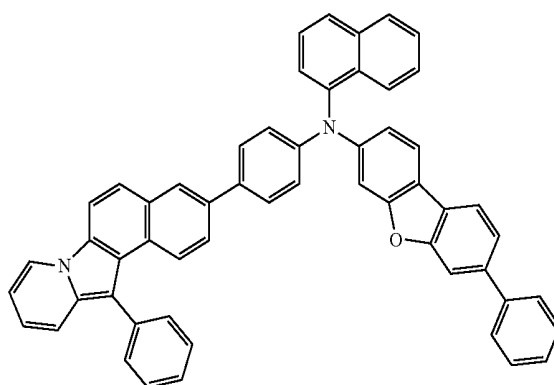
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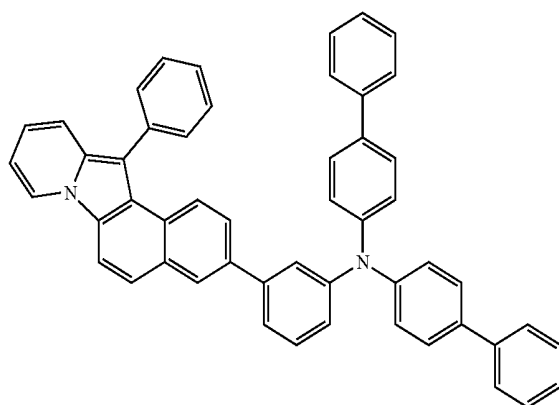
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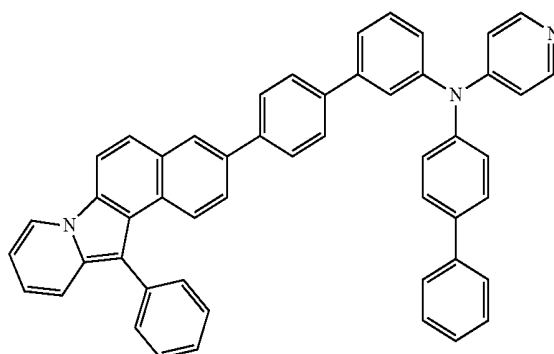
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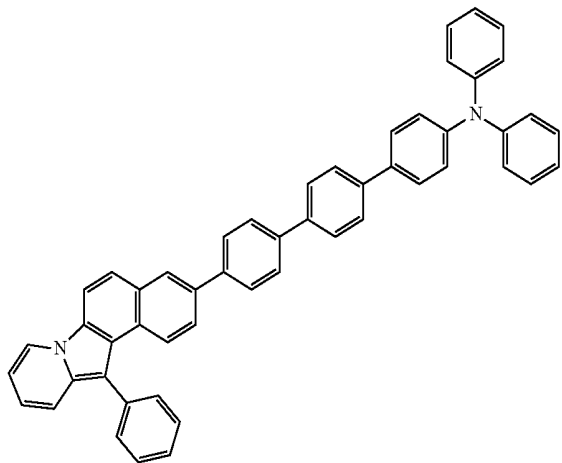


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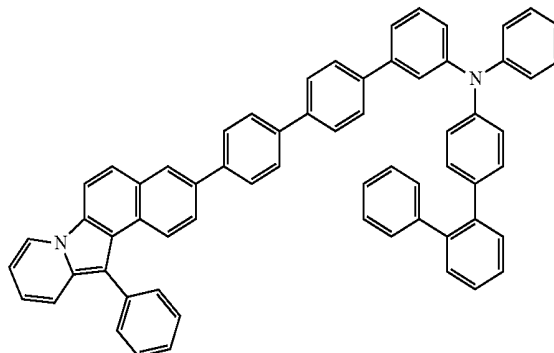


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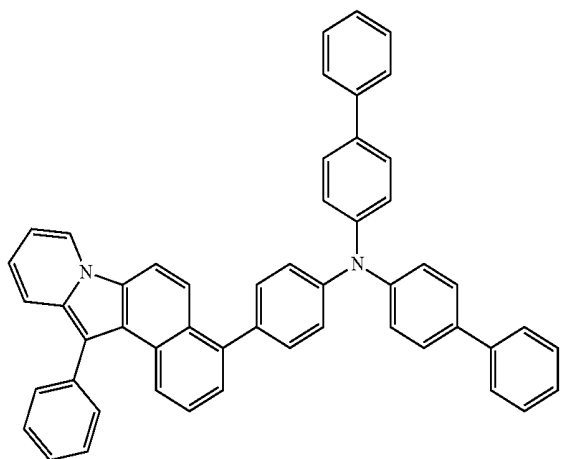
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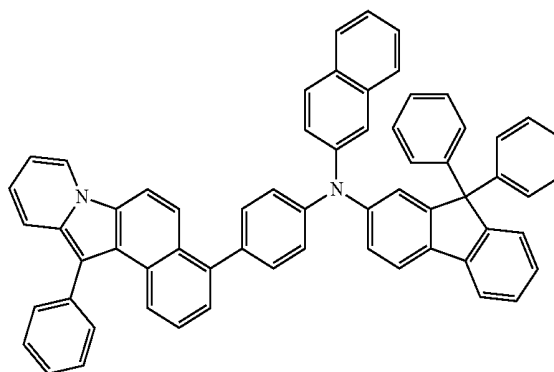
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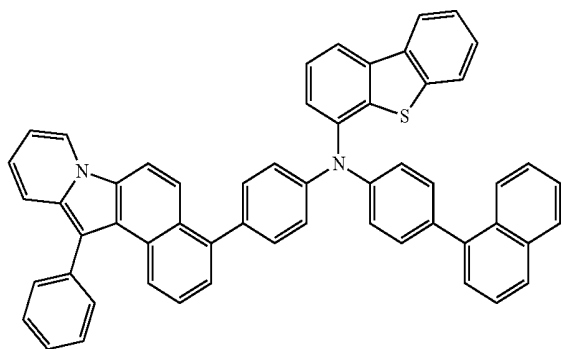
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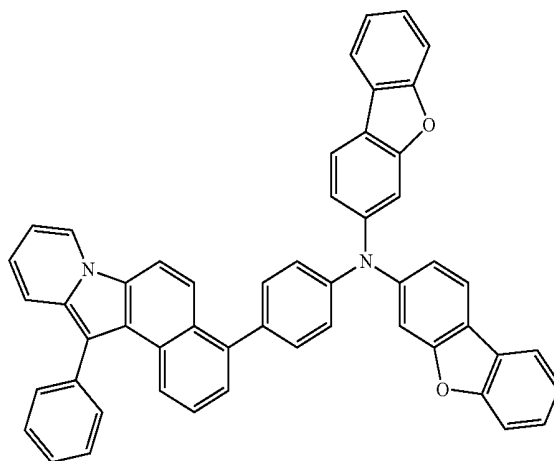
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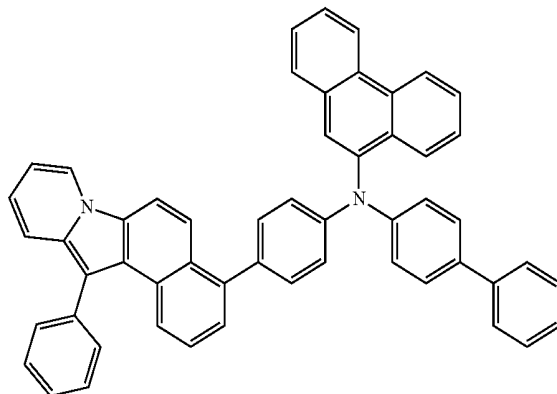
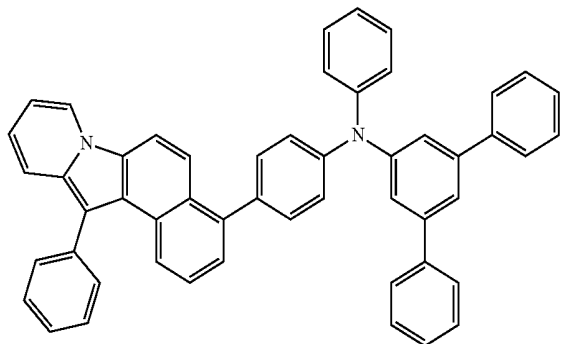


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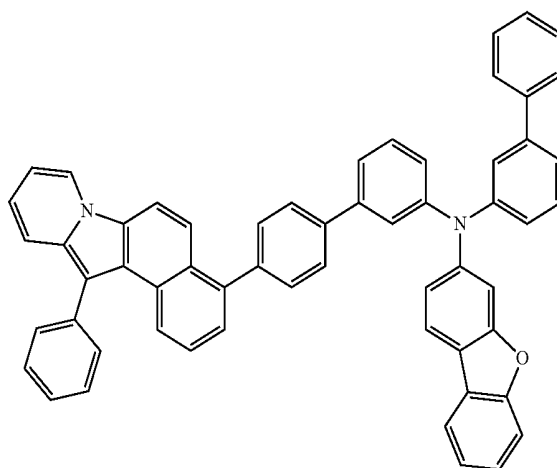
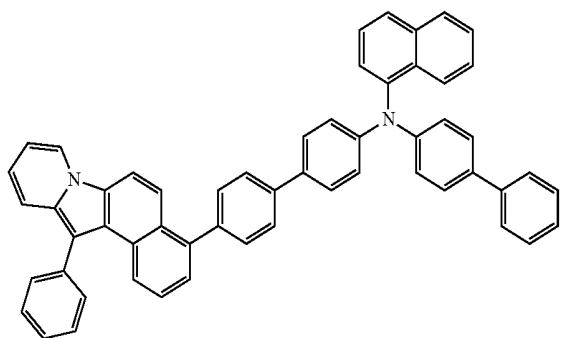
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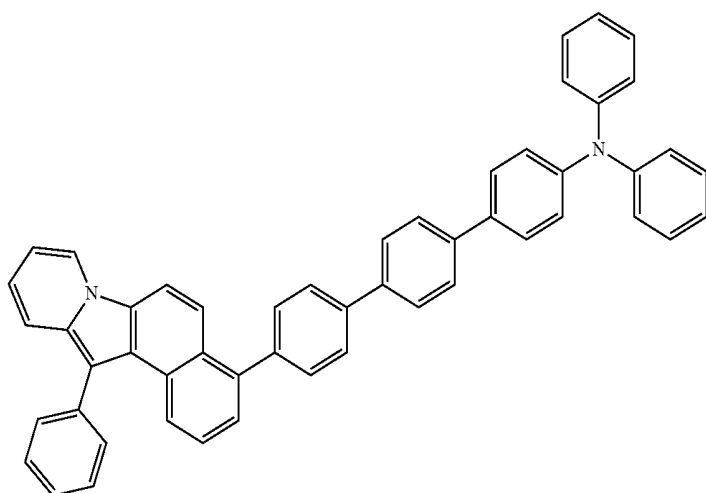


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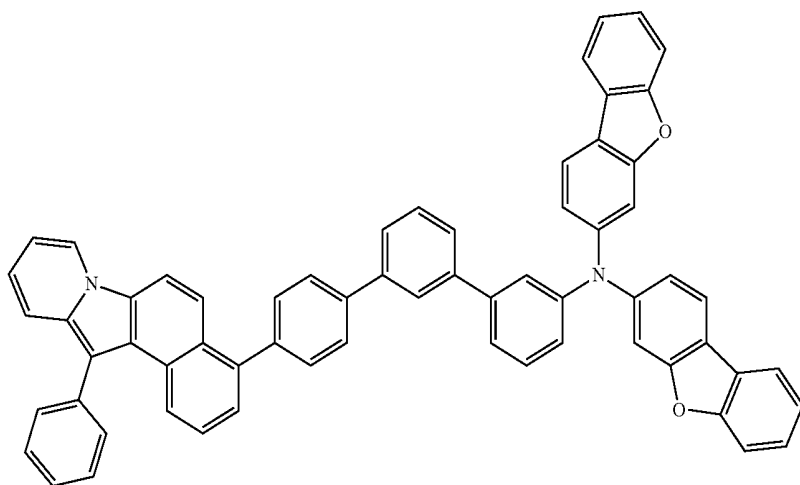


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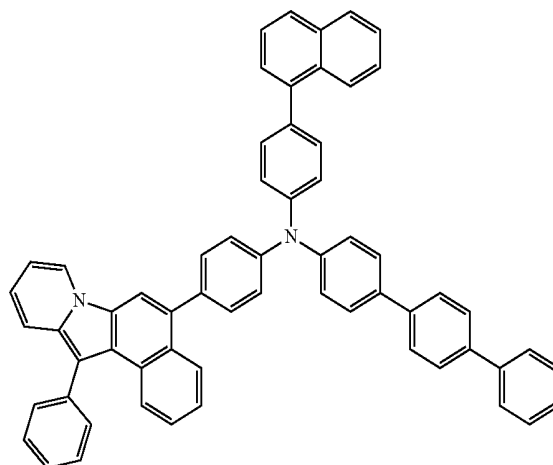
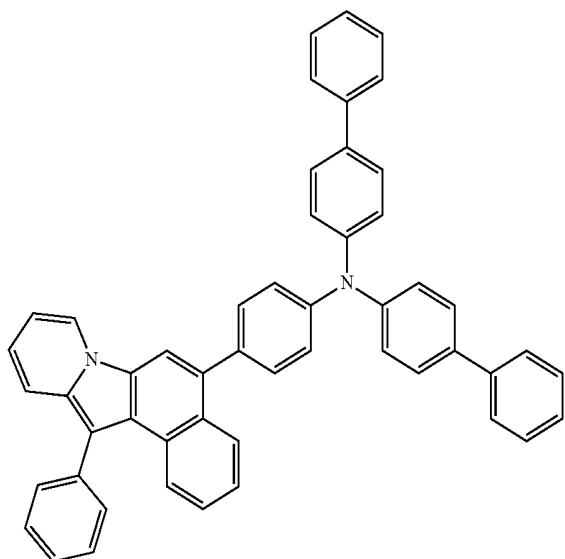
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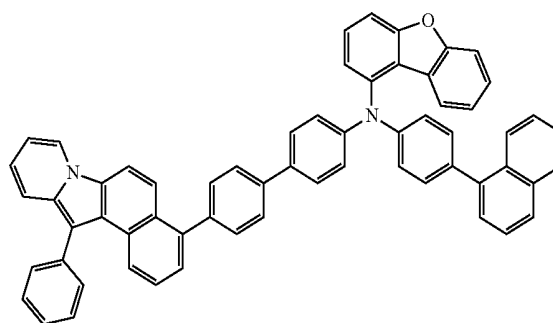
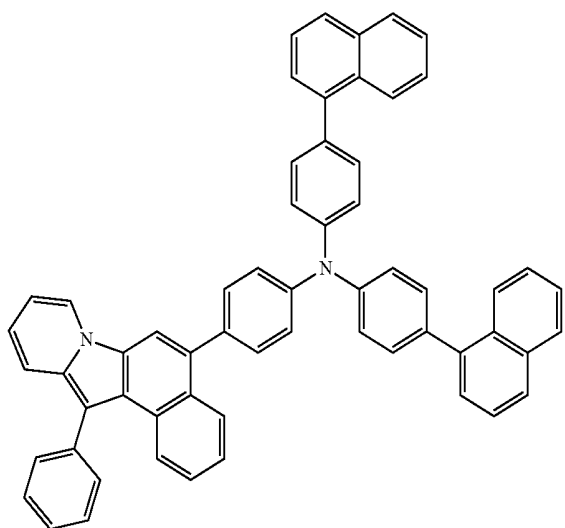
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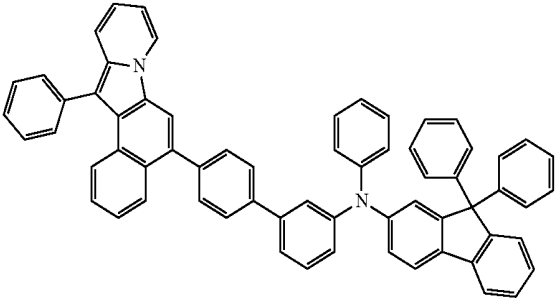
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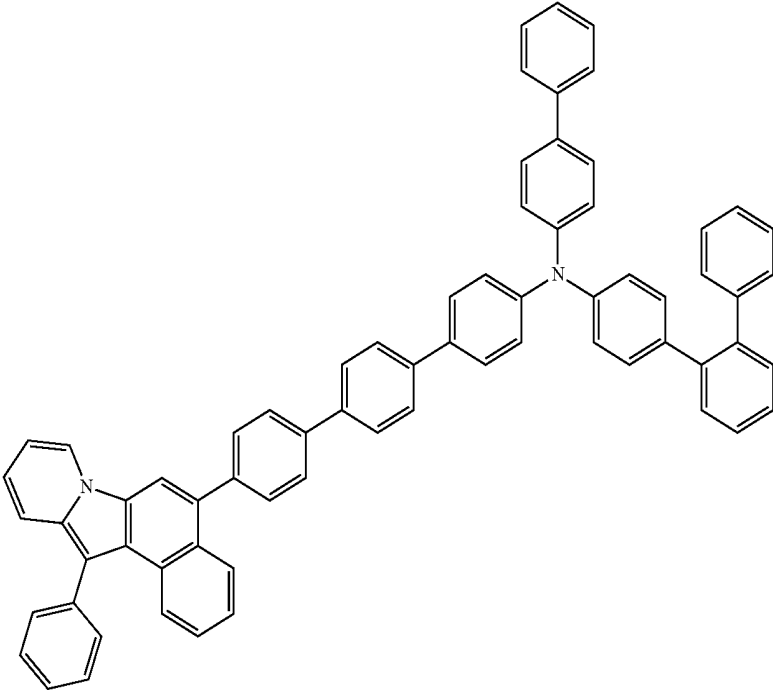


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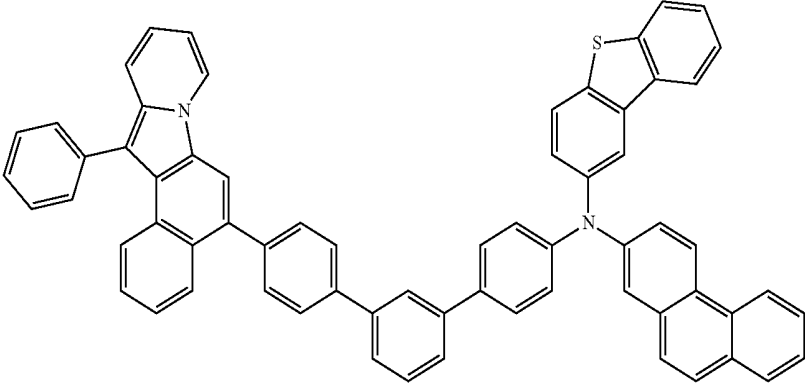
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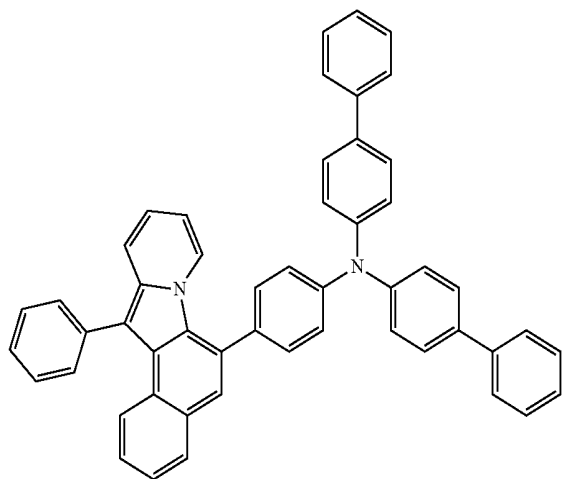


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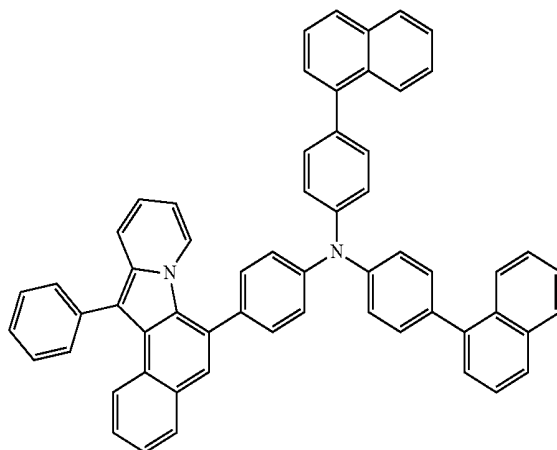


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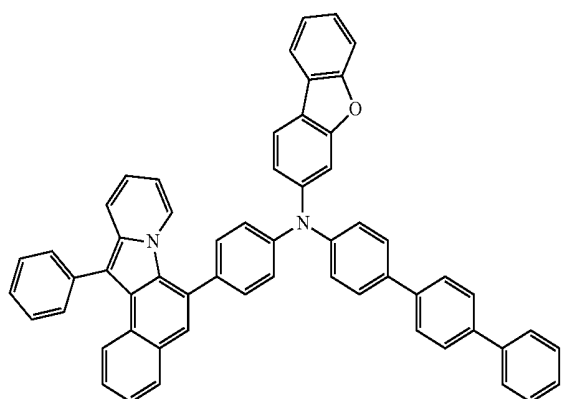
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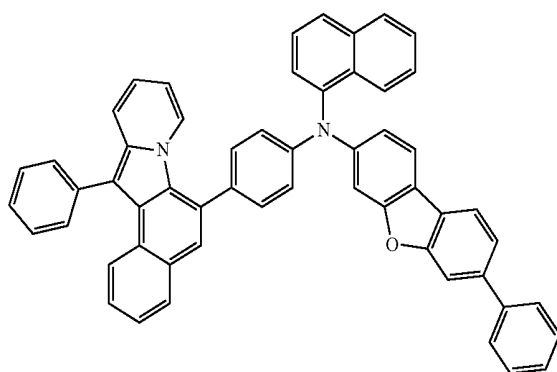
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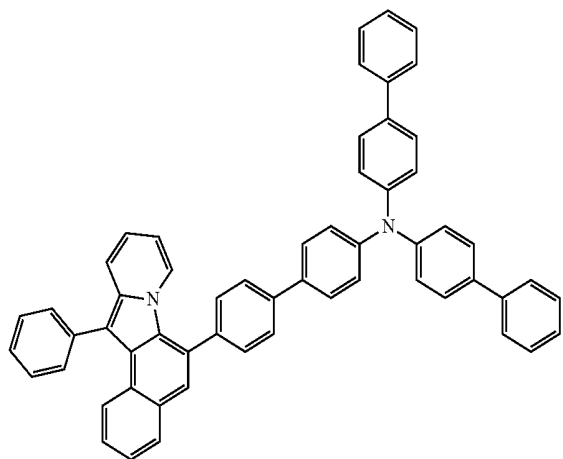
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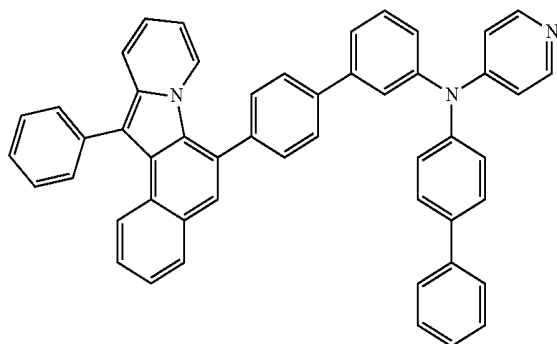
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E55

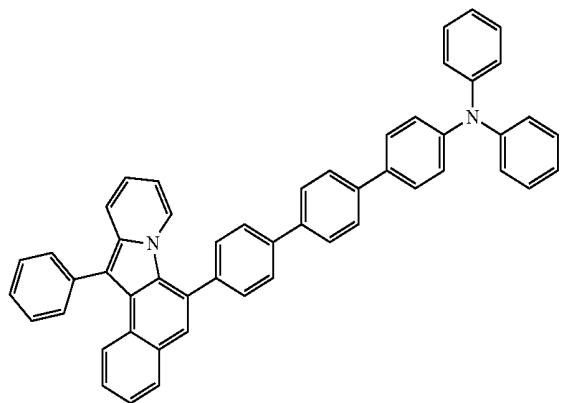


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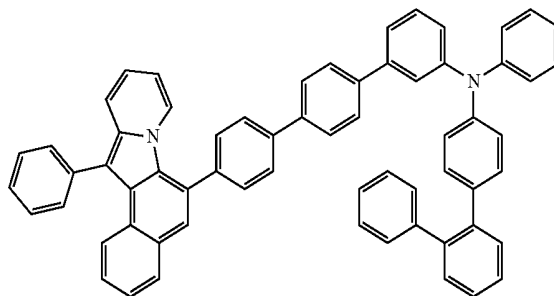


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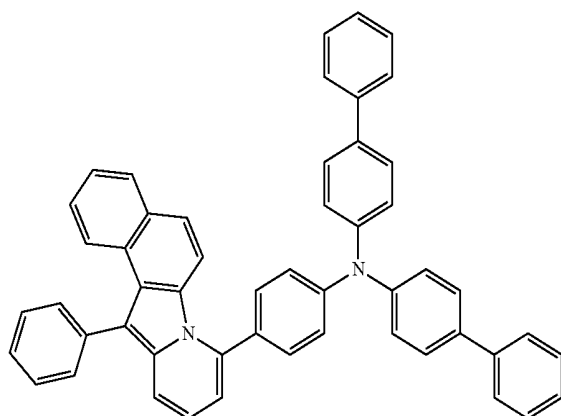
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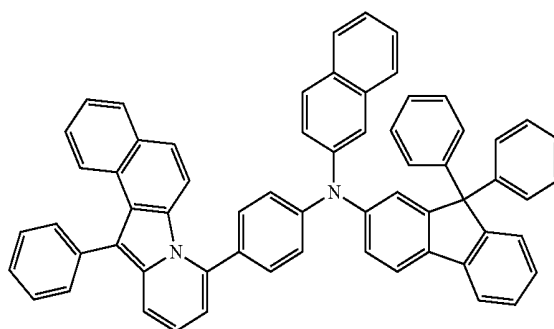
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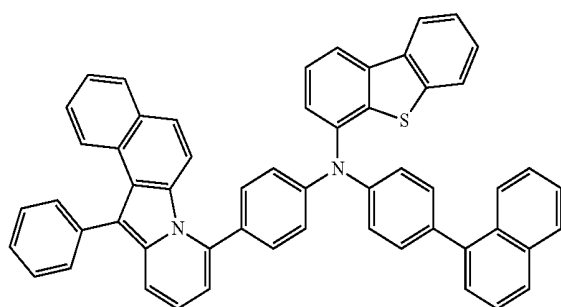
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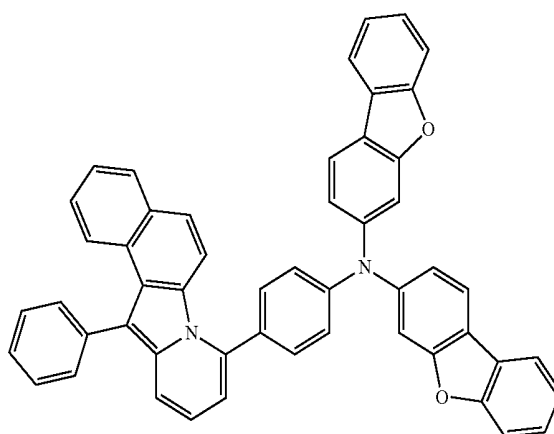
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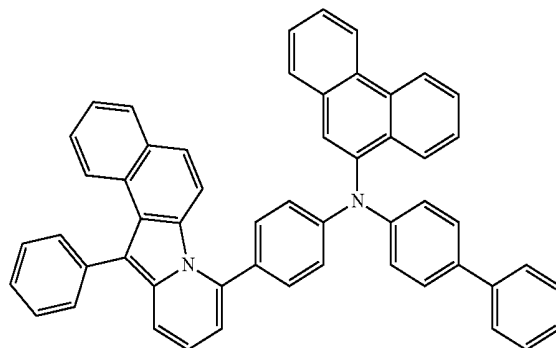
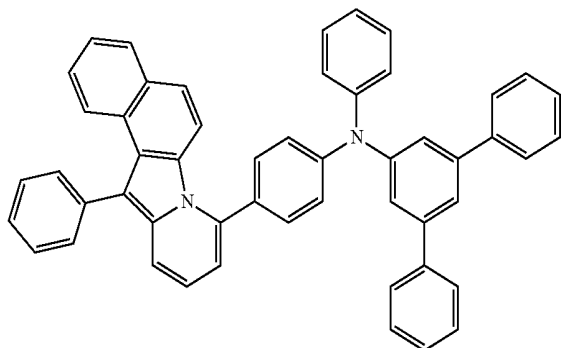


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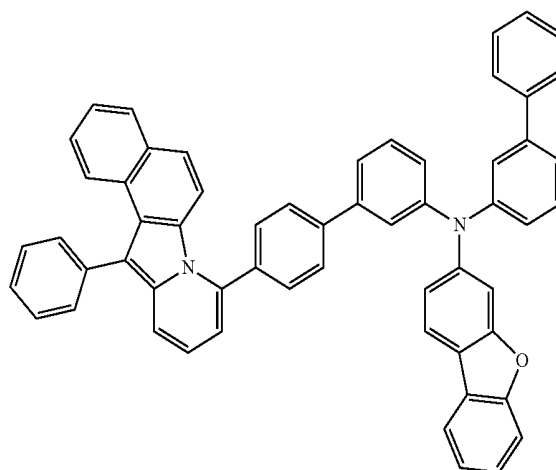
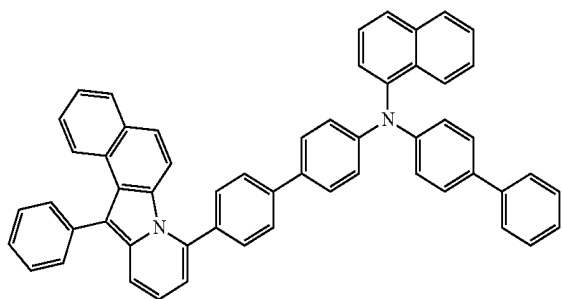
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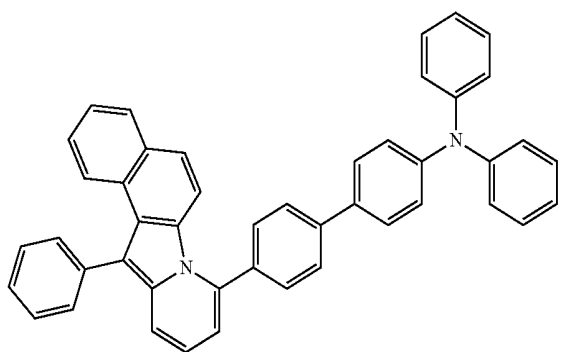


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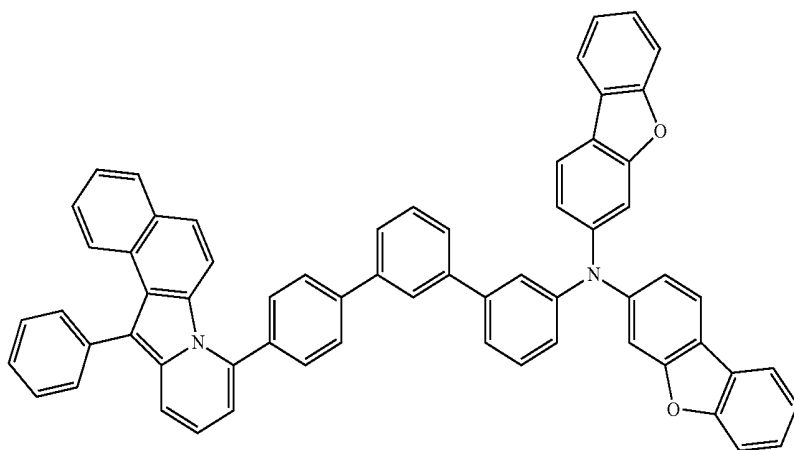
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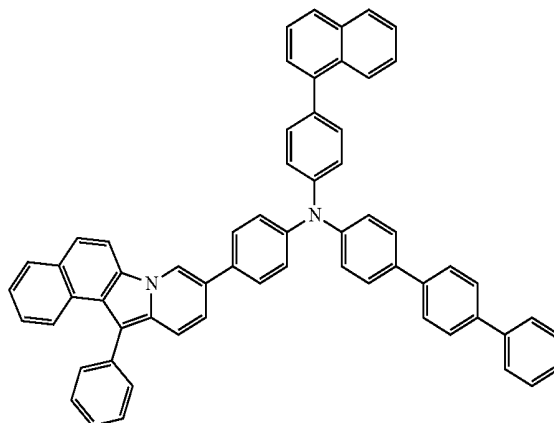
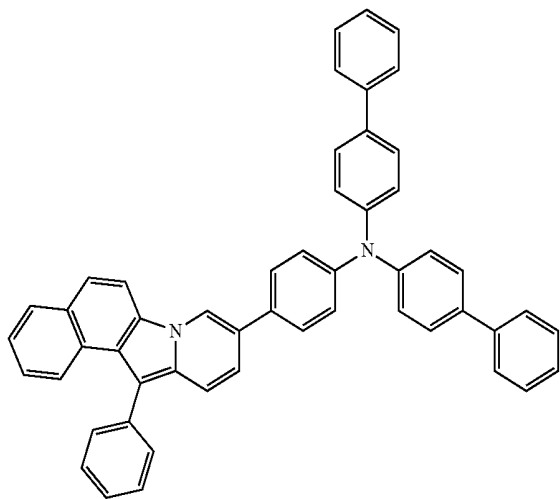
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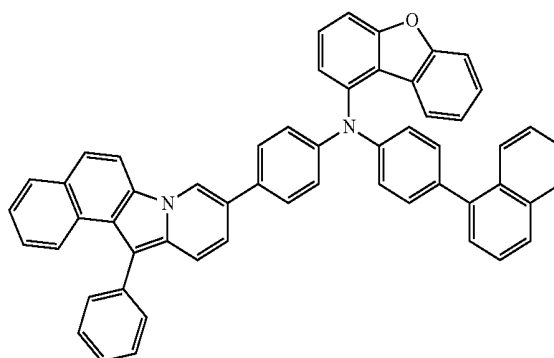
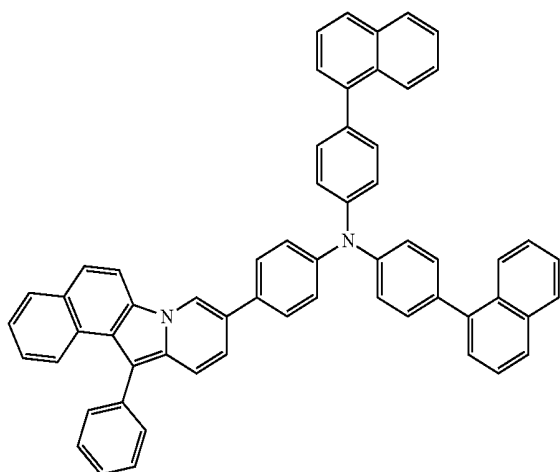
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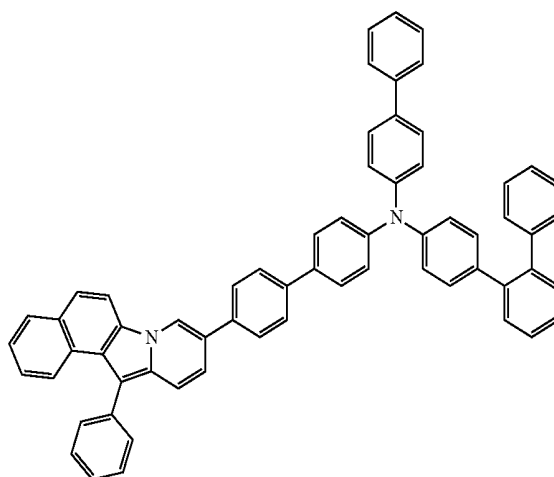
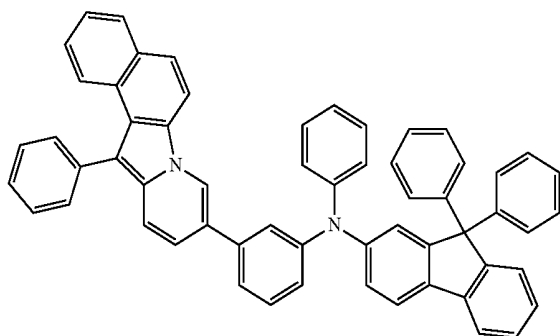
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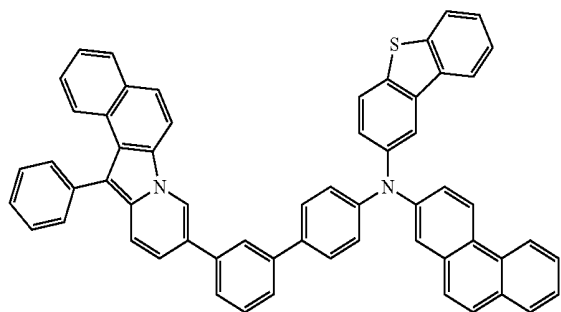
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E74

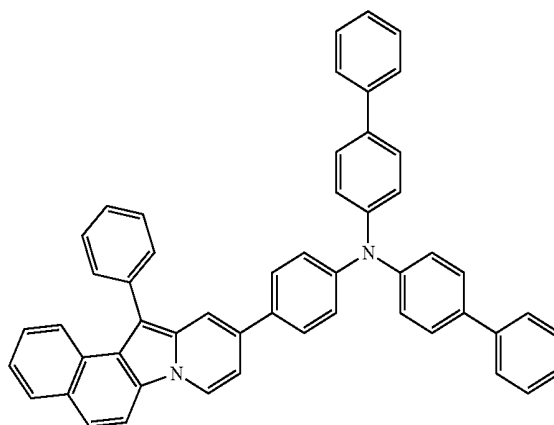


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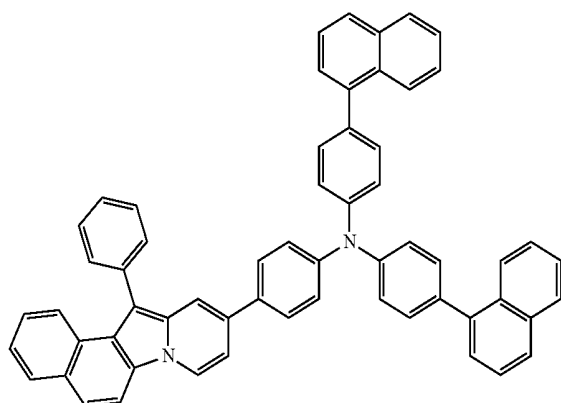
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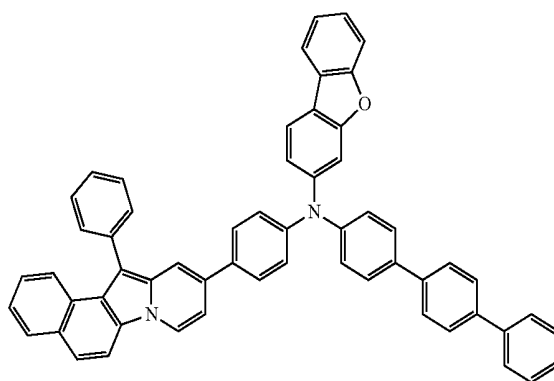
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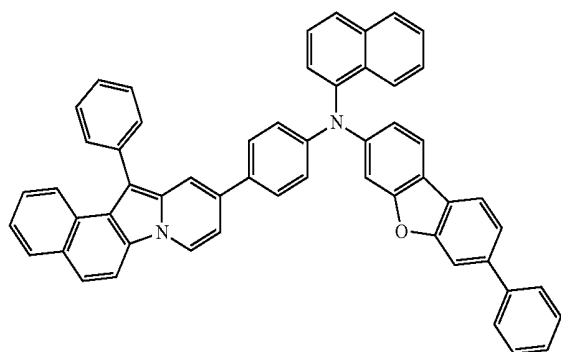
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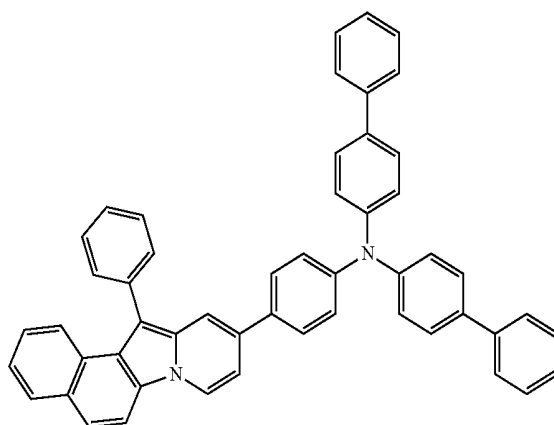
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E79

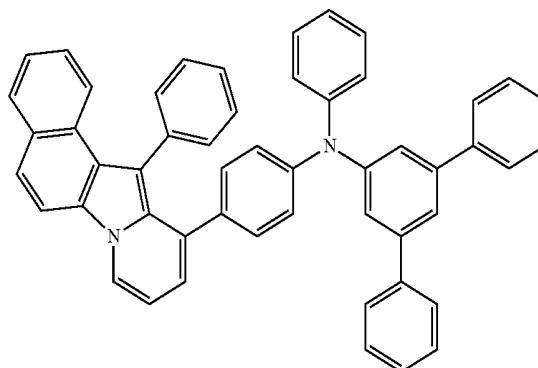
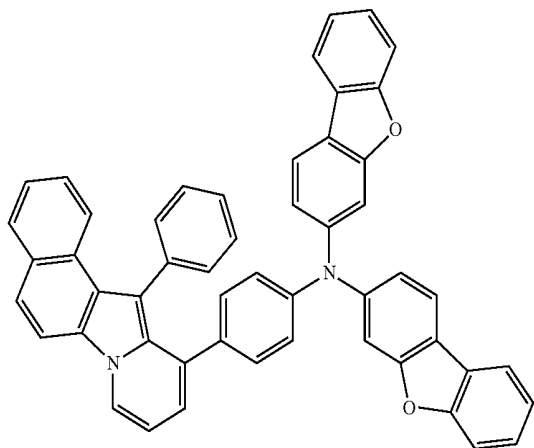


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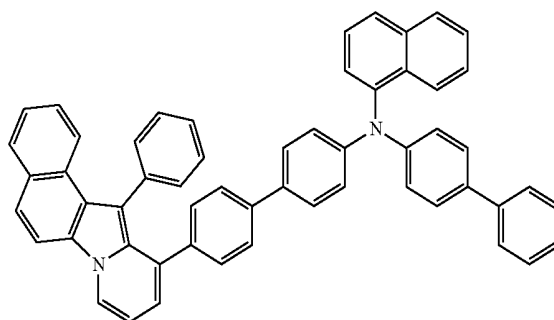
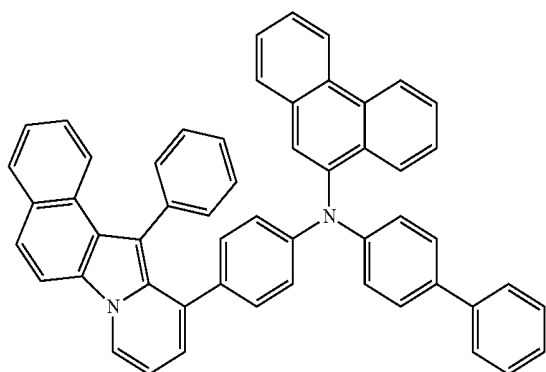
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E88



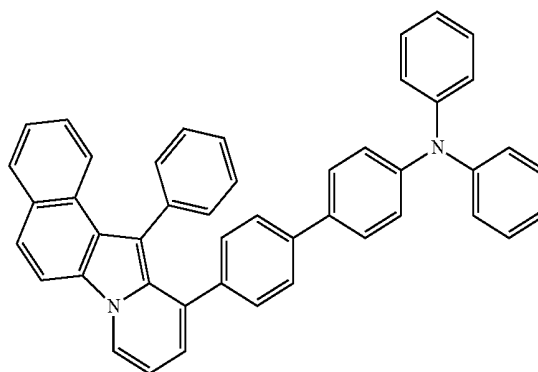
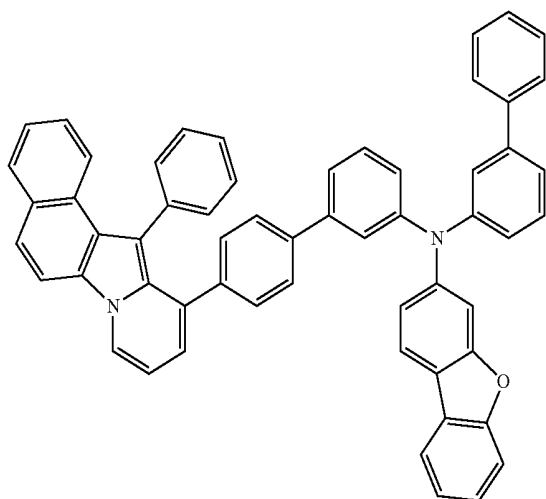
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E90



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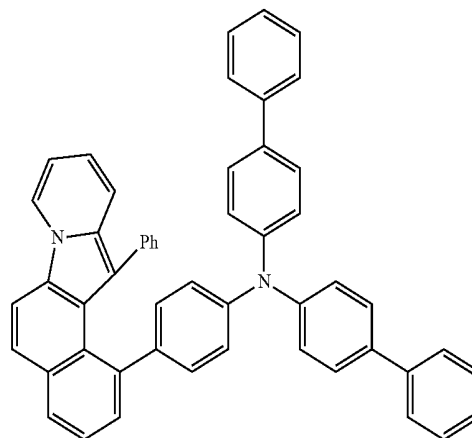
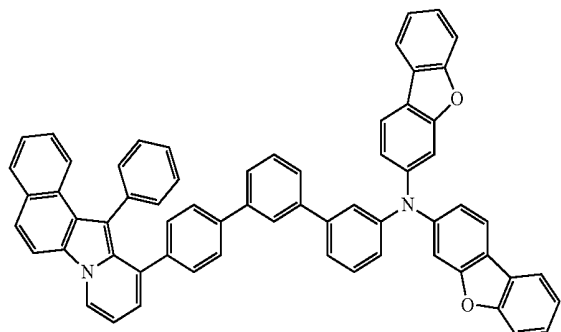
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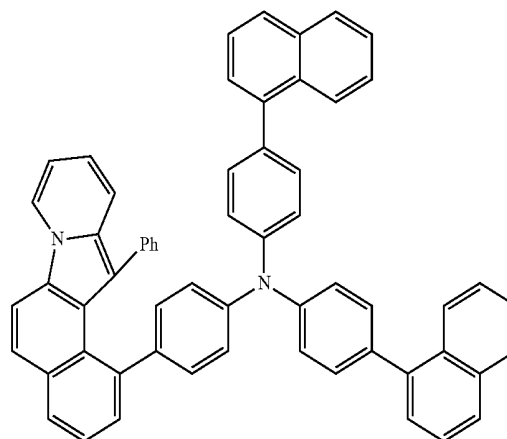
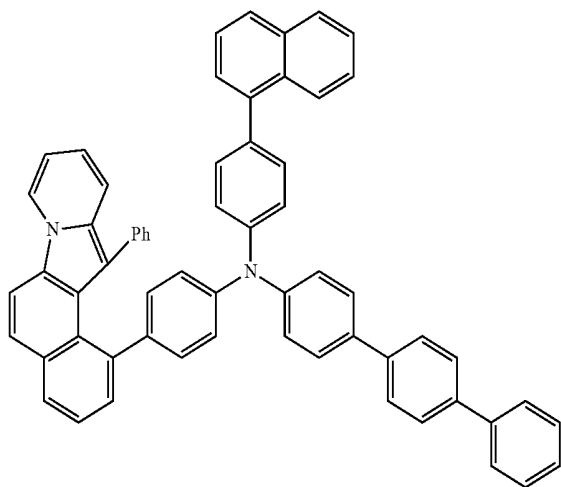
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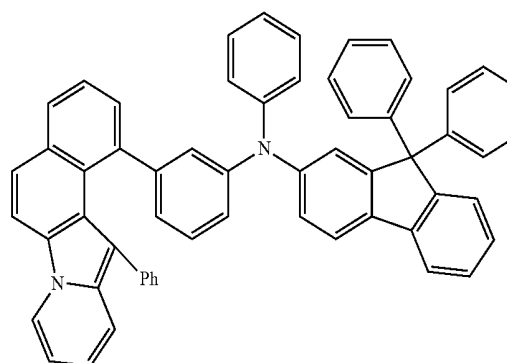
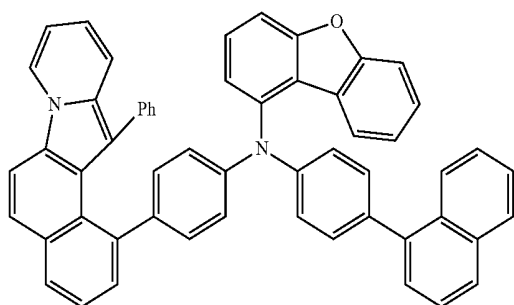
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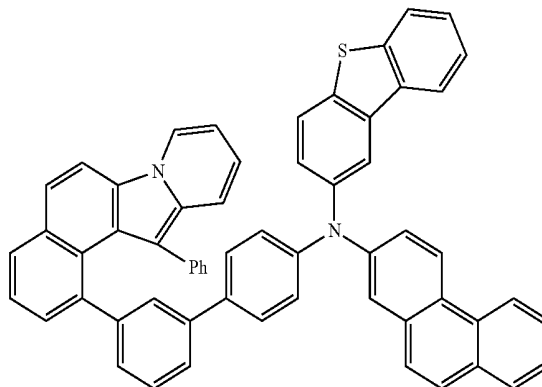
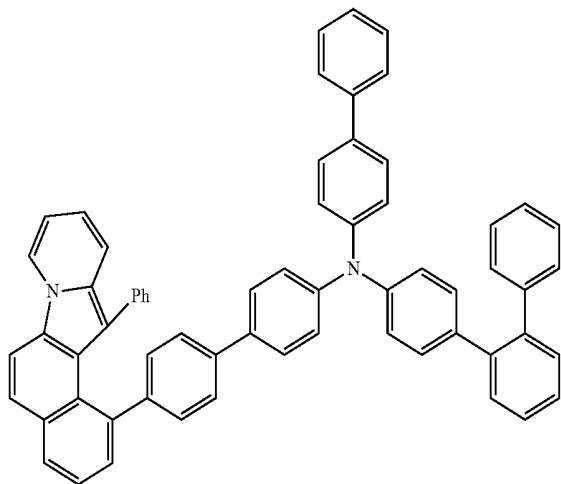
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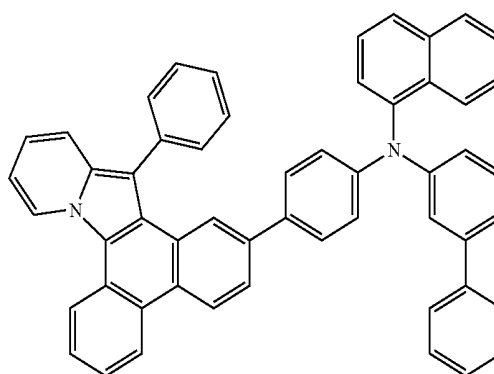
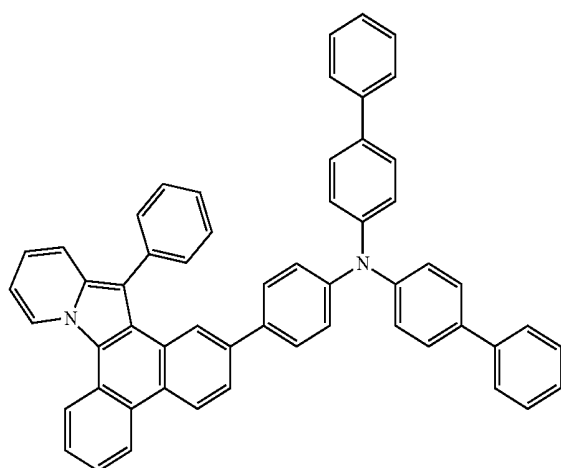
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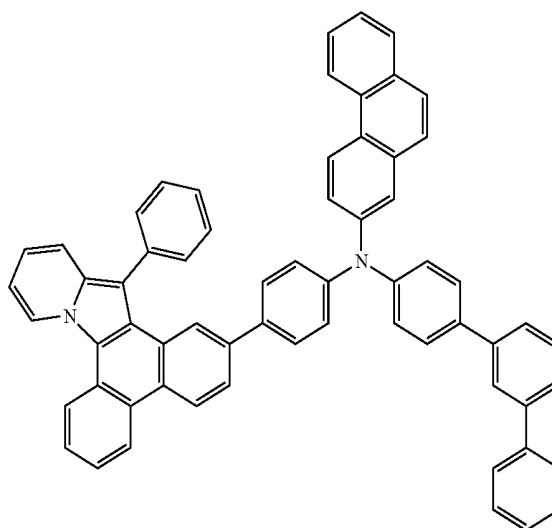
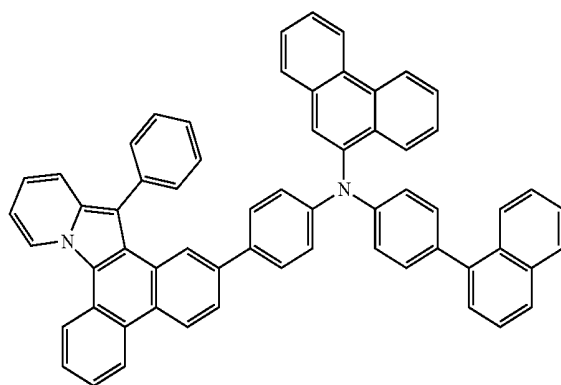
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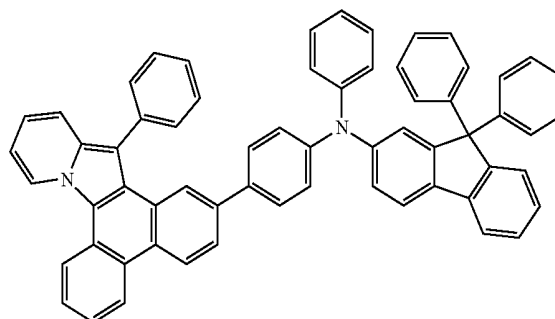
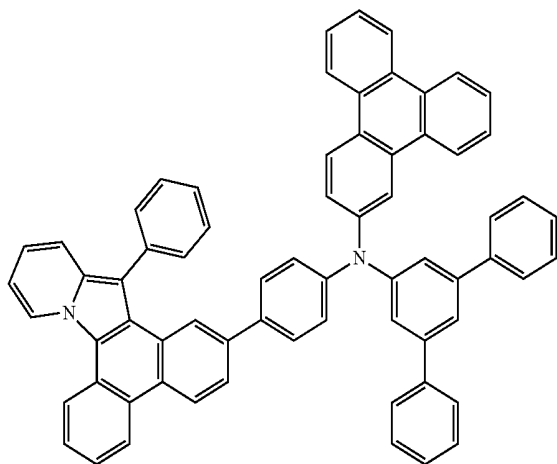
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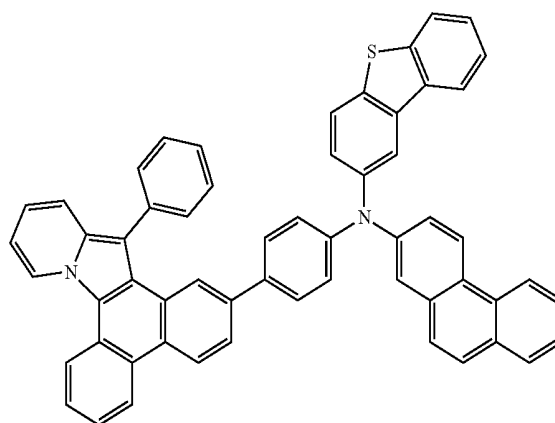
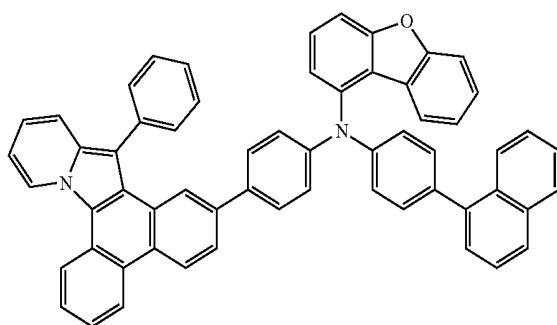
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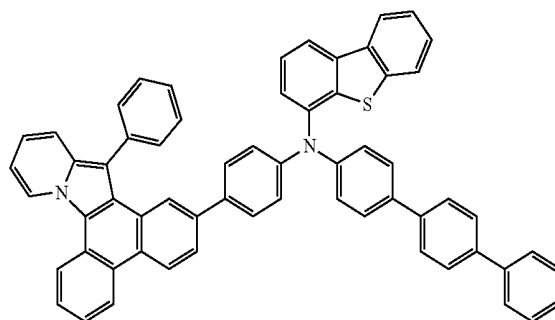
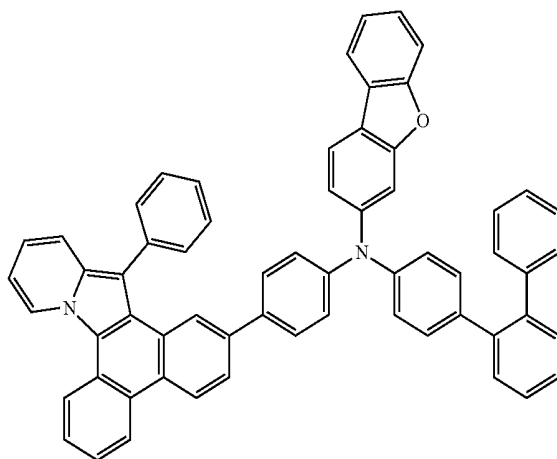
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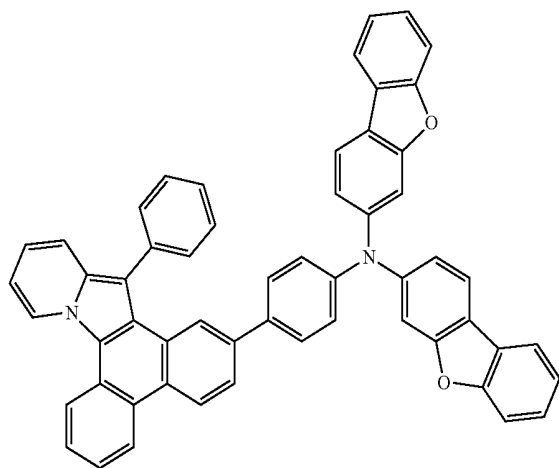


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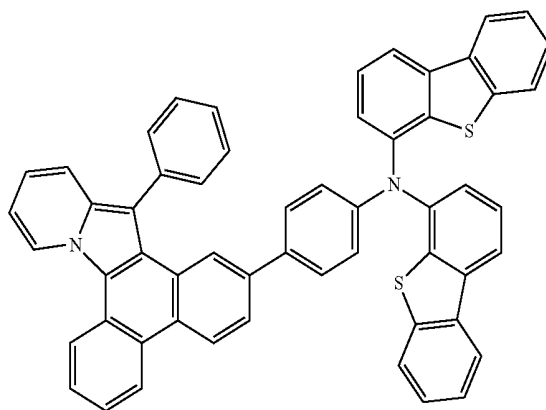
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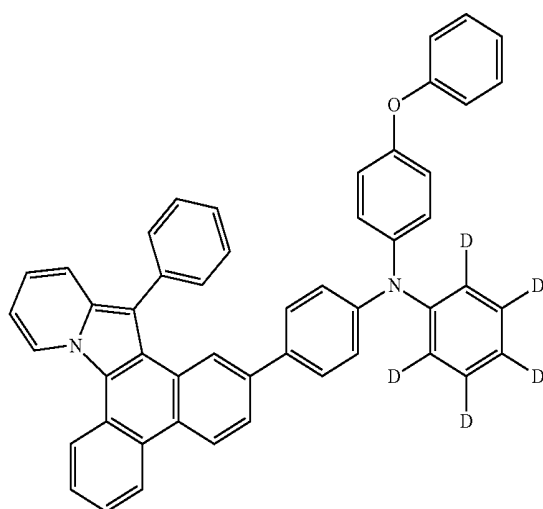
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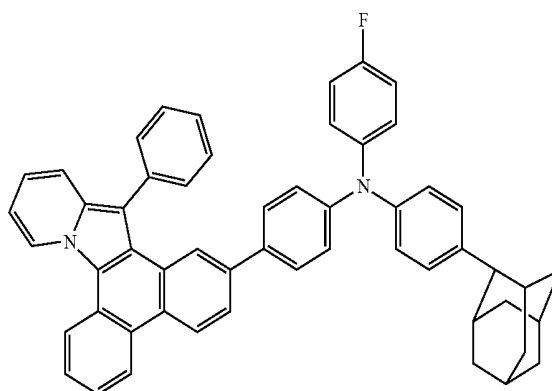
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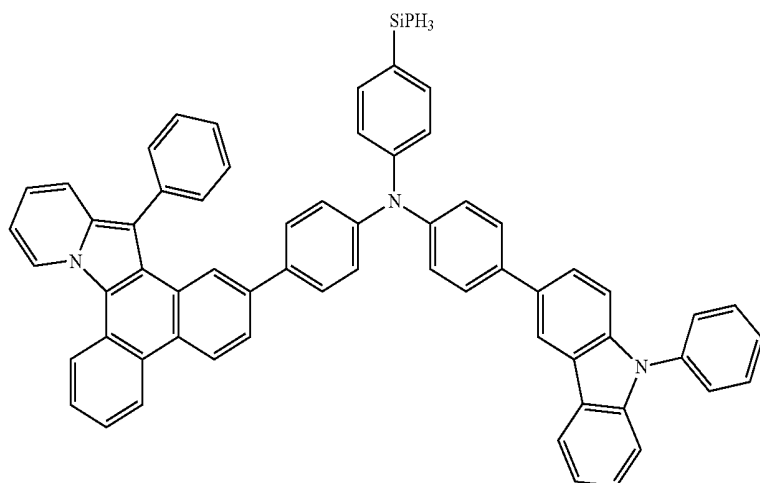
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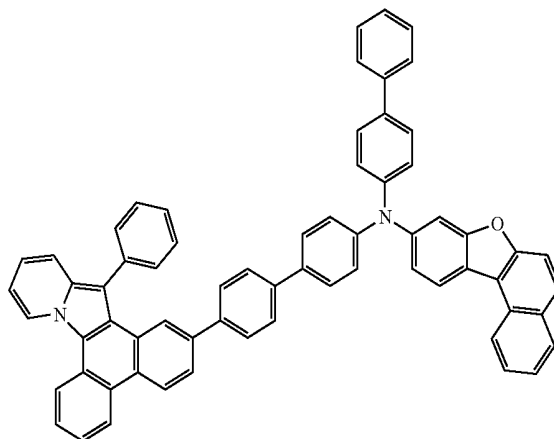
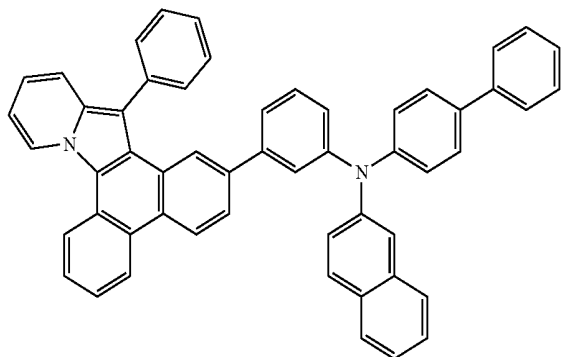


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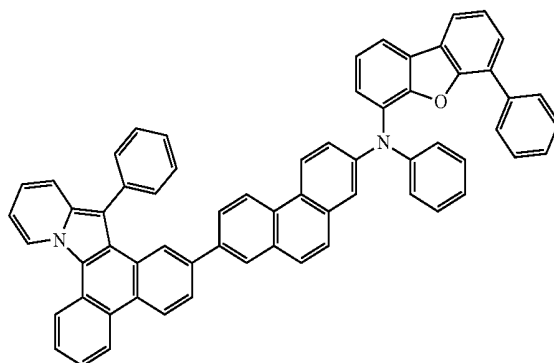
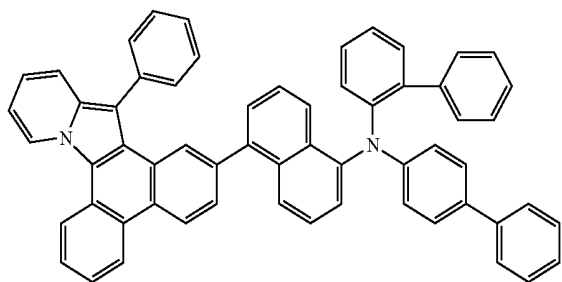
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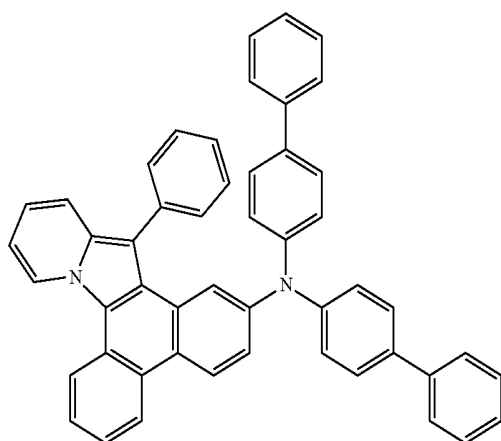
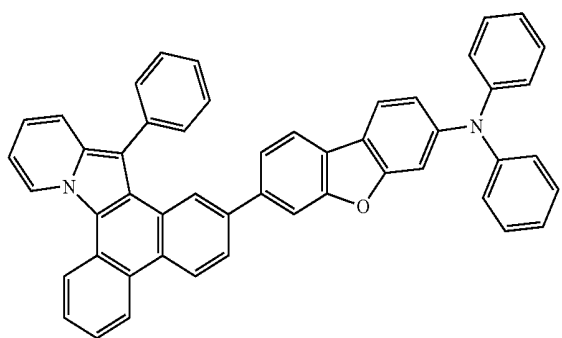
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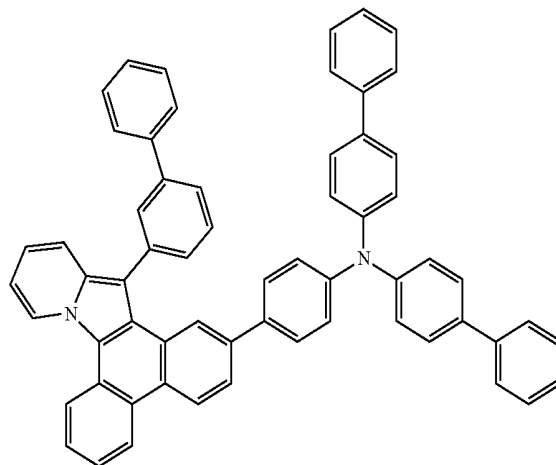
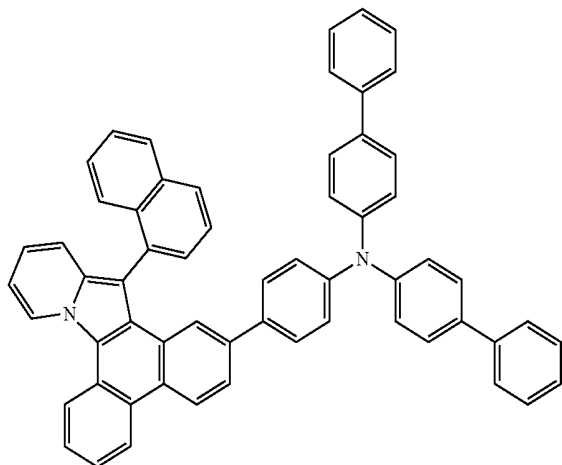
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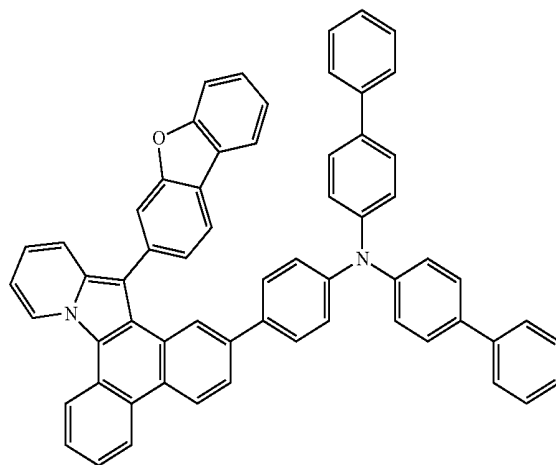
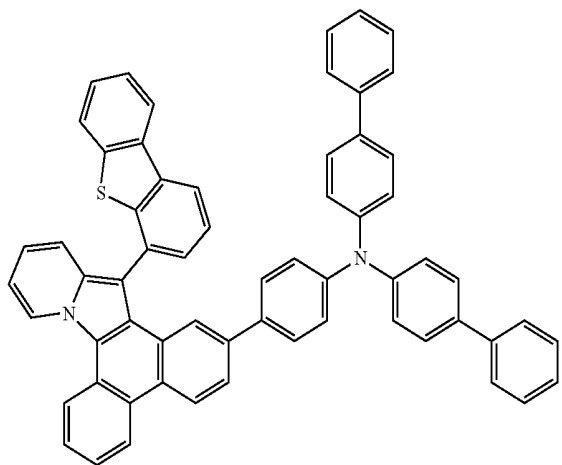
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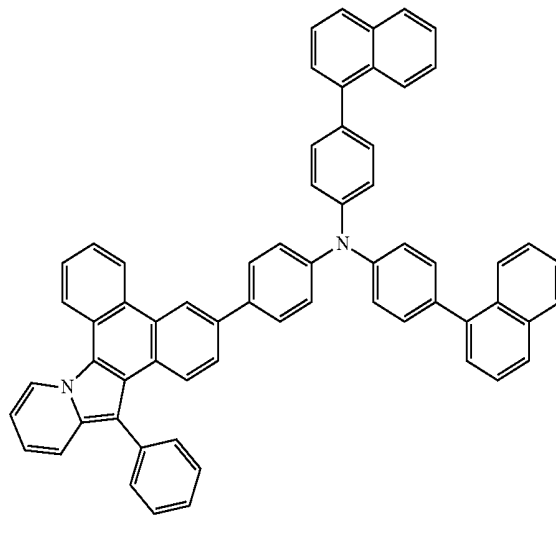
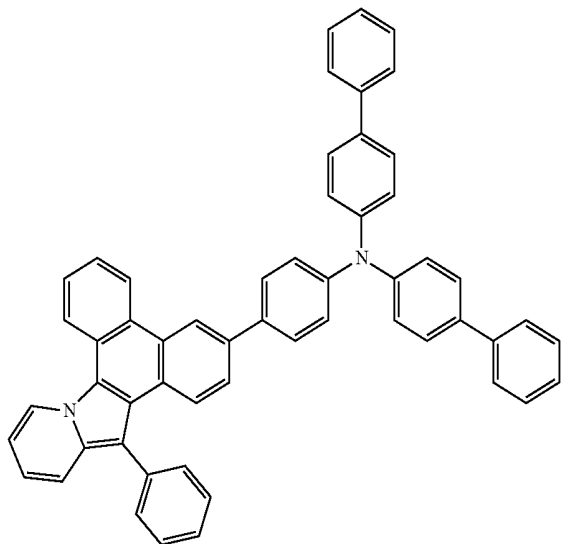
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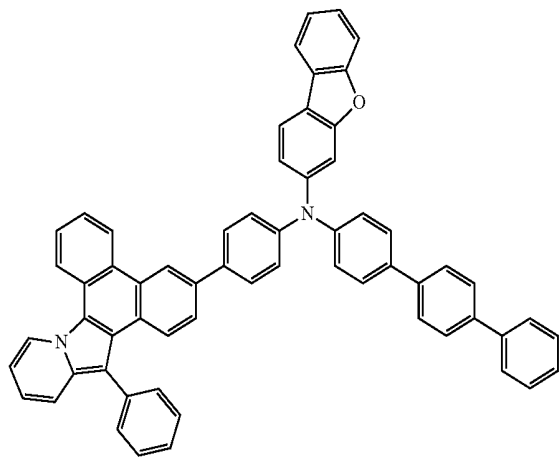
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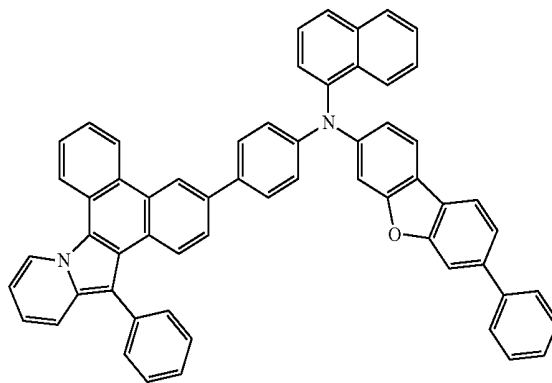


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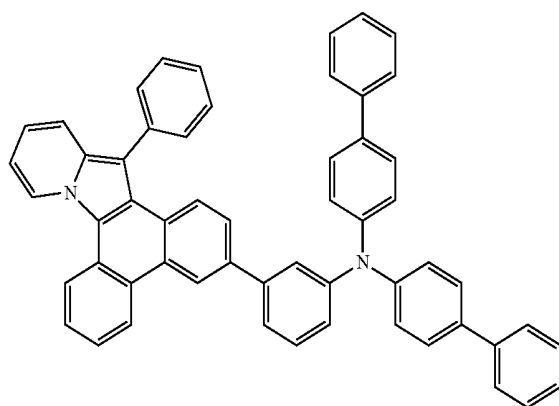
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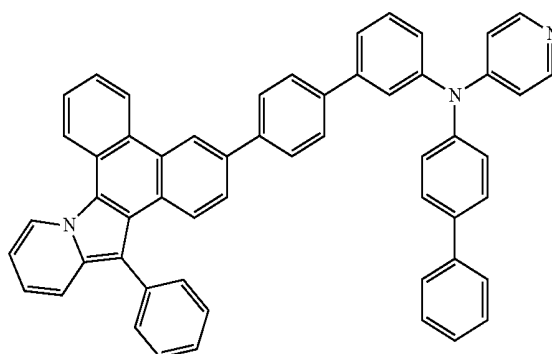
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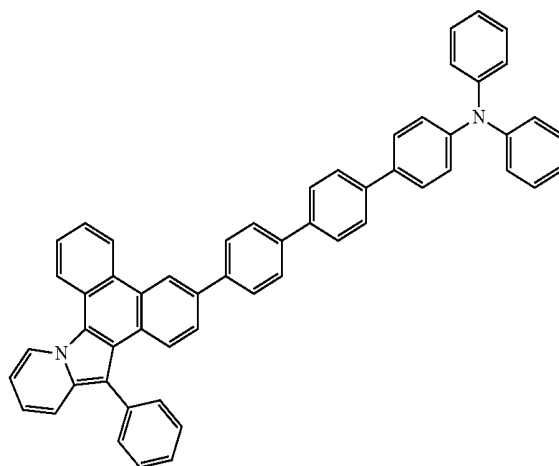
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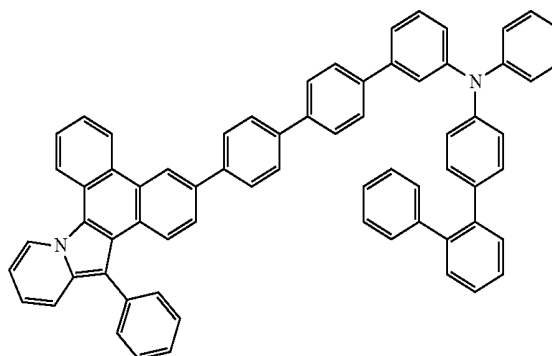
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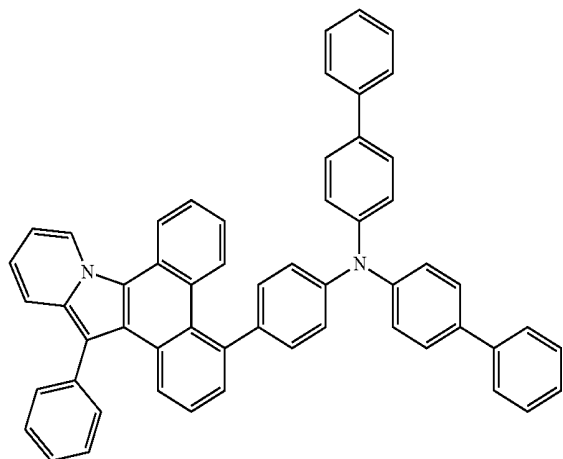


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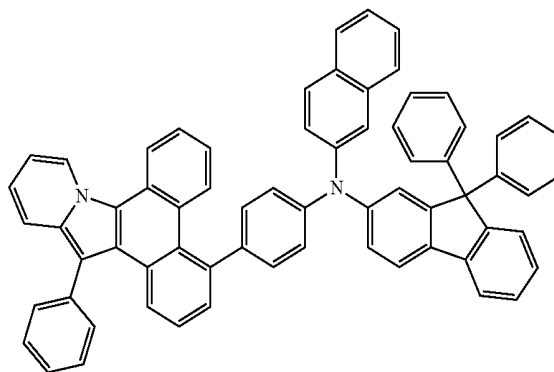


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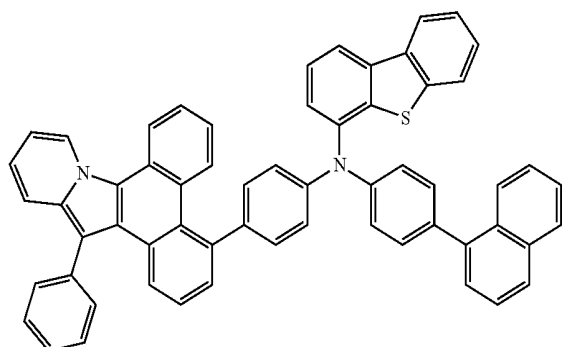
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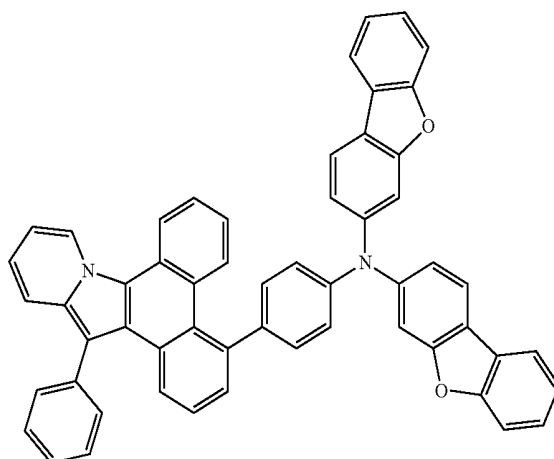
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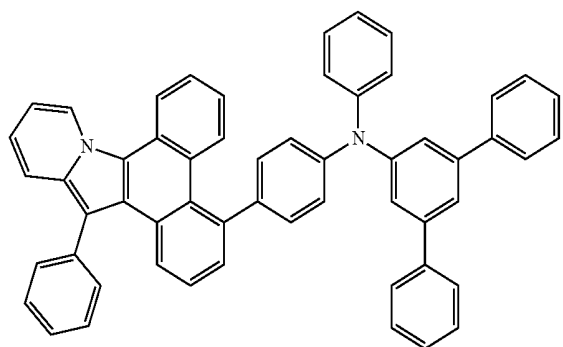
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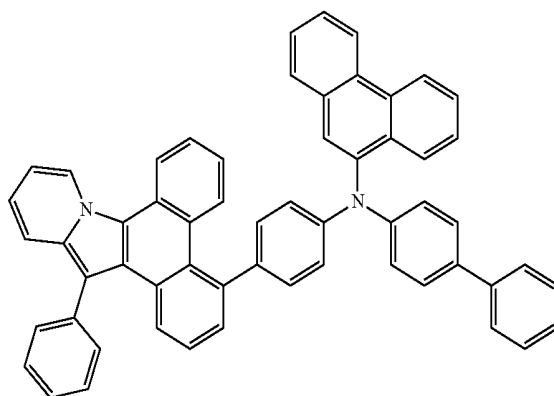
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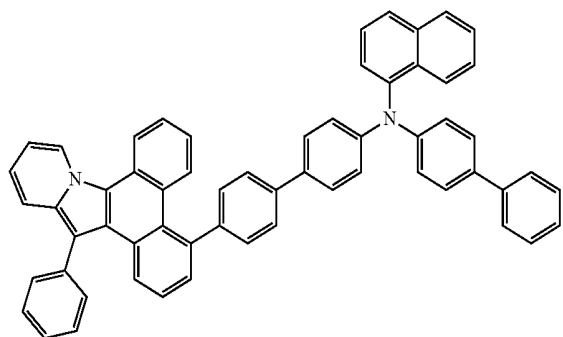


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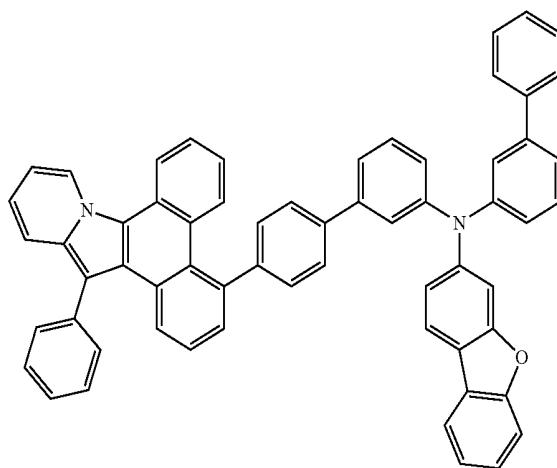


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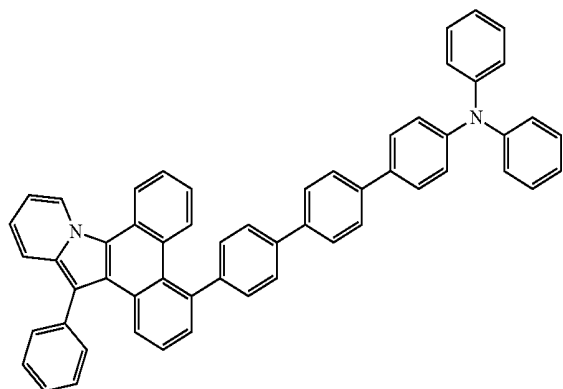
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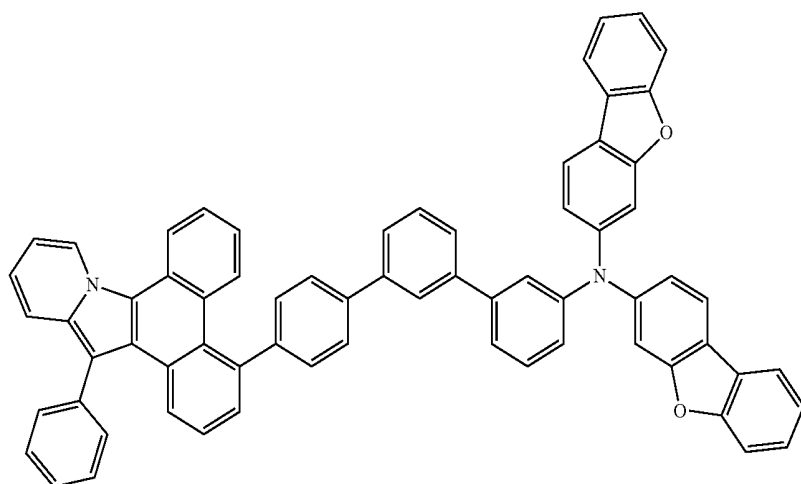
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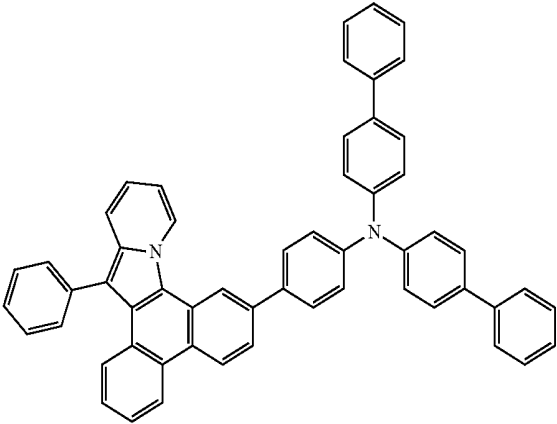


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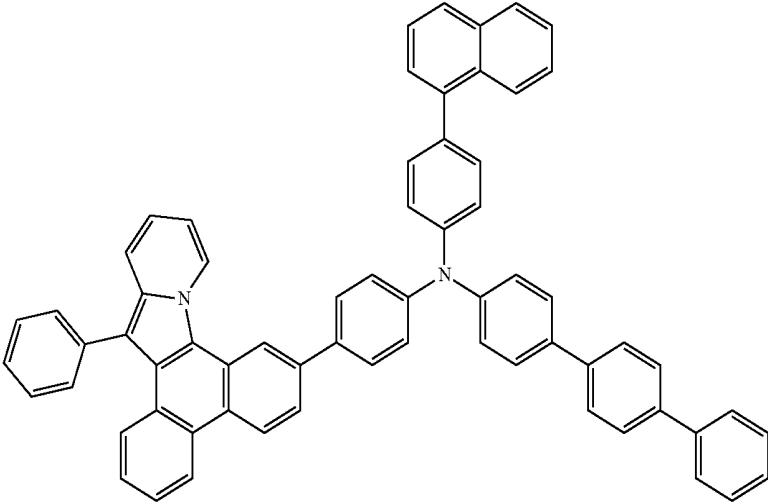


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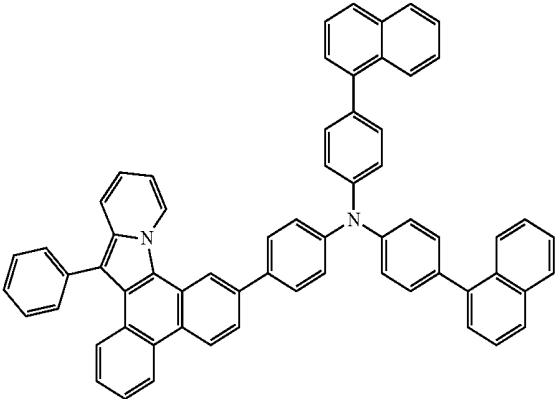
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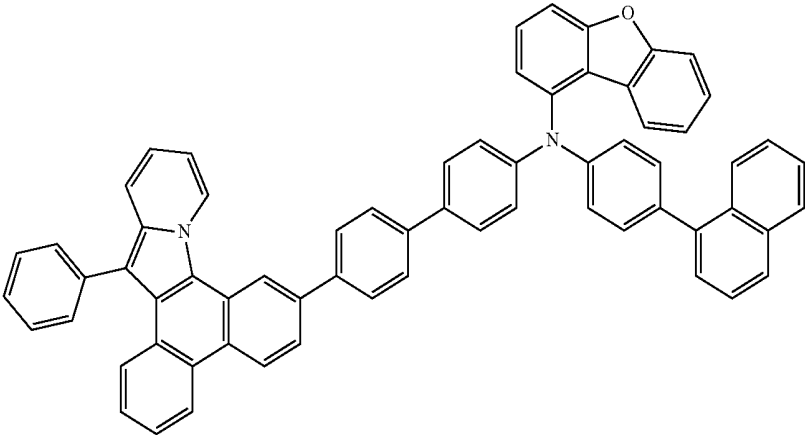


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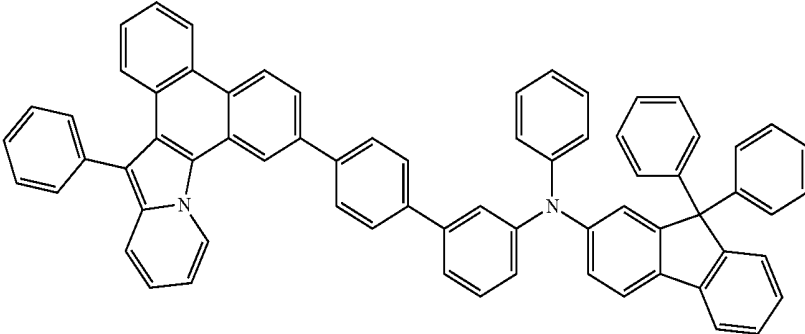


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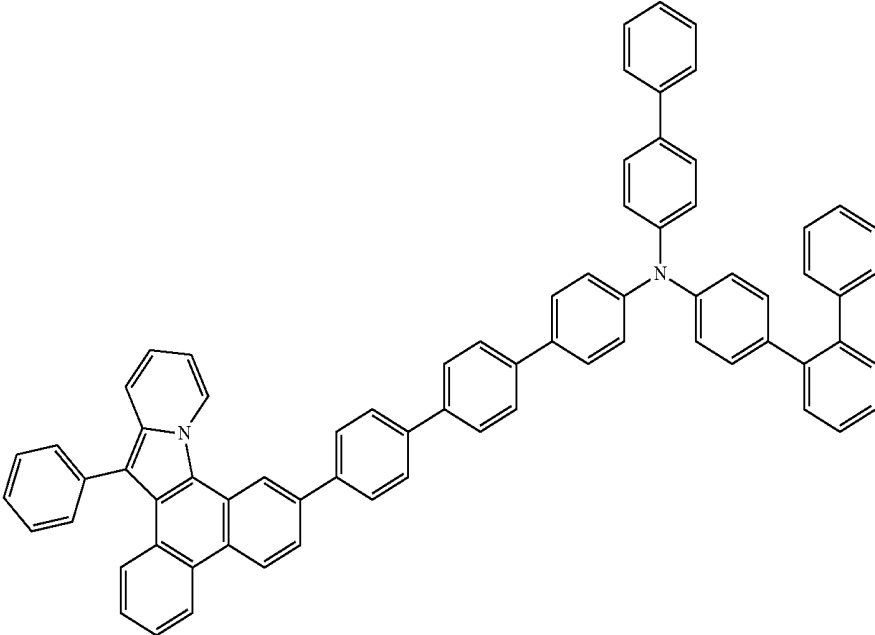
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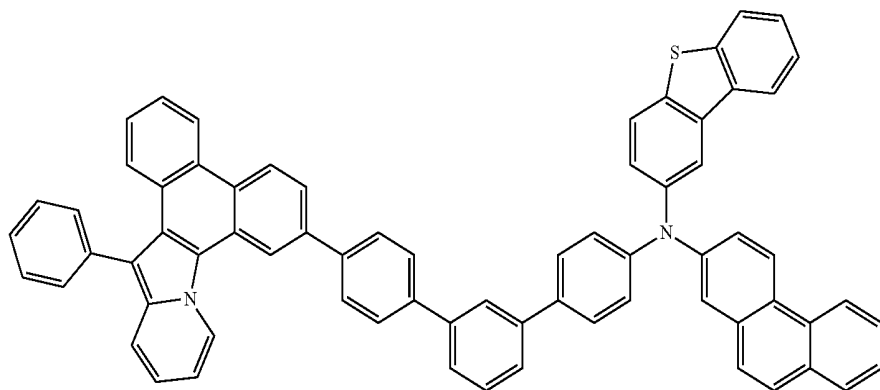


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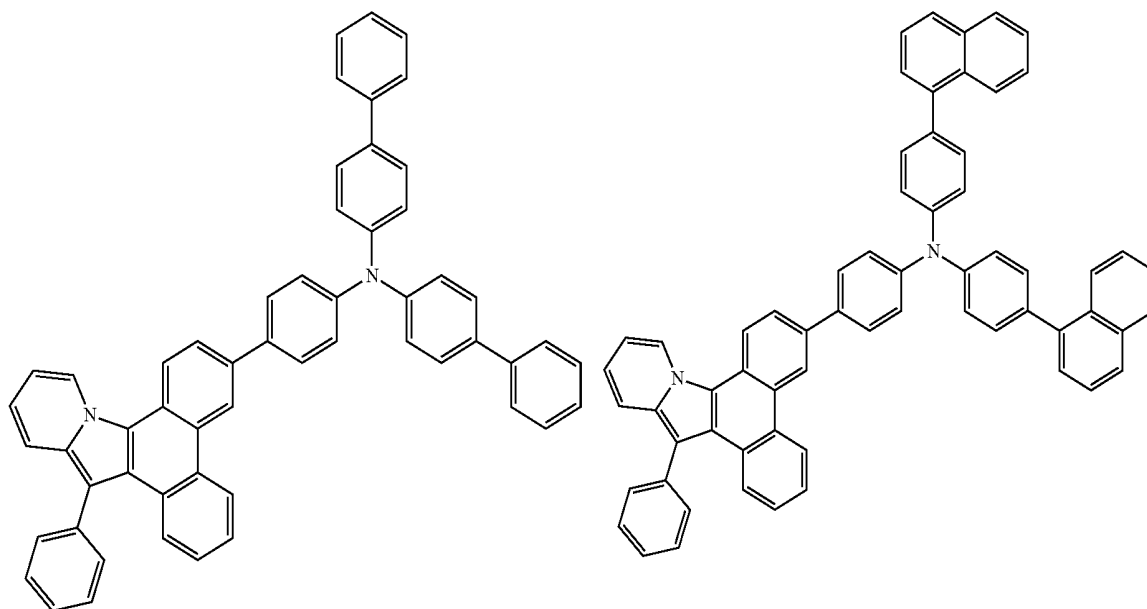
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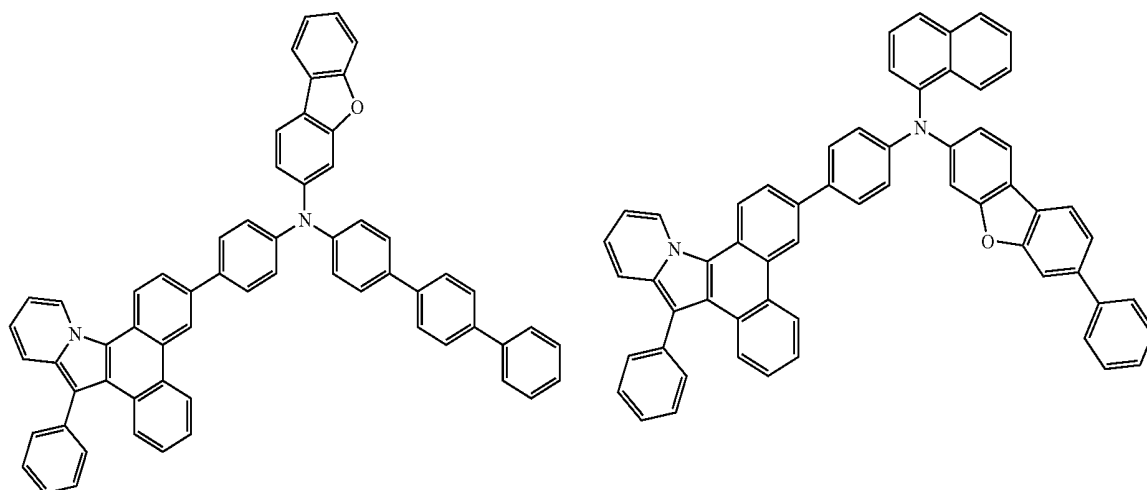
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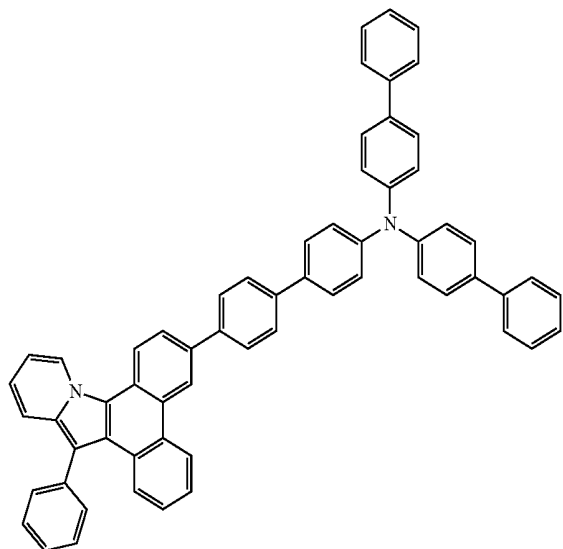
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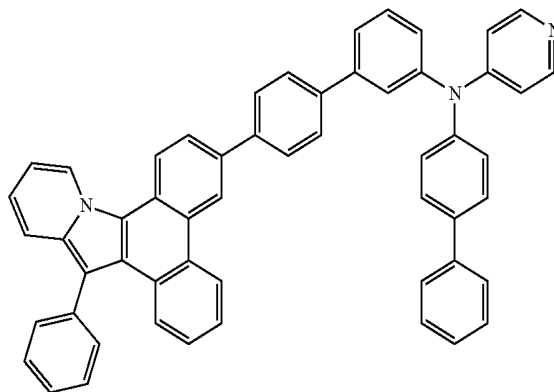


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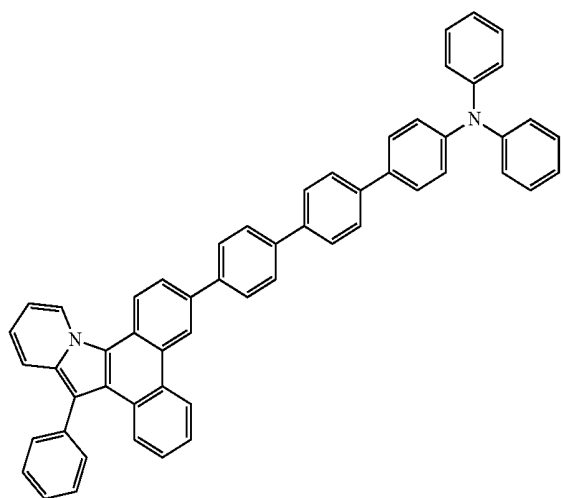
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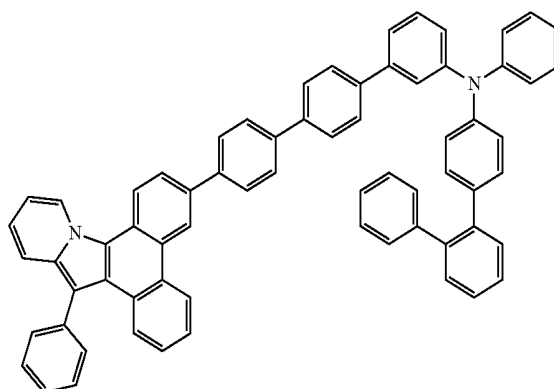
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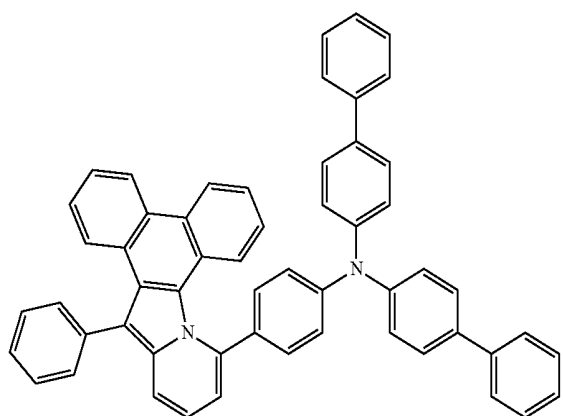
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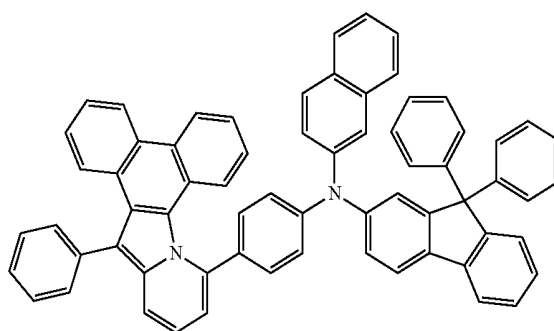
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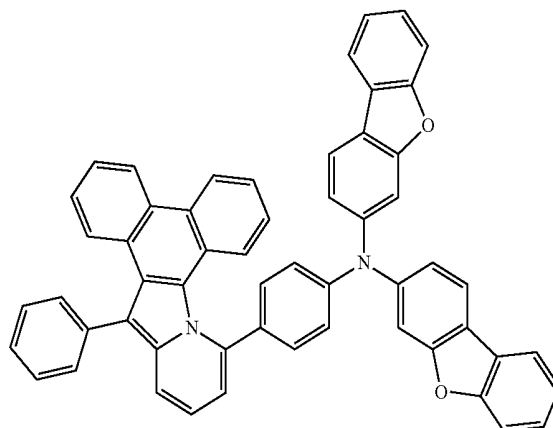
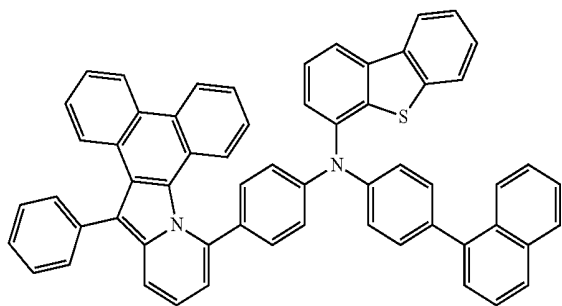


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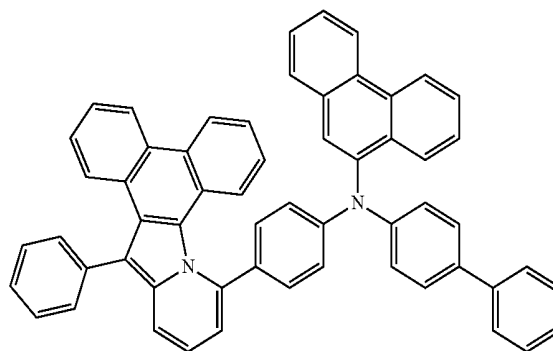
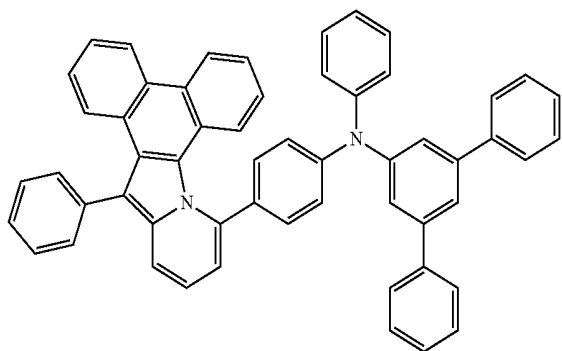
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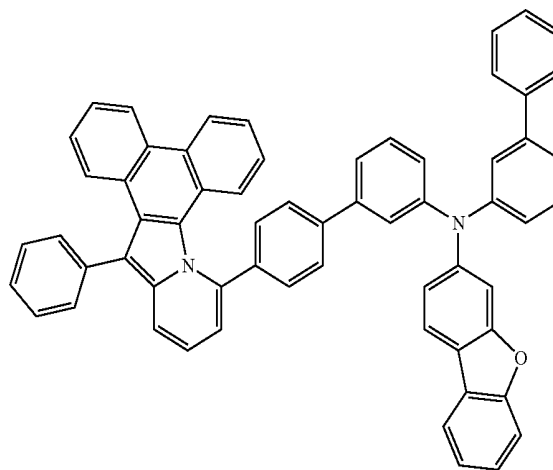
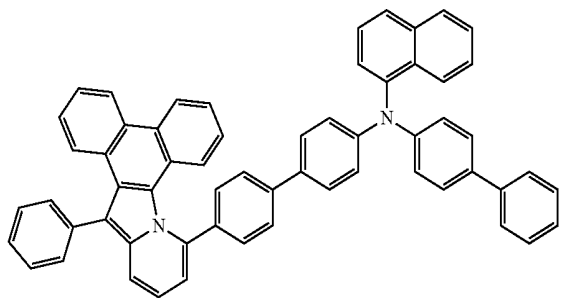
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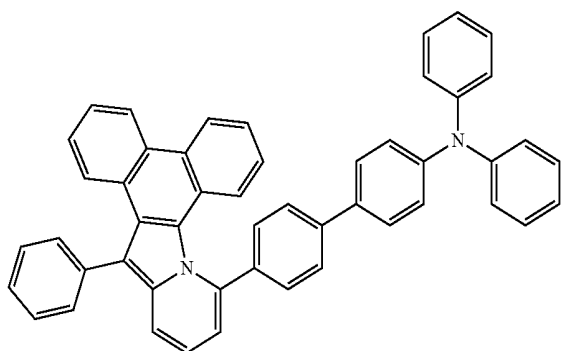


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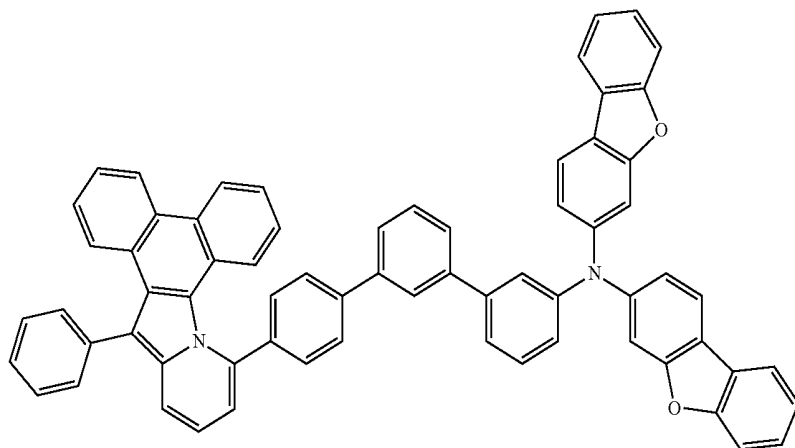


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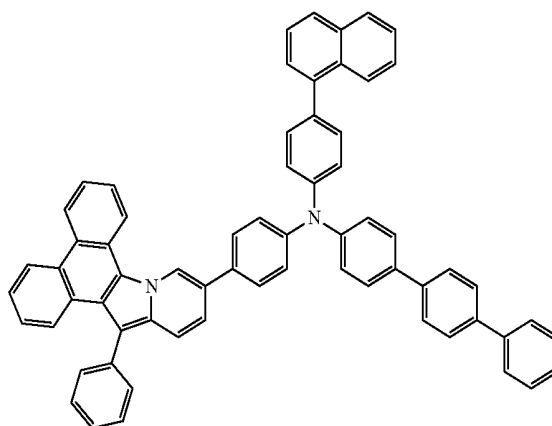
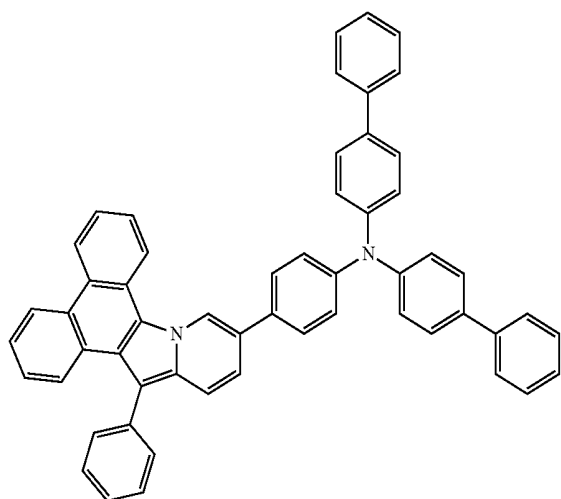
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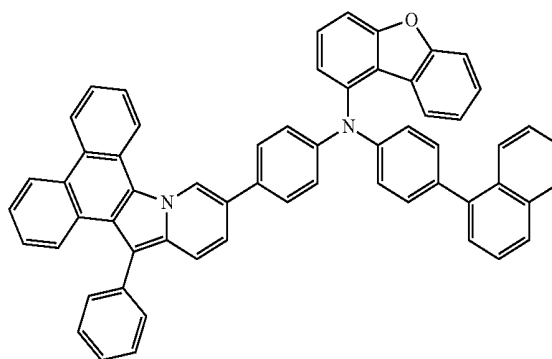
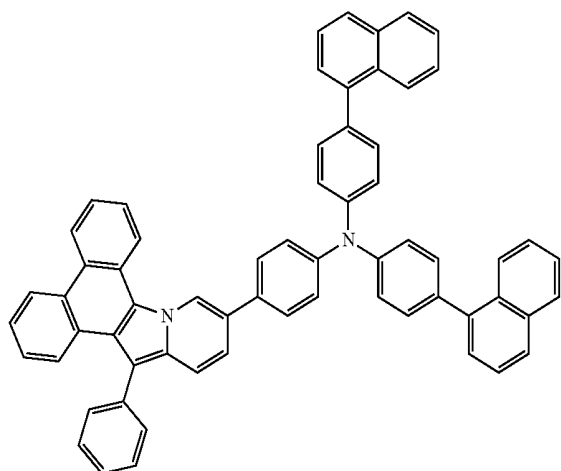
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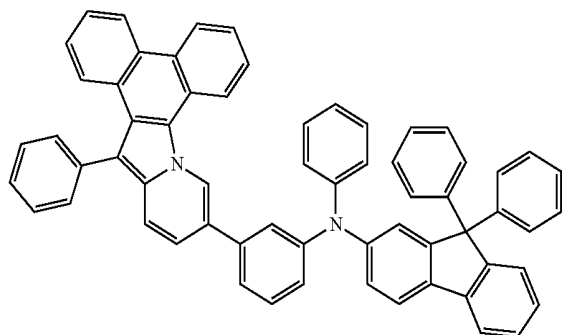
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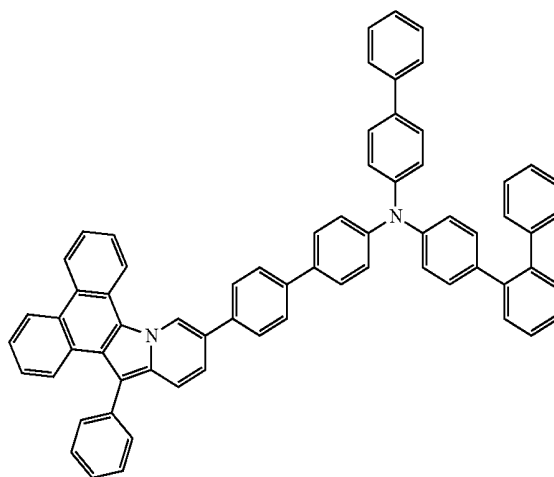


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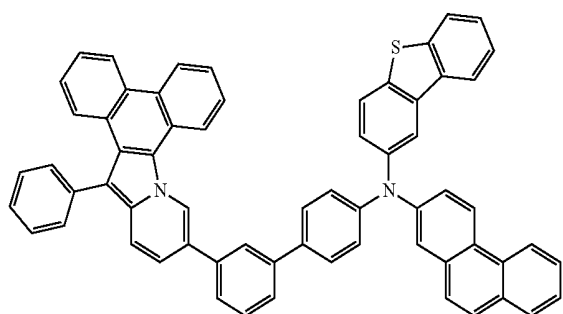
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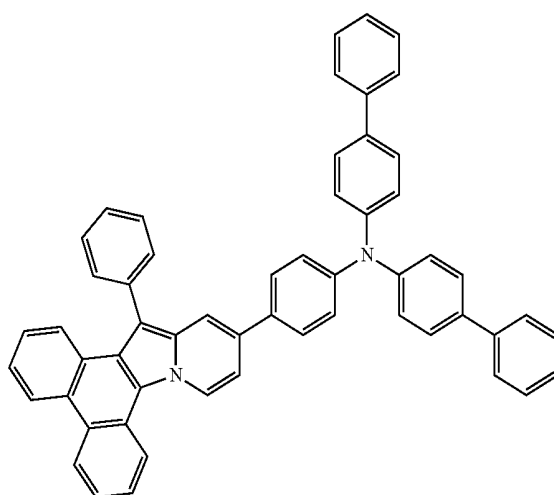
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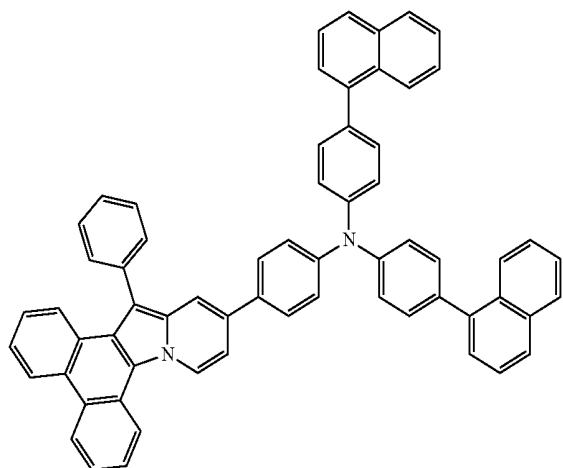
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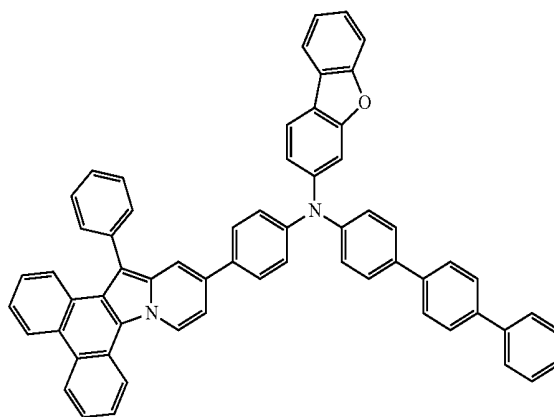
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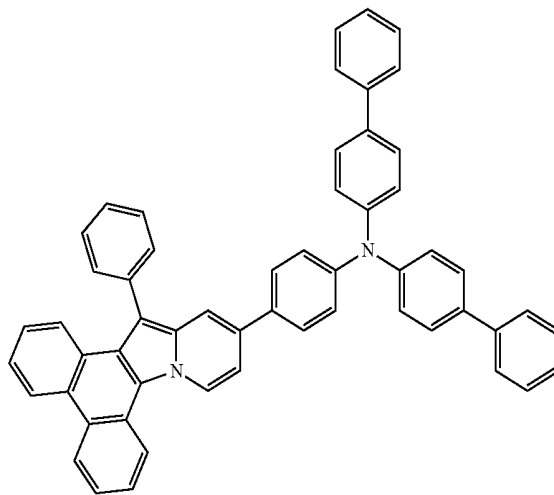
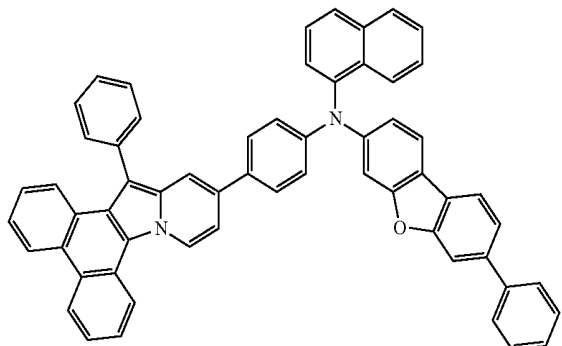
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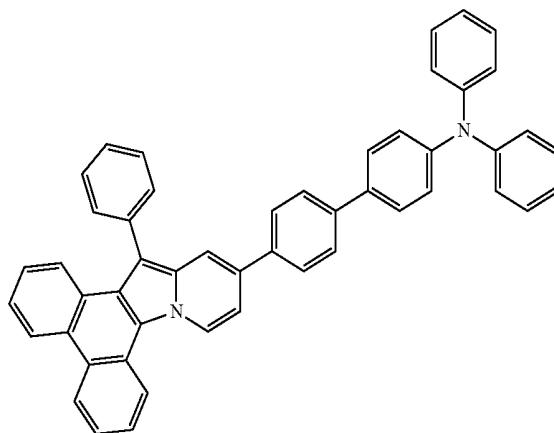
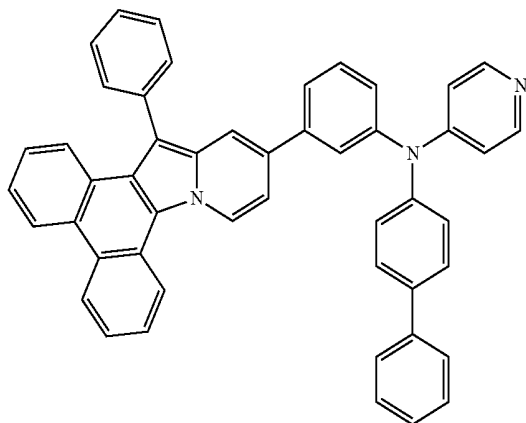
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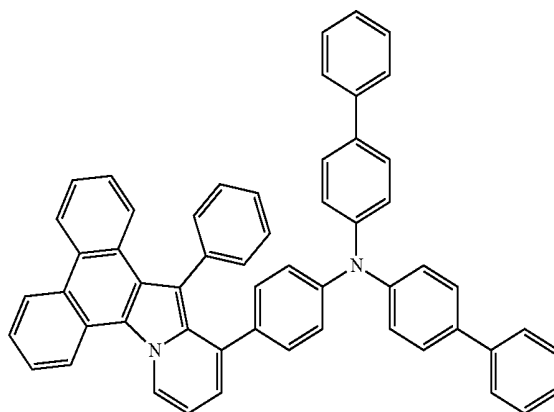
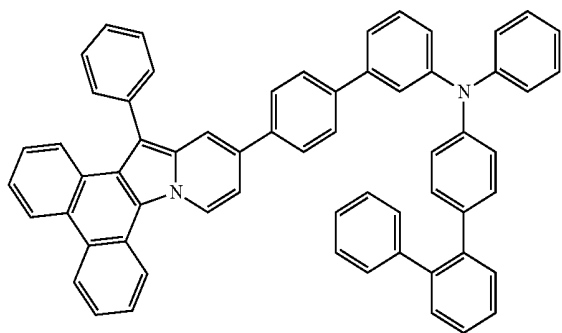
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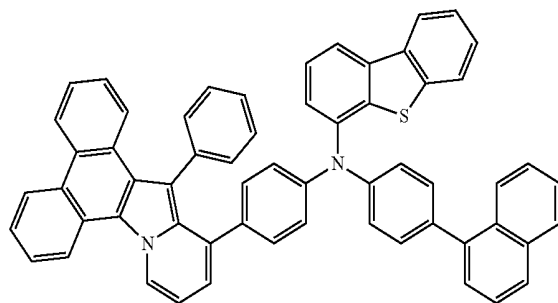
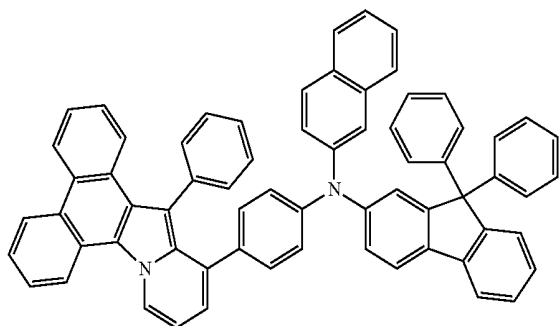
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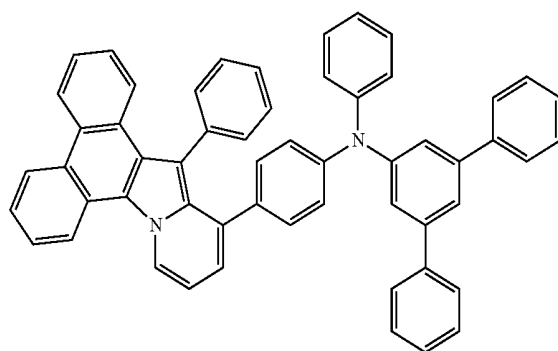
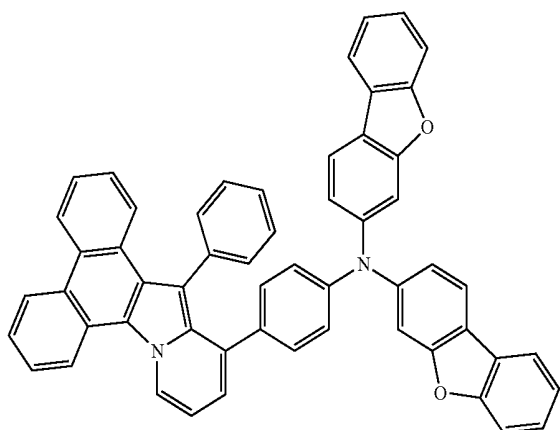
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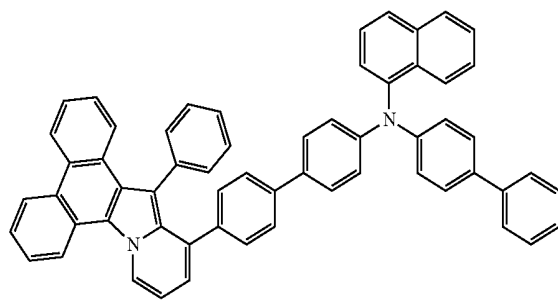
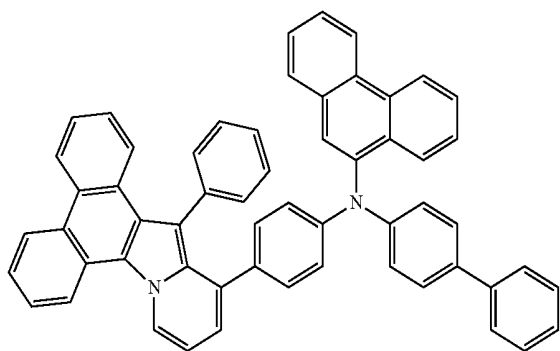
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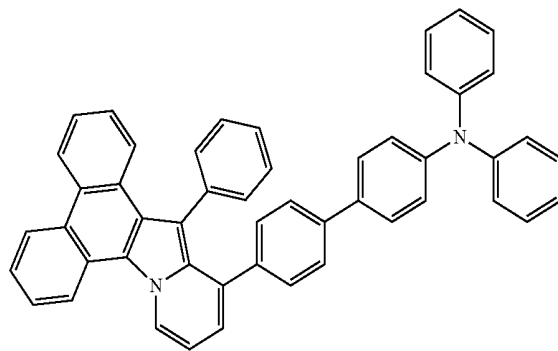
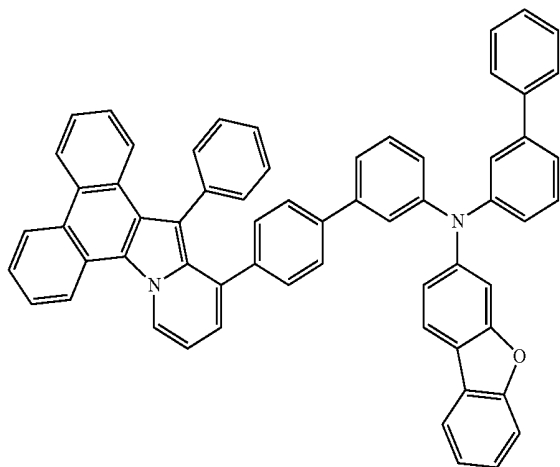
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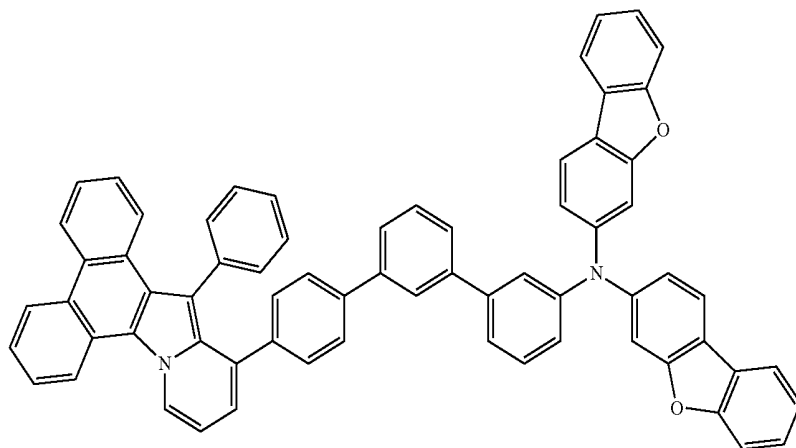
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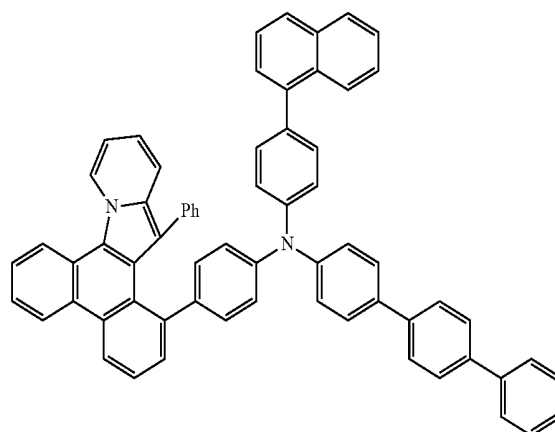
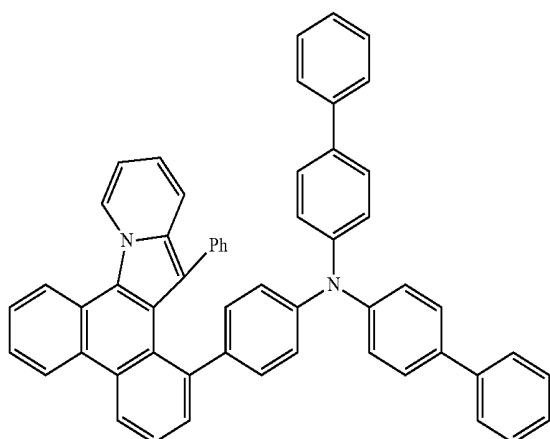
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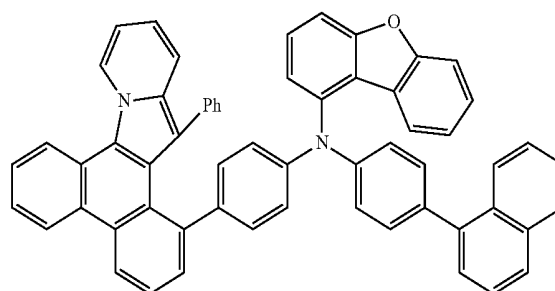
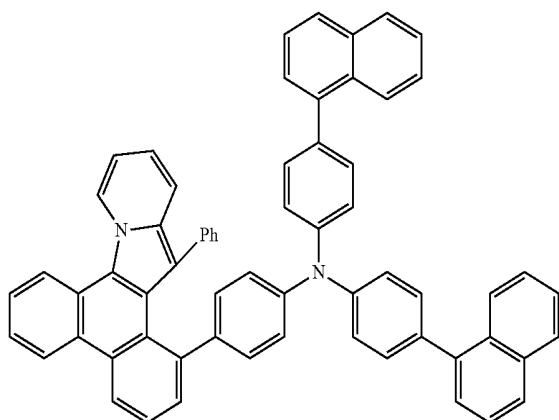
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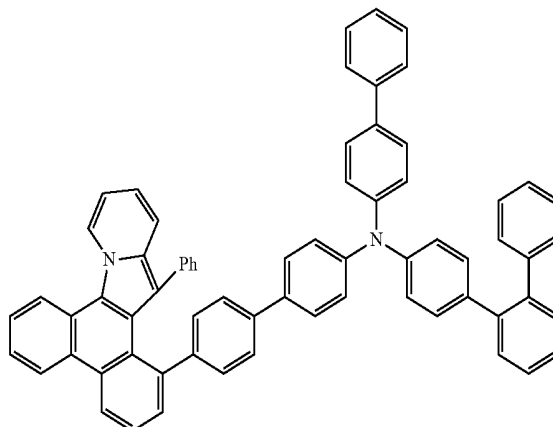
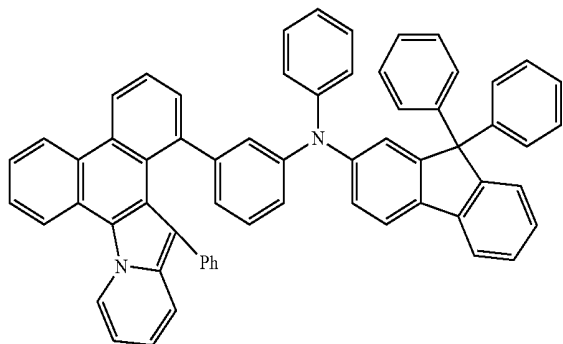
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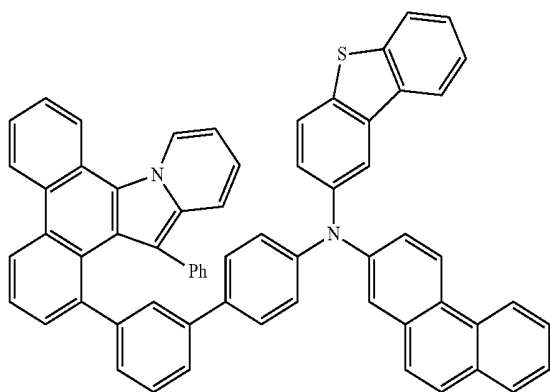


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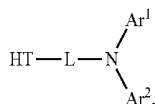
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F100

**14.** An amine compound represented by Formula 1:

Formula 1



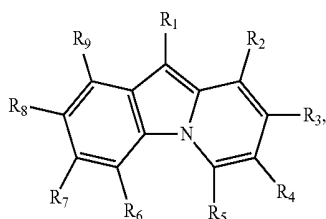
wherein, in Formula 1,

Ar¹ and Ar² are each independently a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

L is a direct linkage, a substituted or unsubstituted arylene group of 6 to 30 carbon atoms for forming a ring, or a substituted or unsubstituted heteroarylene group of 2 to 30 carbon atoms for forming a ring, and

HT is represented by Formula 2:

Formula 2



wherein, in Formula 2,

R₁ to R₉ are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted

aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms, at least one pair selected from R₂ and R₃, R₃ and R₄, R₄ and R₅, R₆ and R₇, R₇ and R₈, and R₈ and R₉ is combined with each other to form a hexagonal hydrocarbon ring, and

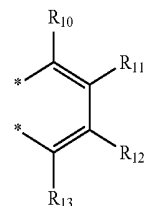
when at least one pair selected from R₂ and R₃, R₃ and R₄, and R₄ and R₅ forms a hexagonal hydrocarbon ring, R₈ is a hydrogen atom.

15. The amine compound of claim 14, wherein one or two pairs selected from R₂ and R₃, R₃ and R₄, and R₄ and R₅ each form the hexagonal hydrocarbon ring.

16. The amine compound of claim 14, wherein one or two pairs selected from R₆ and R₇, R₇ and R₈, and R₈ and R₉ each form the hexagonal hydrocarbon ring.

17. The amine compound of claim 14, wherein the hexagonal hydrocarbon ring is represented by Formula 3:

Formula 3



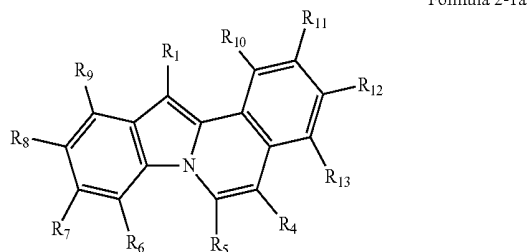
wherein, in Formula 3,

R₁₀ to R₁₃ are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted

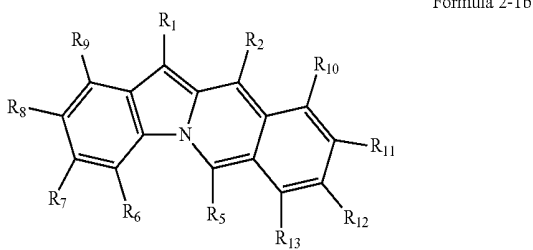
aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms, and * is a combining part with Formula 2.

18. The amine compound of claim 17, wherein one selected from R_2 to R_9 or one selected from R_{10} to R_{13} that is not a part of the hexagonal hydrocarbon ring is combined with L in Formula 1.

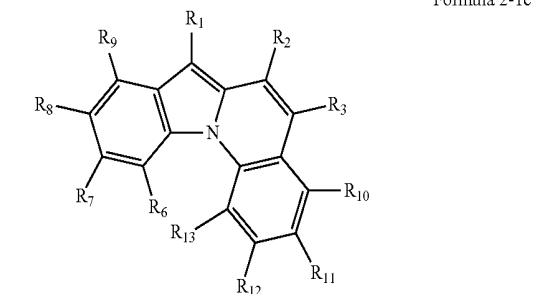
19. The amine compound of claim 17, wherein HT is represented by one selected from Formula 2-1a to Formula 2-1d:



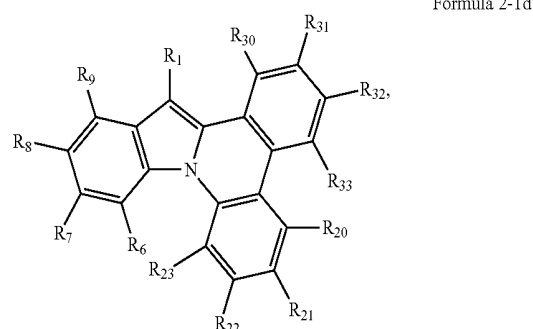
Formula 2-1a



Formula 2-1b



Formula 2-1c



Formula 2-1d

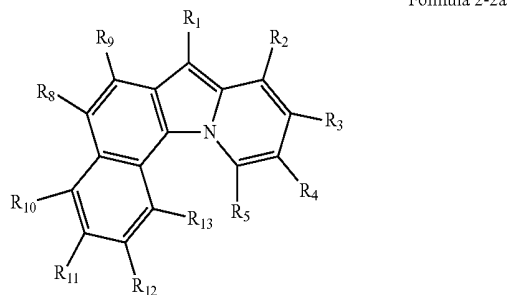
wherein, in Formula 2-1d,

R_{20} to R_{23} and R_{30} to R_{33} are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

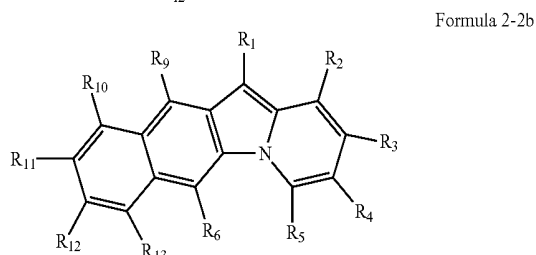
wherein, in Formula 2-1a to Formula 2-1d,

R_1 to R_9 are the same as defined in Formula 2, and R_{10} to R_{13} are the same as defined in Formula 3.

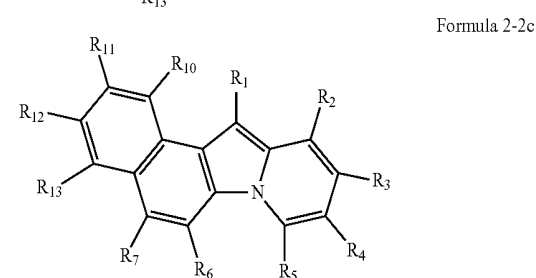
20. The amine compound of claim 17, wherein HT is represented by one selected from Formula 2-2a to Formula 2-2d:



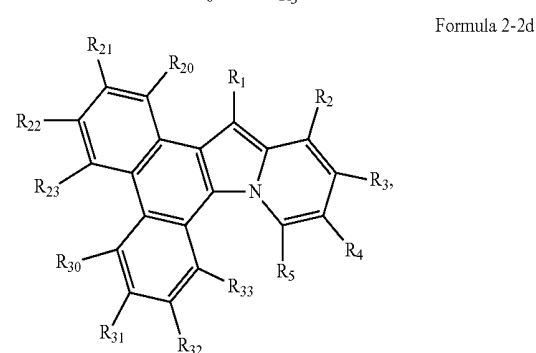
Formula 2-2a



Formula 2-2b



Formula 2-2c



Formula 2-2d

wherein, in Formula 2-2d,

R_{20} to R_{23} and R_{30} to R_{33} are each independently a hydrogen atom, a deuterium atom, a halogen atom, a cyano group, a nitro group, an amino group, a substituted or unsubstituted aryl group of 6 to 40 carbon atoms for forming a ring, a substituted or unsubstituted heteroaryl group of 2 to 40 carbon atoms for forming a ring, or a substituted or unsubstituted alkyl group of 1 to 20 carbon atoms,

wherein, in Formula 2-2a to Formula 2-2d,

R_1 to R_9 are the same as defined in Formula 2, and

R_{10} to R_{13} are the same as defined in Formula 3.

21. The amine compound of claim 14, wherein R_1 is an unsubstituted phenyl group, an unsubstituted naphthyl group, an unsubstituted biphenyl group, an unsubstituted dibenzofuranyl group, or an unsubstituted dibenzothiophene group.

22. The amine compound of claim 14, wherein L is a direct linkage, a substituted or unsubstituted phenylene group, a substituted or unsubstituted divalent biphenyl

group, a substituted or unsubstituted divalent terphenyl group, a substituted or unsubstituted divalent phenanthrene group, a substituted or unsubstituted naphthylene group, or a substituted or unsubstituted divalent dibenzofuran group.

23. The amine compound of claim 14, wherein Ar_1 and Ar_2 are each independently a substituted or unsubstituted phenyl group, a substituted or unsubstituted biphenyl group, a substituted or unsubstituted terphenyl group, a substituted or unsubstituted phenanthrene group, a substituted or unsubstituted triphenylene group, a substituted or unsubstituted naphthyl group, a substituted or unsubstituted fluorenyl group, a substituted or unsubstituted adamantyl group, a substituted or unsubstituted dibenzofuran group, a substituted or unsubstituted dibenzothiophene group, or a substituted or unsubstituted pyridinyl group.

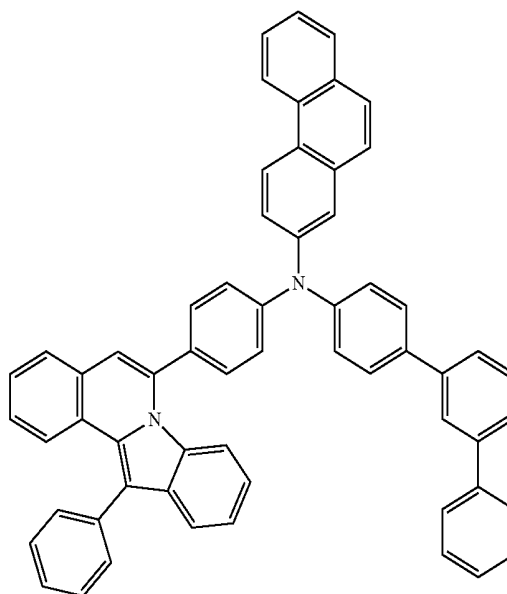
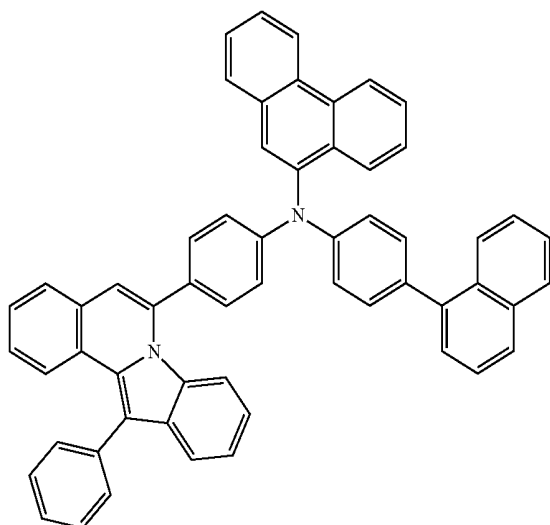
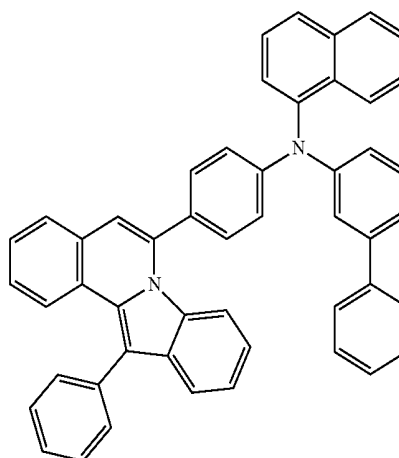
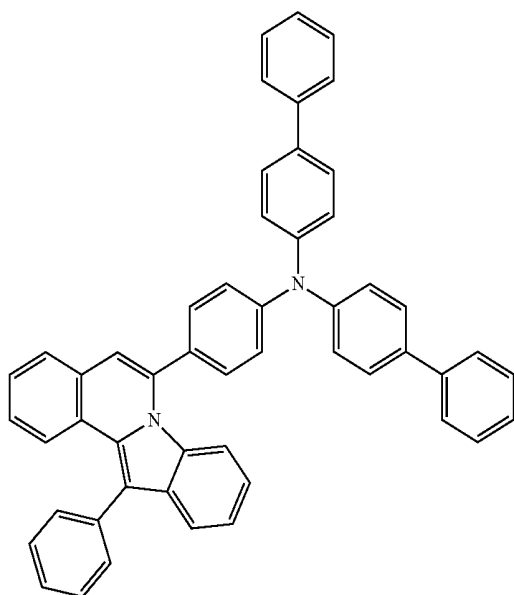
24. The amine compound of claim 14, wherein Ar_1 and Ar_2 are each independently:

an aryl group of 6 to 40 carbon atoms for forming a ring, which is unsubstituted or substituted with at least one substituent selected from a halogen atom, a cyano group, an alkyl group of 1 to 20 carbon atoms, an alkoxy group of 1 to 10 carbon atoms, an aryloxy group of 1 to 20 carbon atoms, an aryl group of 6 to 30 carbon atoms, a triarylsilyl group of 18 to 50 carbon atoms, and an adamantyl group, or

a heteroaryl group of 2 to 40 carbon atoms for forming a ring, which is unsubstituted or substituted with at least one substituent selected from a halogen atom, a cyano group, an alkyl group of 1 to 20 carbon atoms, an alkoxy group of 1 to 10 carbon atoms, an aryloxy group of 1 to 20 carbon atoms, an aryl group of 6 to 30 carbon atoms, a triarylsilyl group of 18 to 50 carbon atoms, and an adamantyl group.

25. The amine compound of claim 14, wherein the amine compound is represented by at least one selected from Compound Group 1 and Compound Group 2:

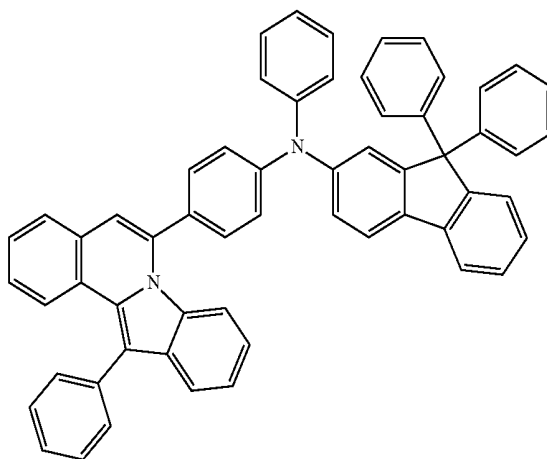
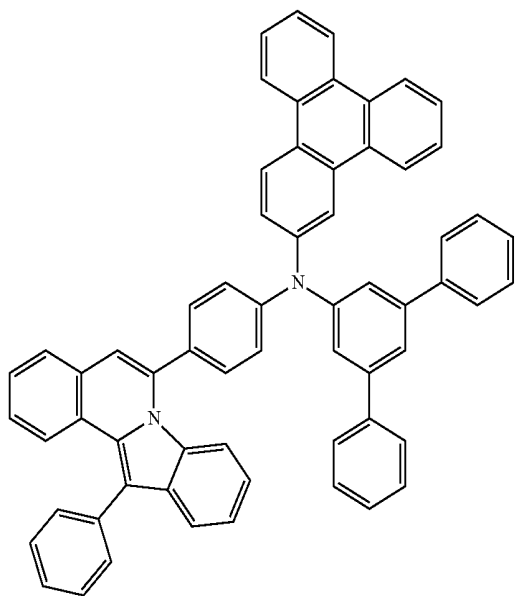
Compound Group 1



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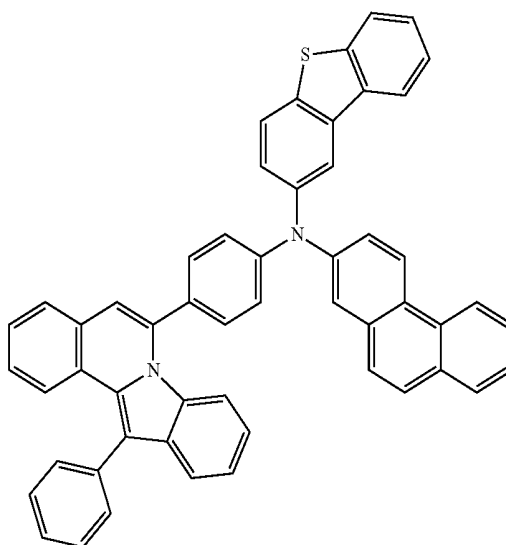
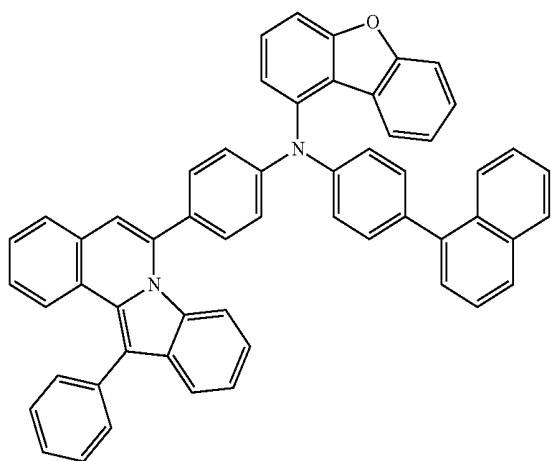
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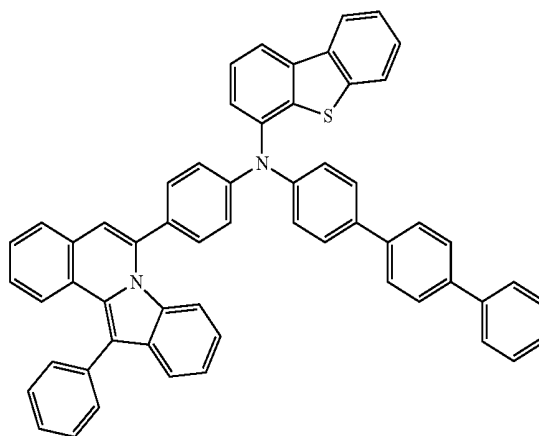
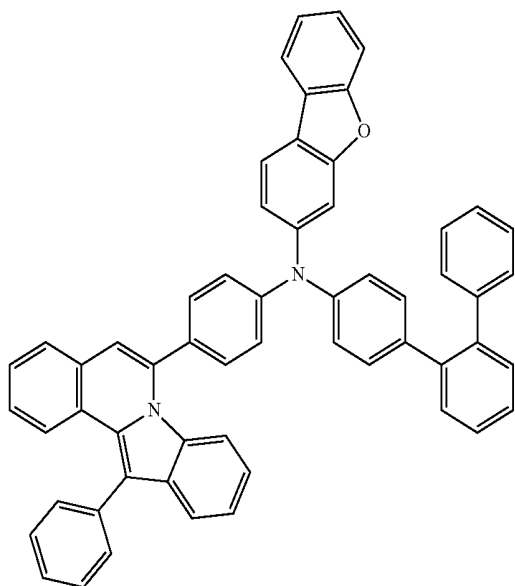
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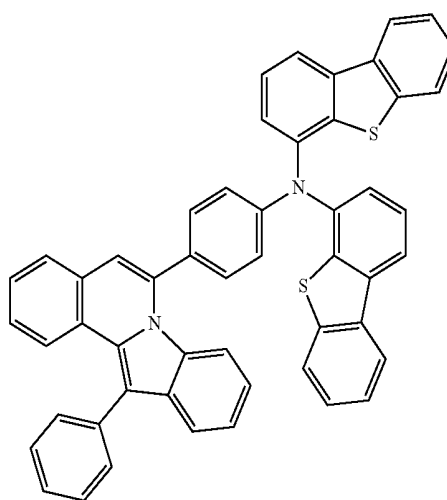
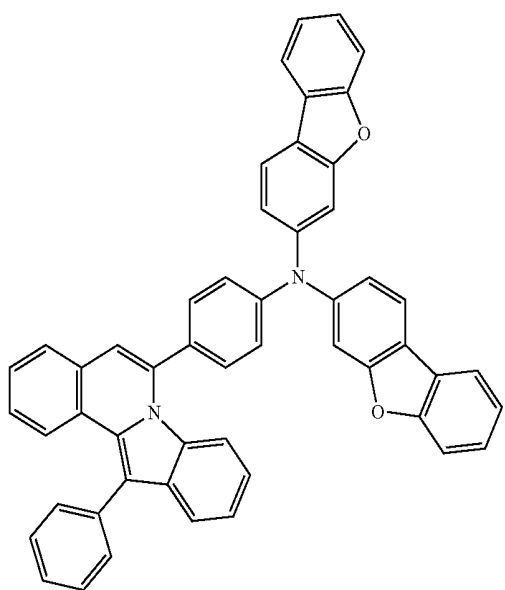
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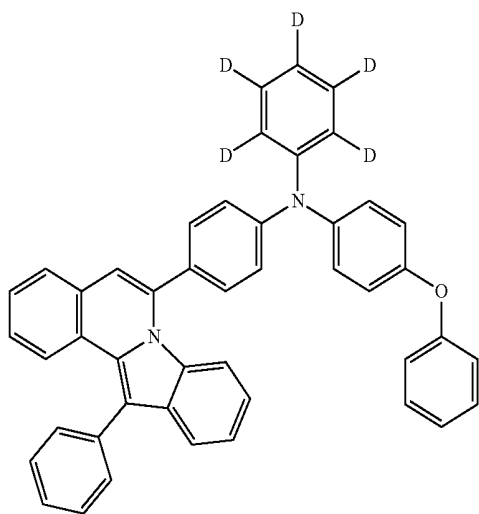
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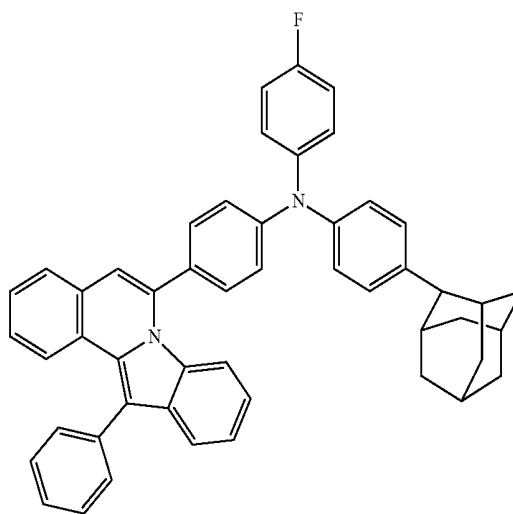


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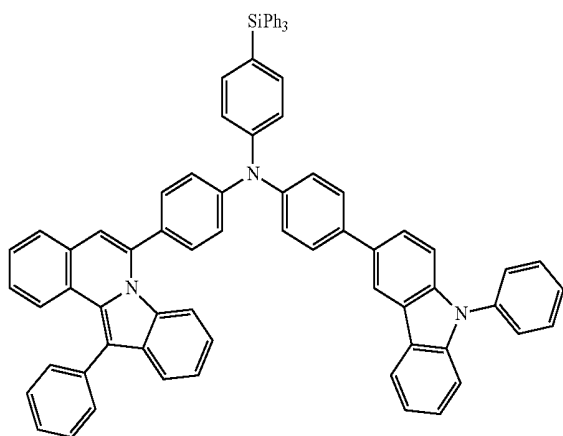
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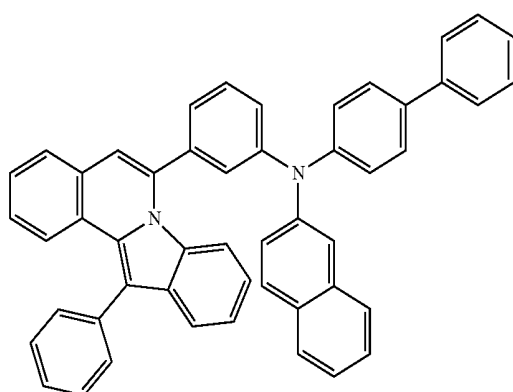
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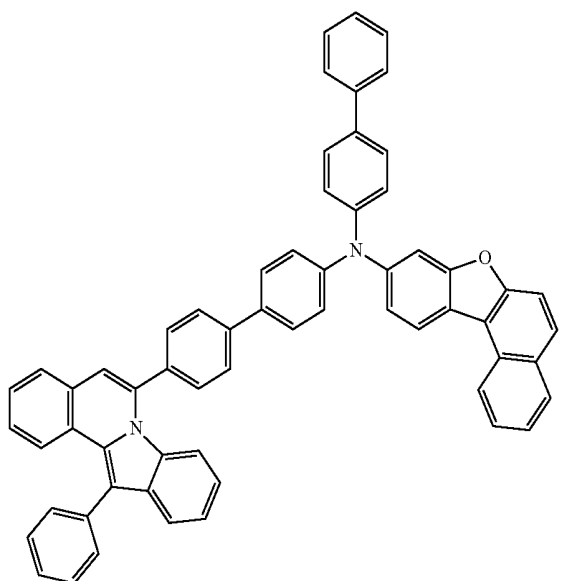
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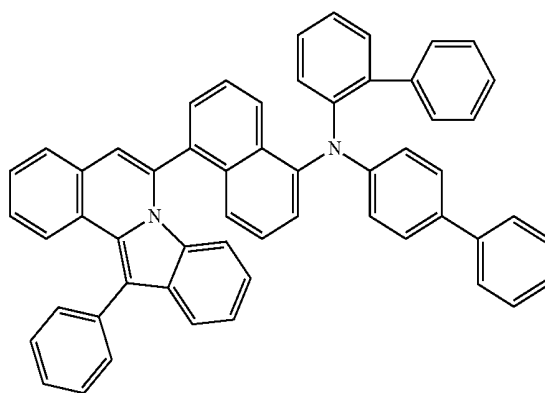
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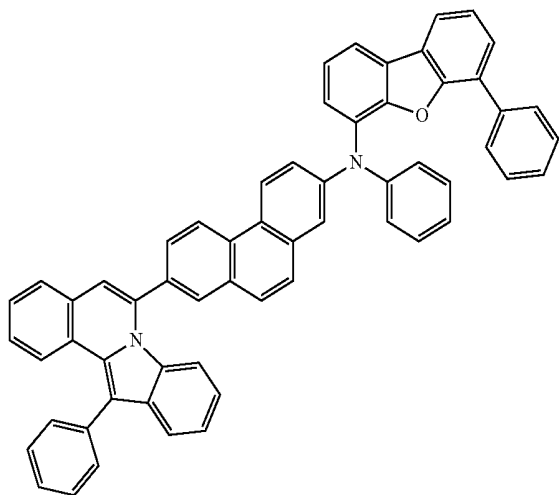


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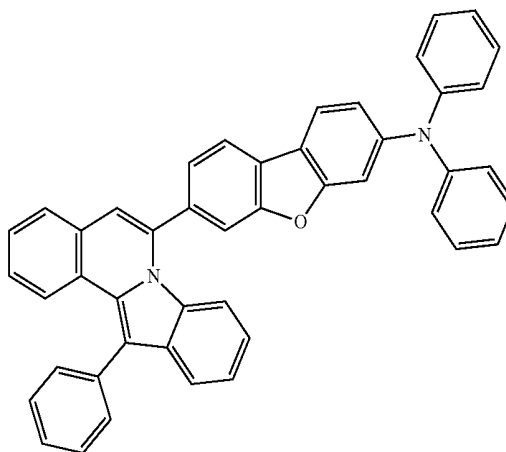


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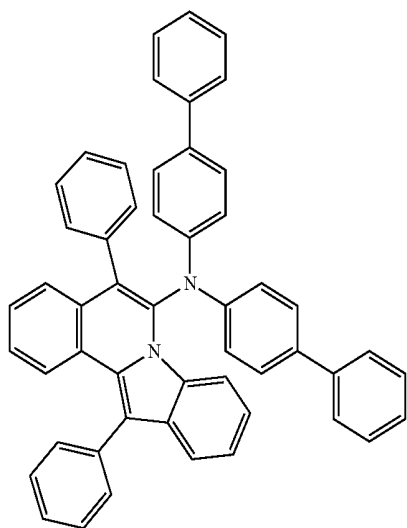
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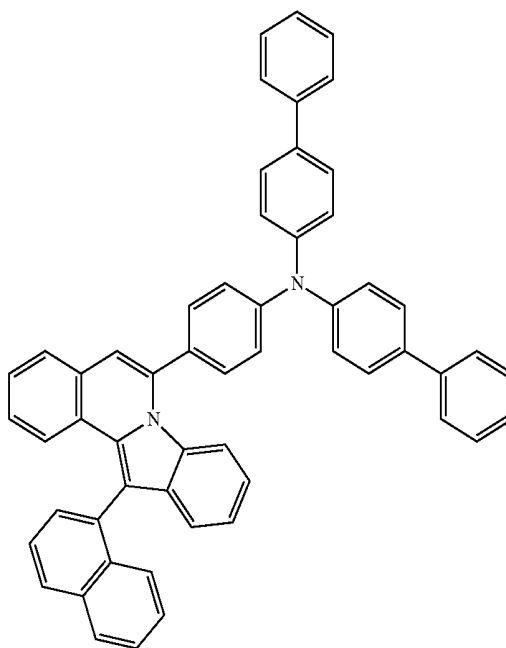
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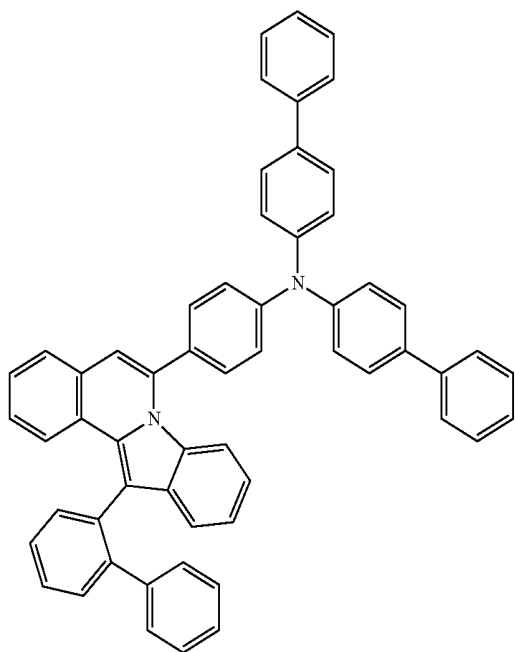


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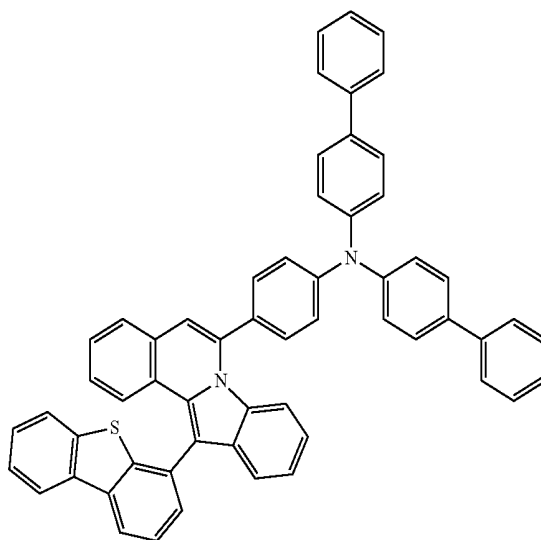


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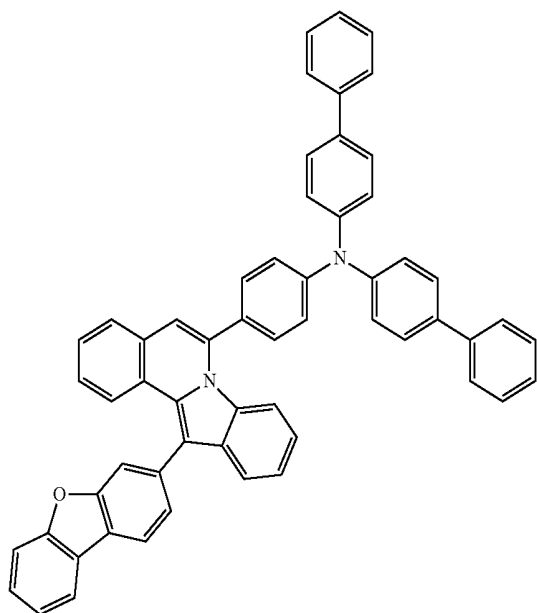
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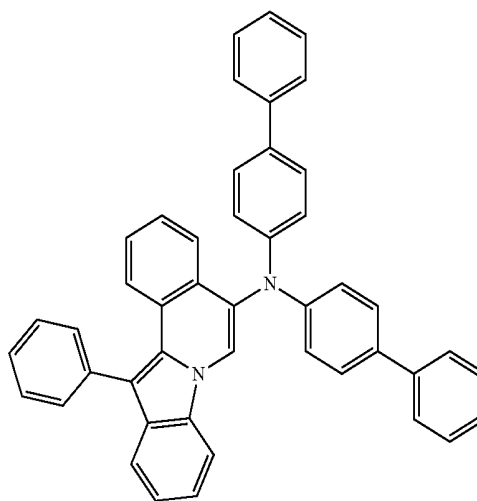
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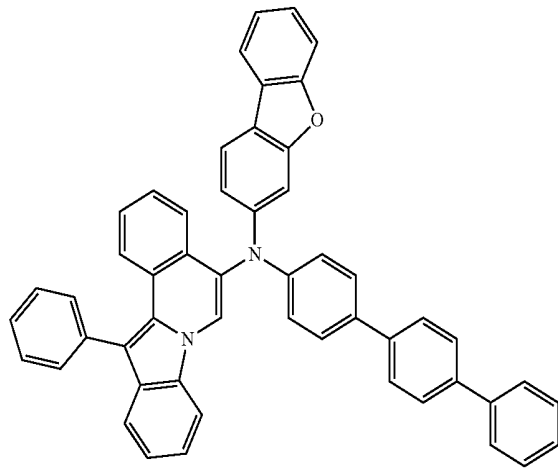
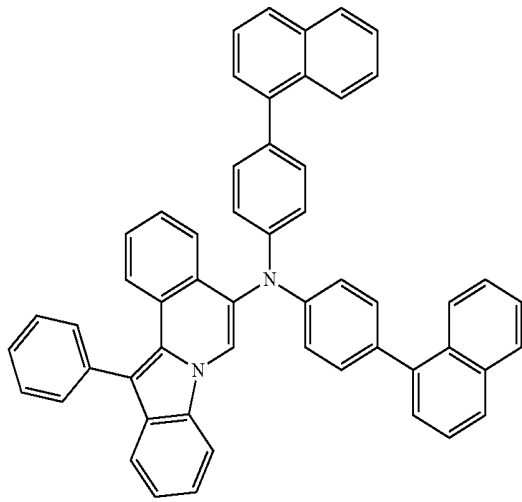
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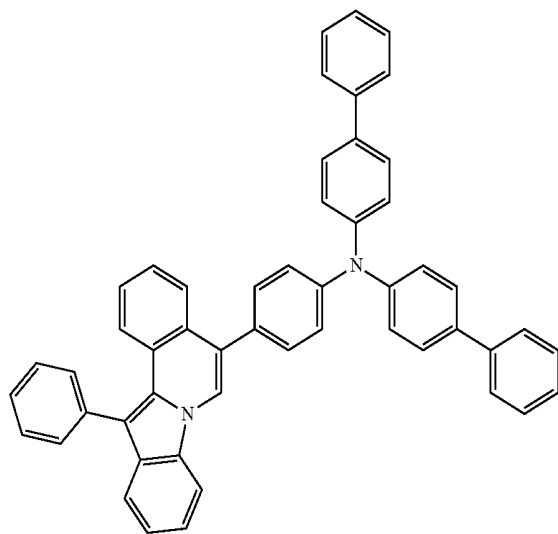
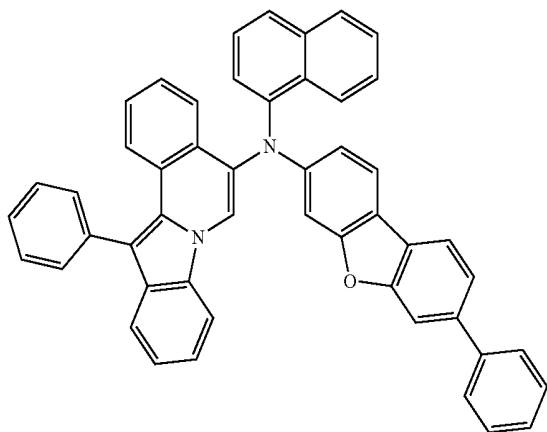
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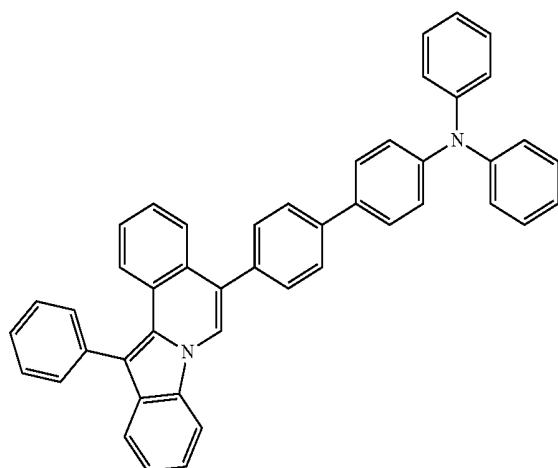
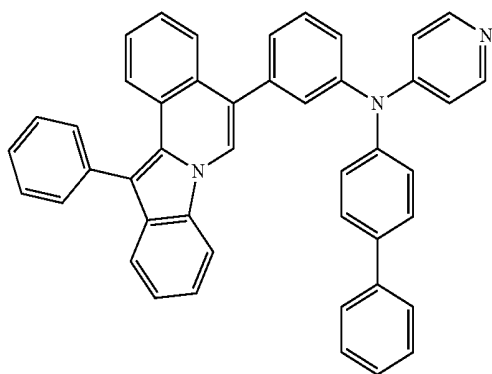
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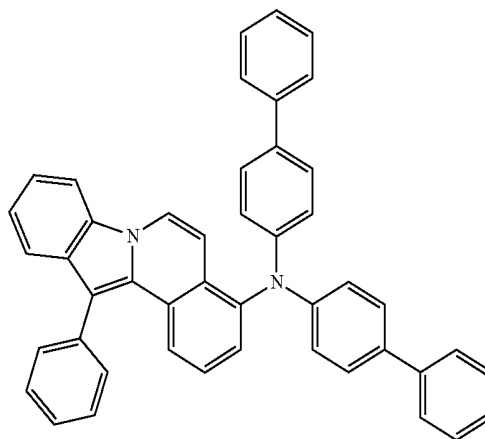
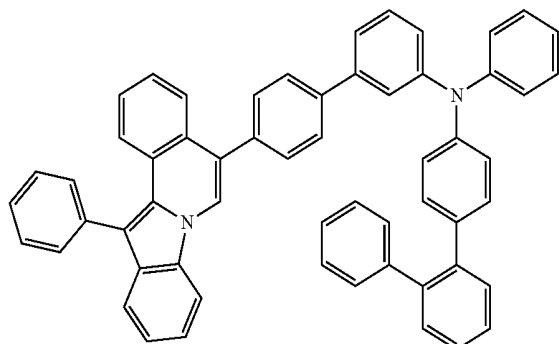
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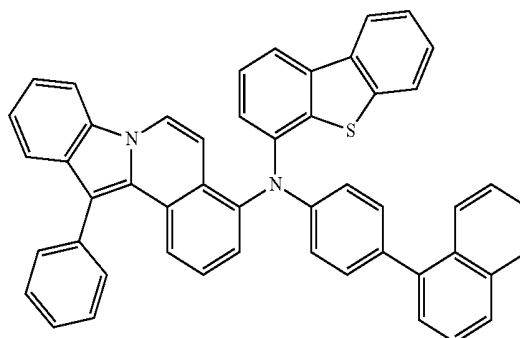
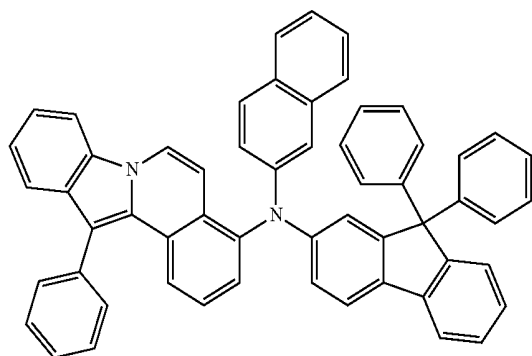
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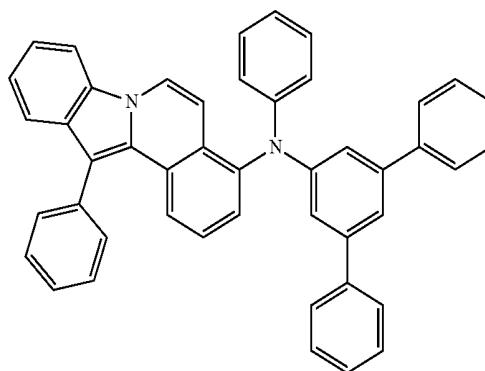
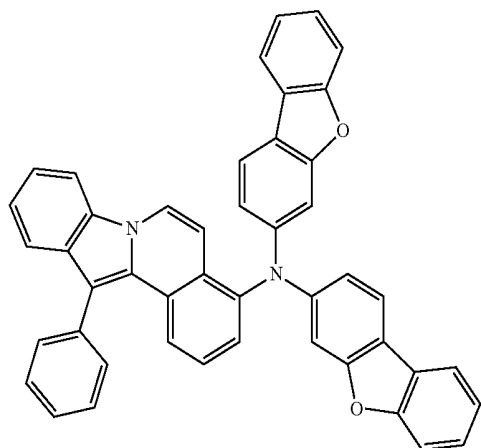
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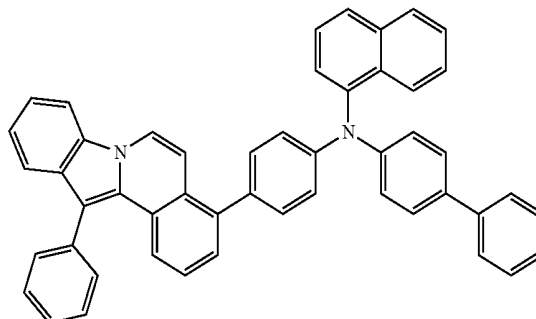
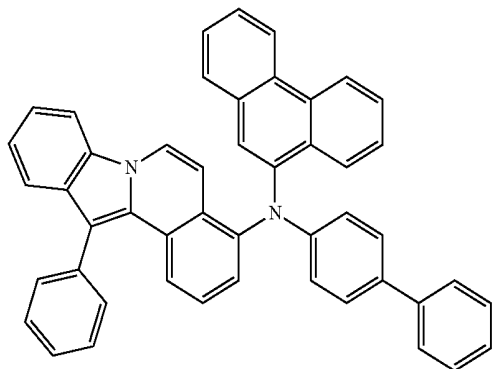
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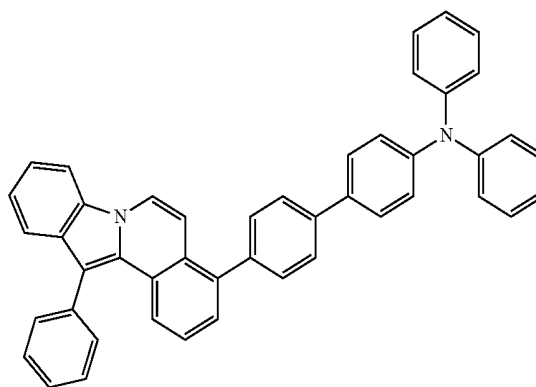
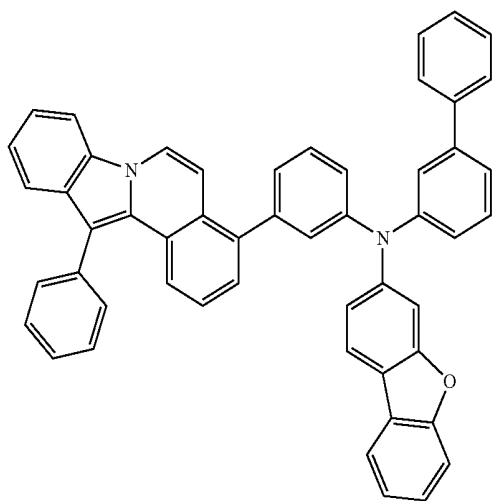
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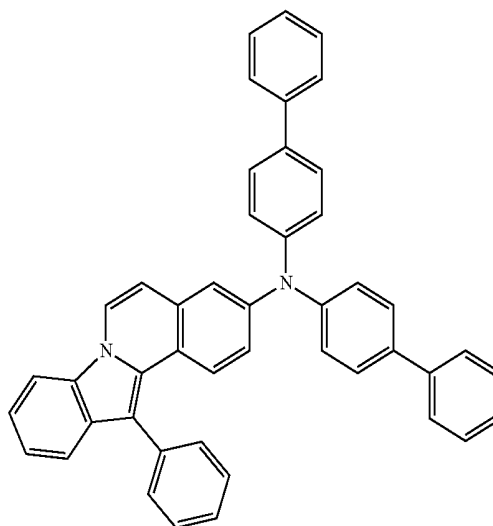
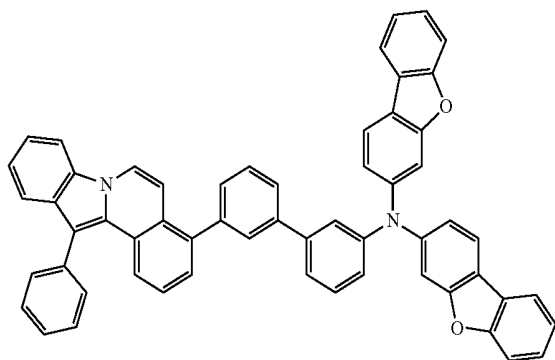
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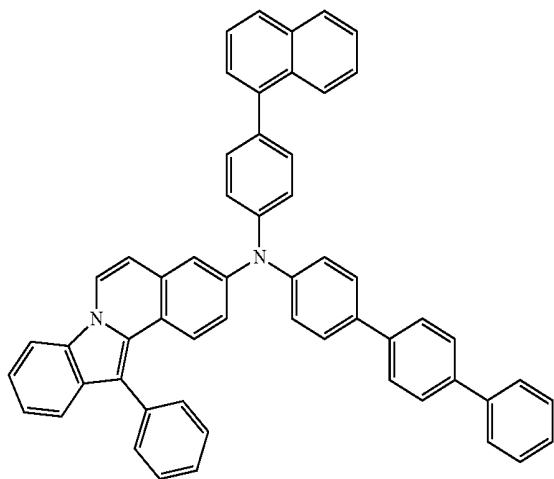
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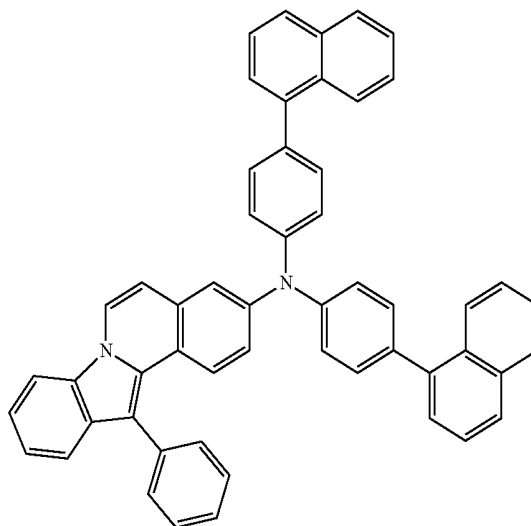


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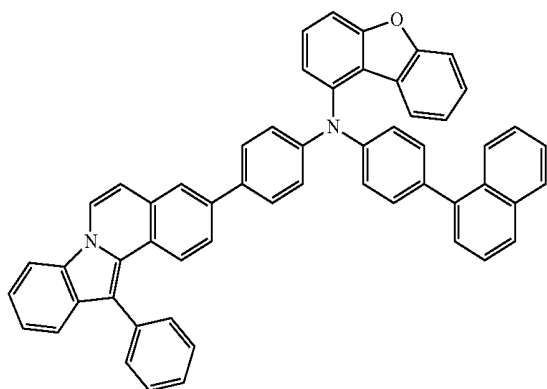
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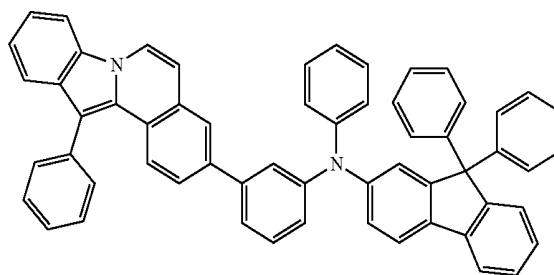
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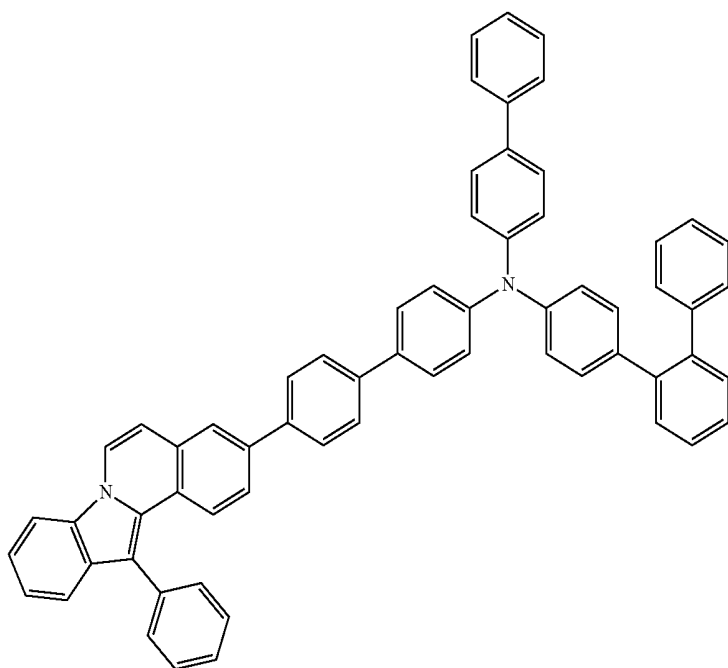
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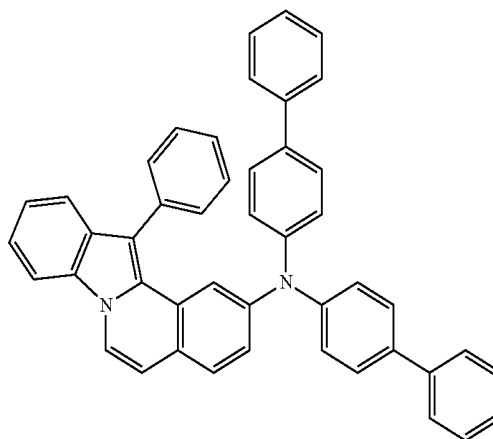
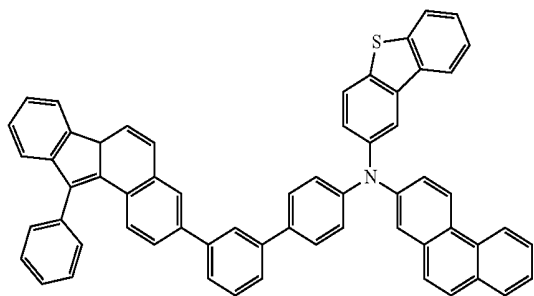
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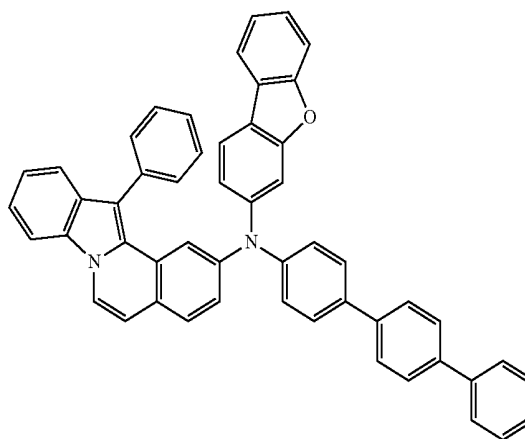
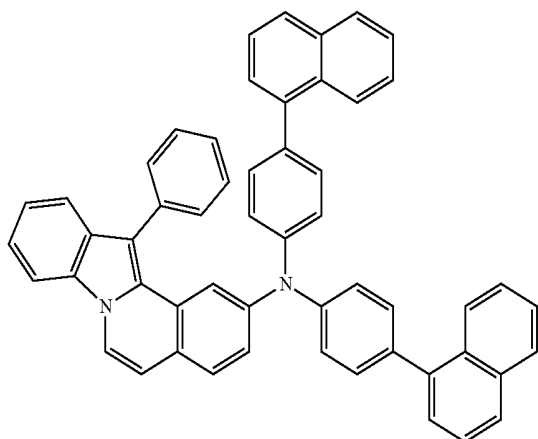
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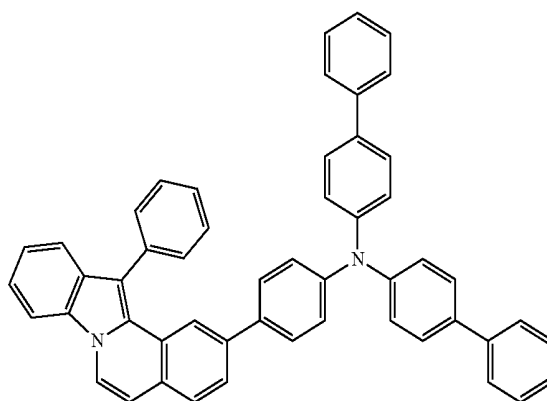
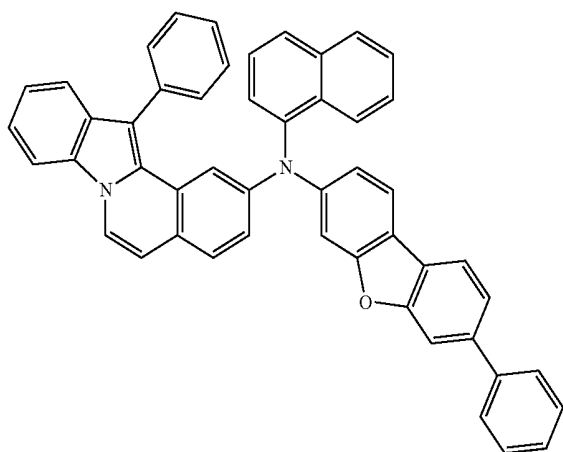
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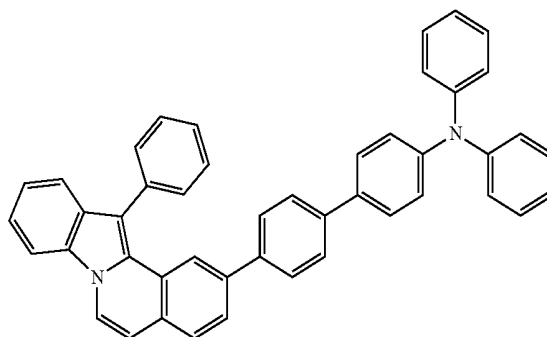
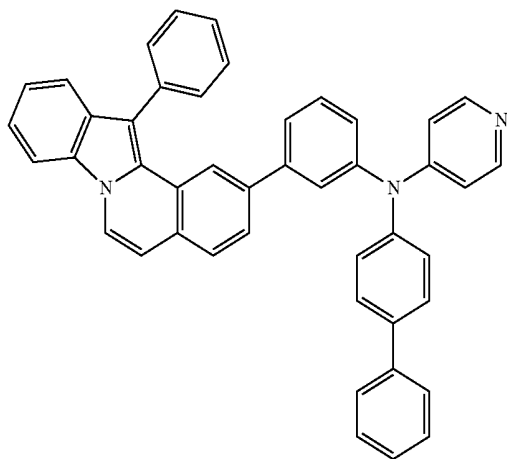
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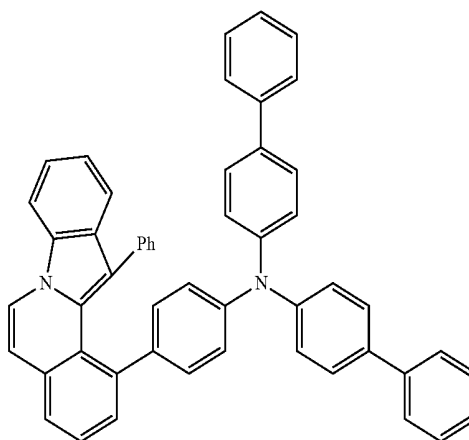
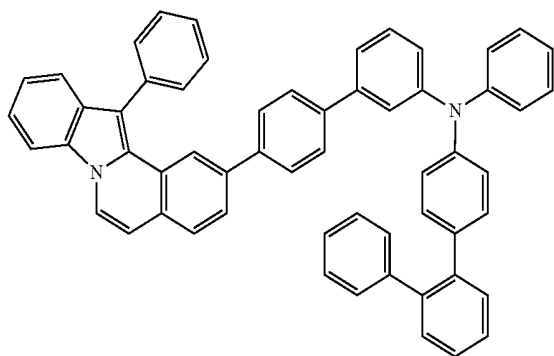
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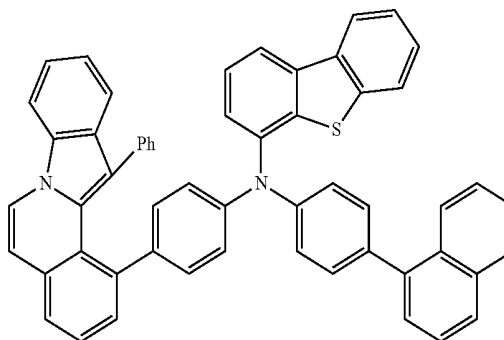
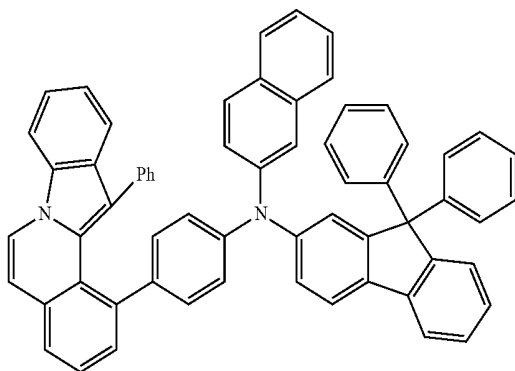
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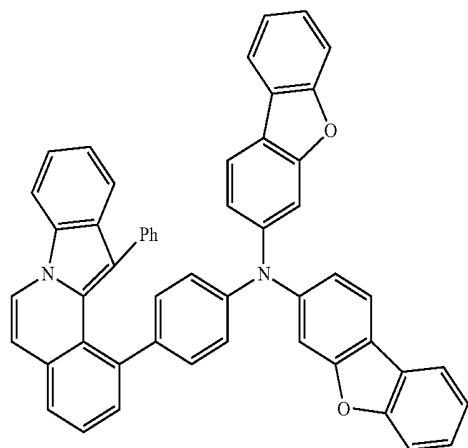


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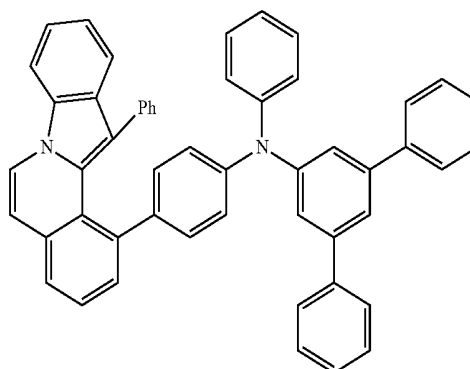


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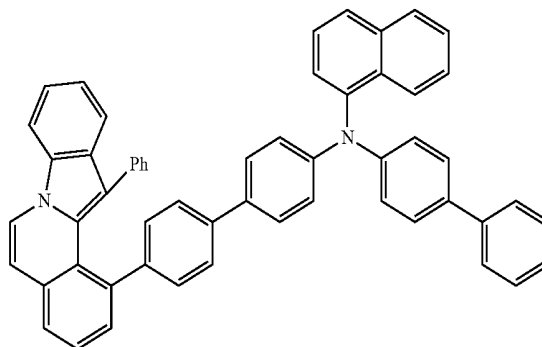
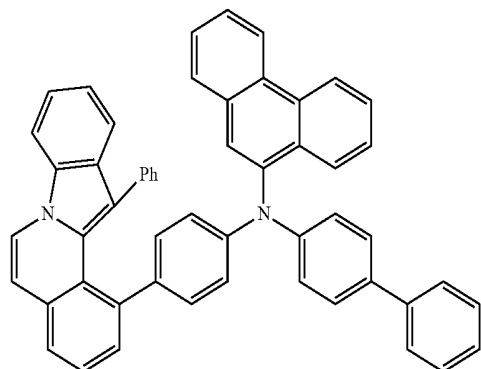
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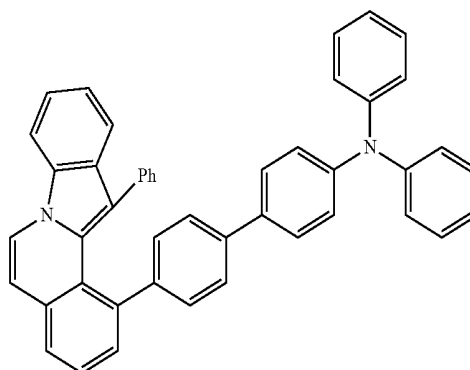
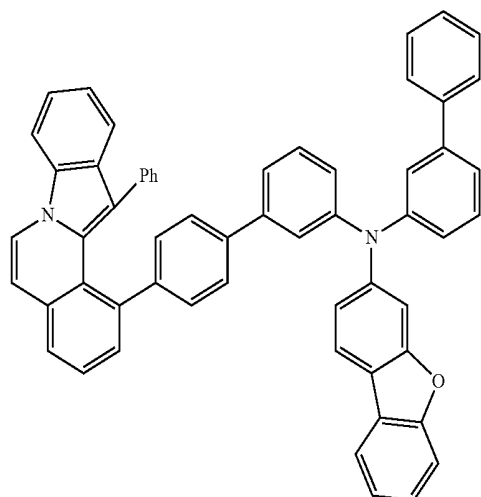
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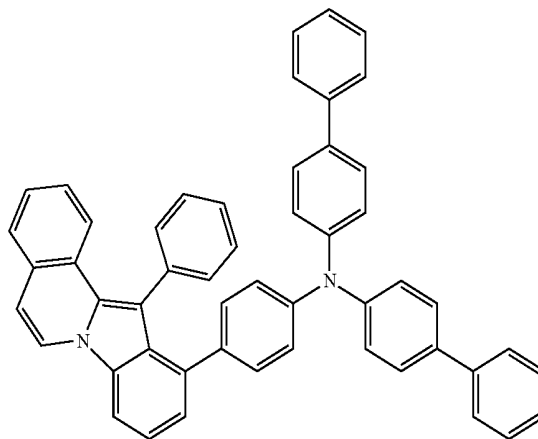
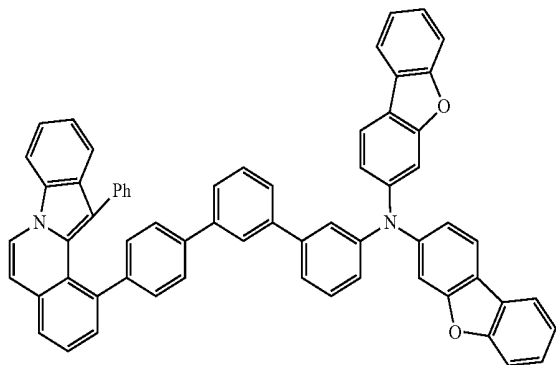
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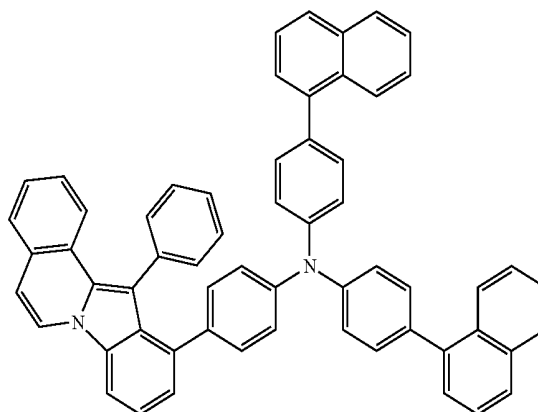
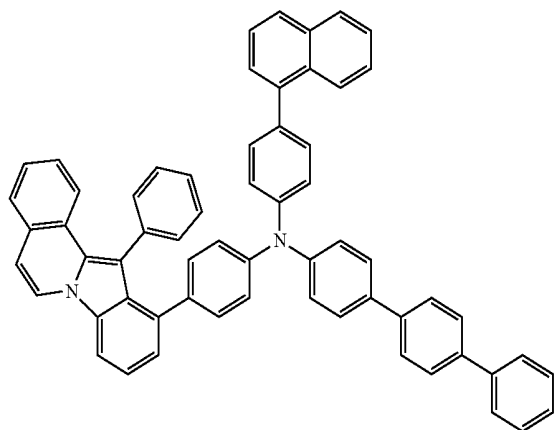
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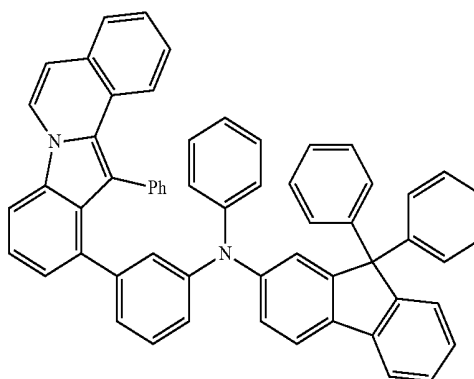
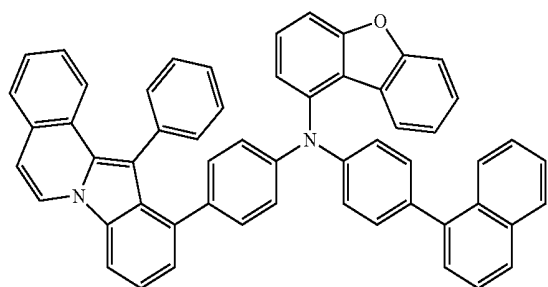
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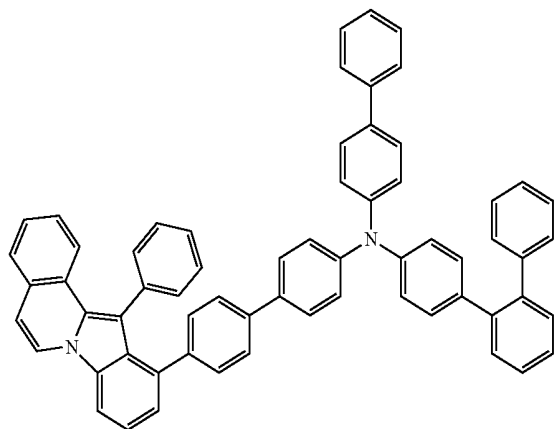


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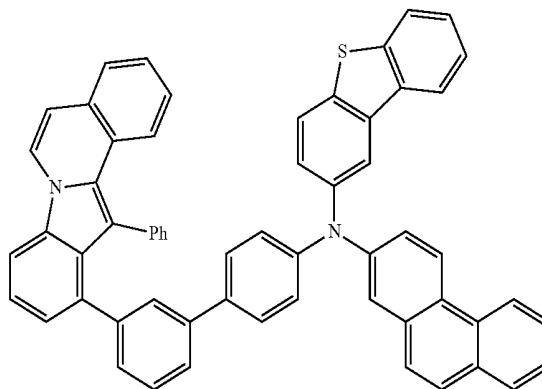
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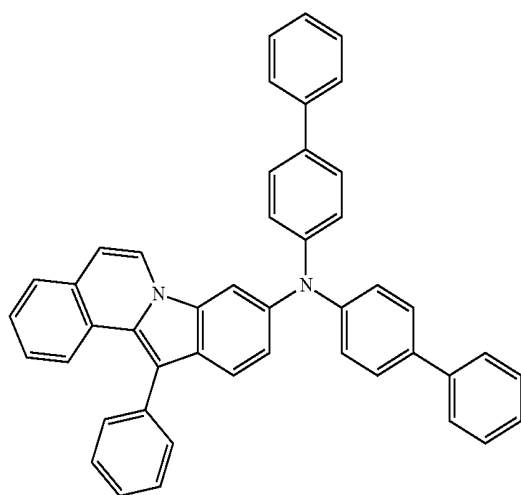
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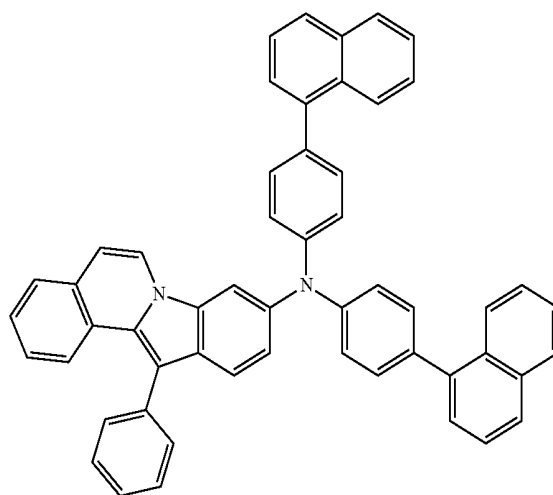
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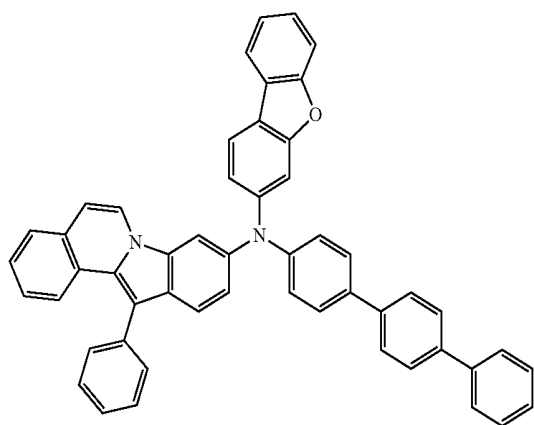
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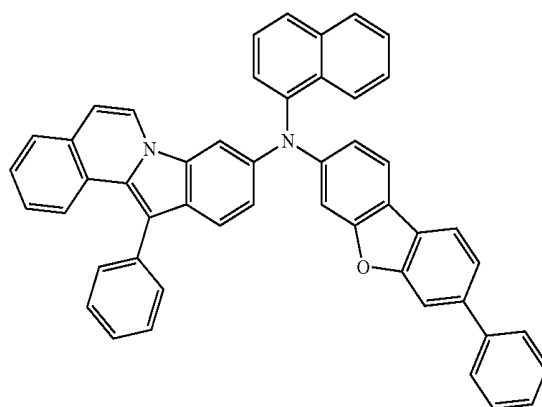
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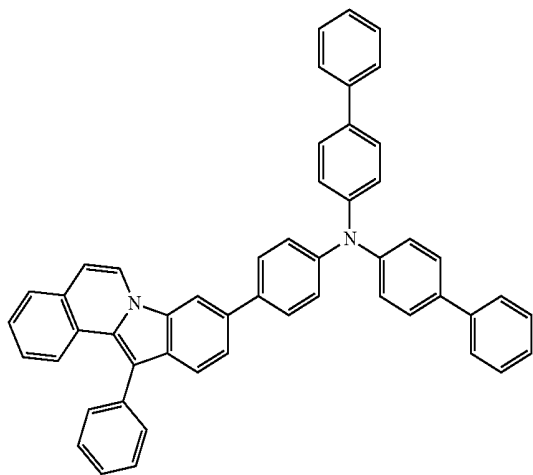


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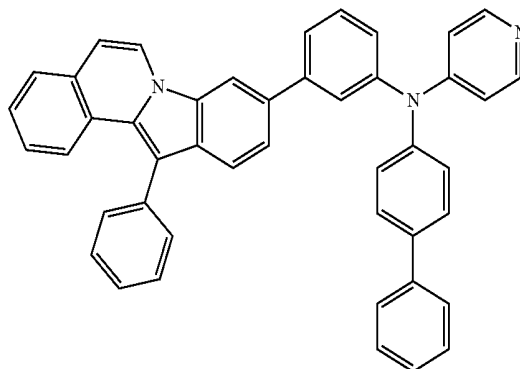


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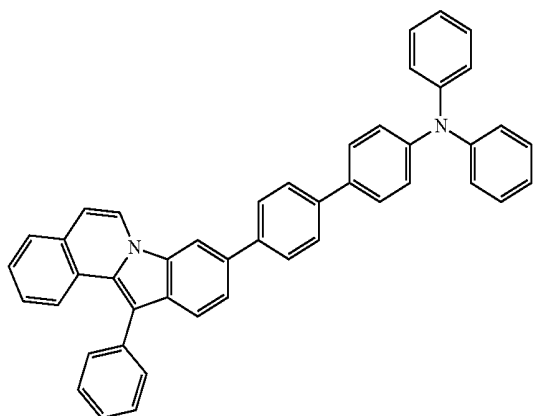
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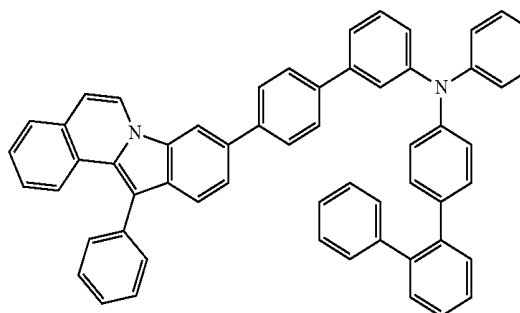
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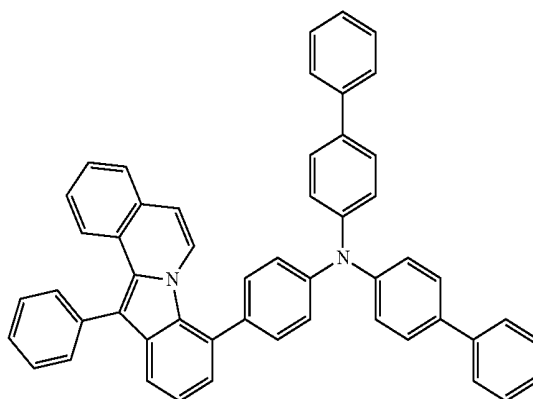
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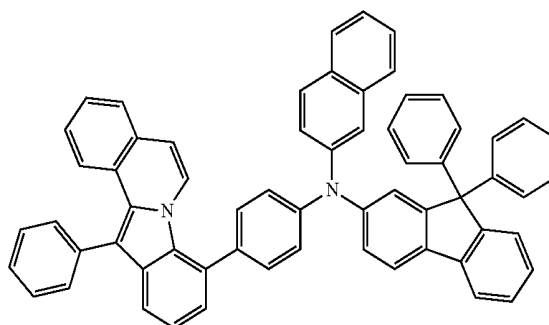
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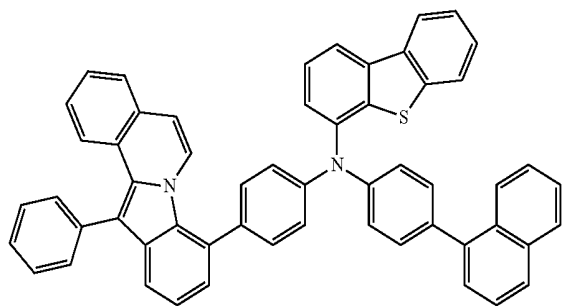


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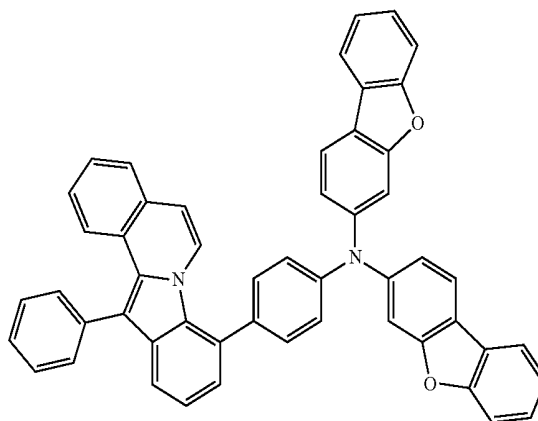


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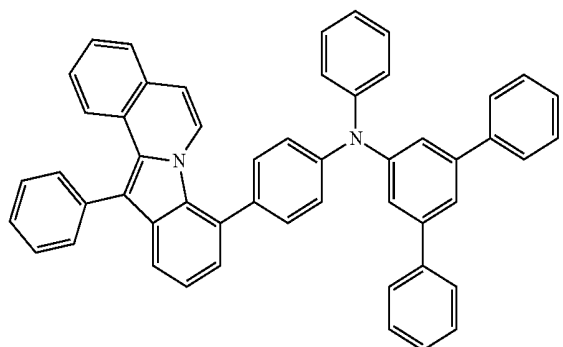
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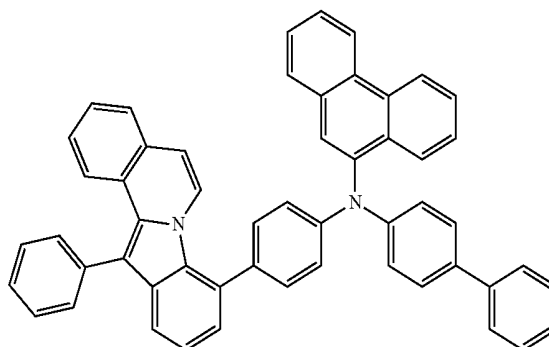
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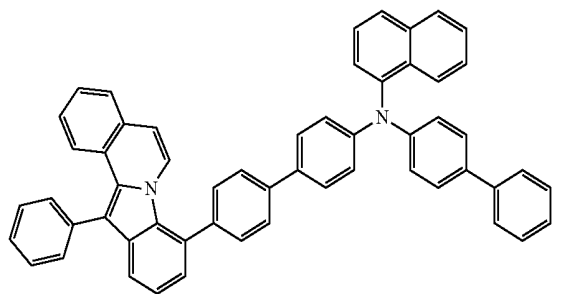
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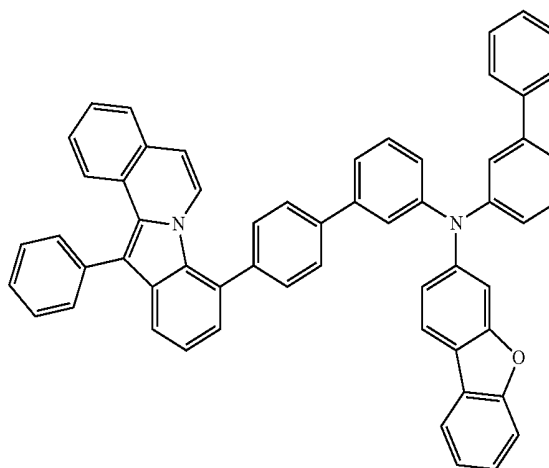
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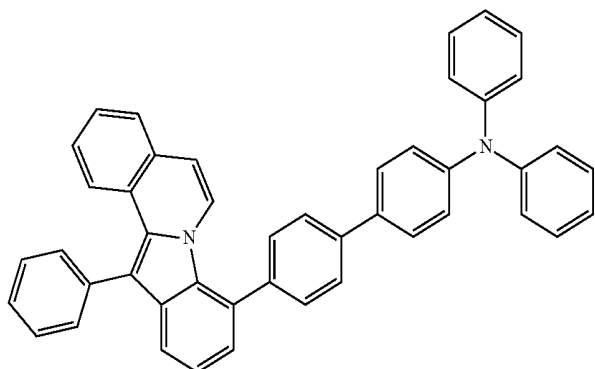


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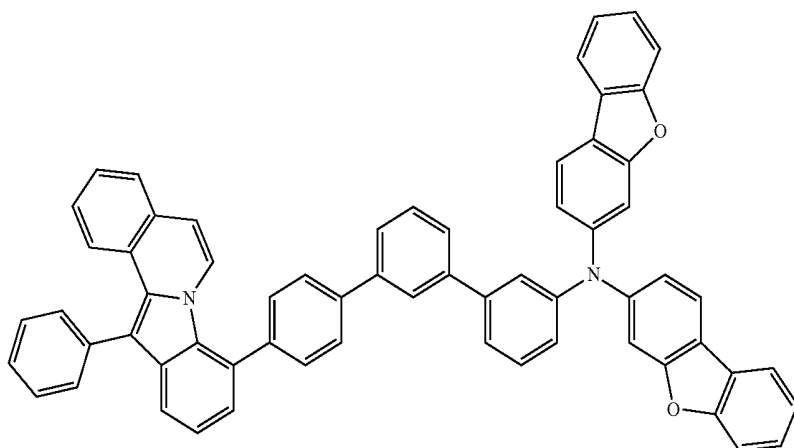


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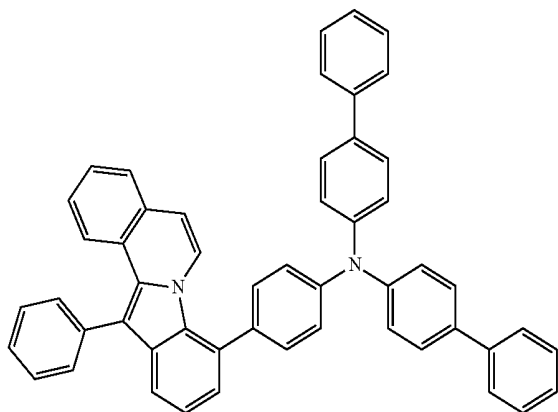


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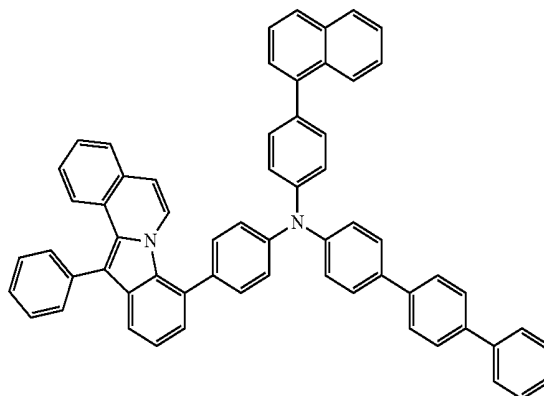


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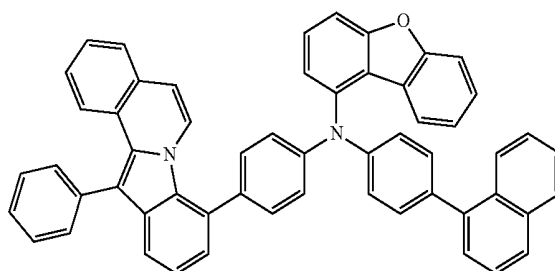
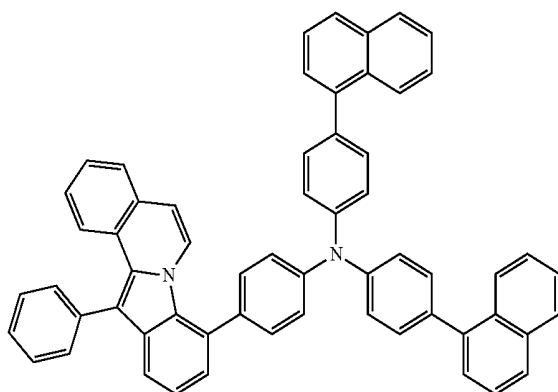
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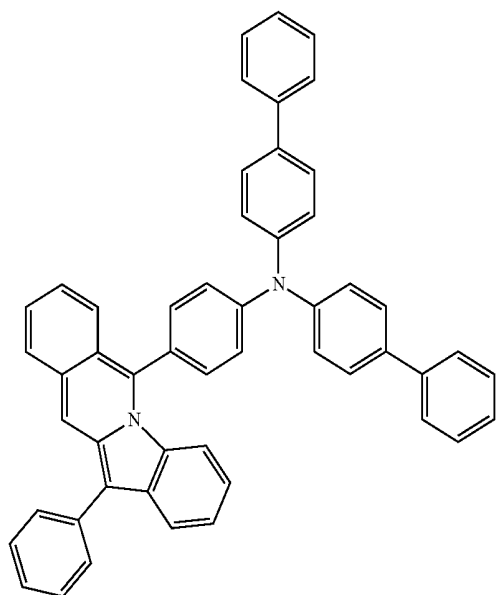
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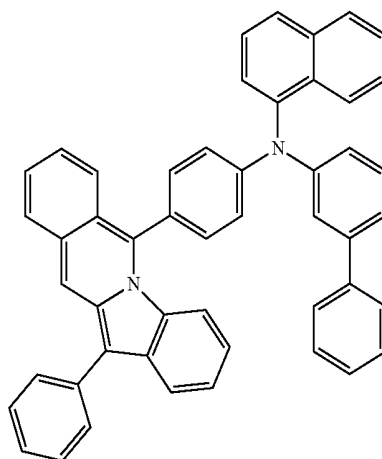
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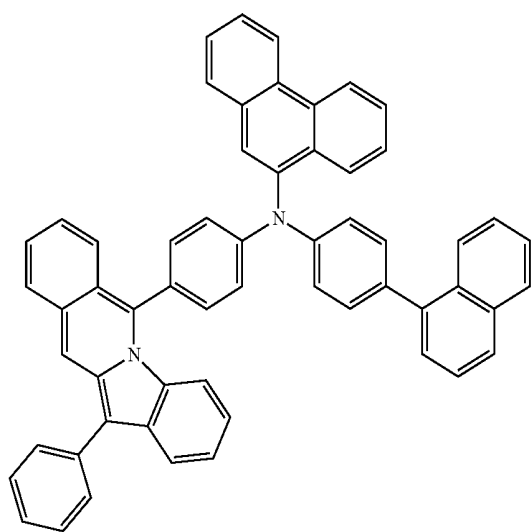
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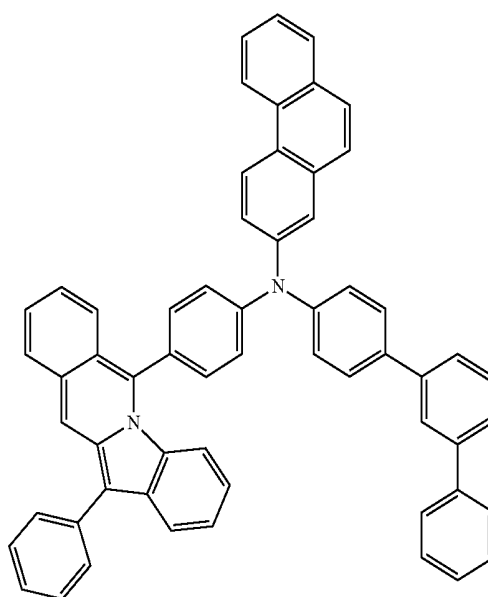
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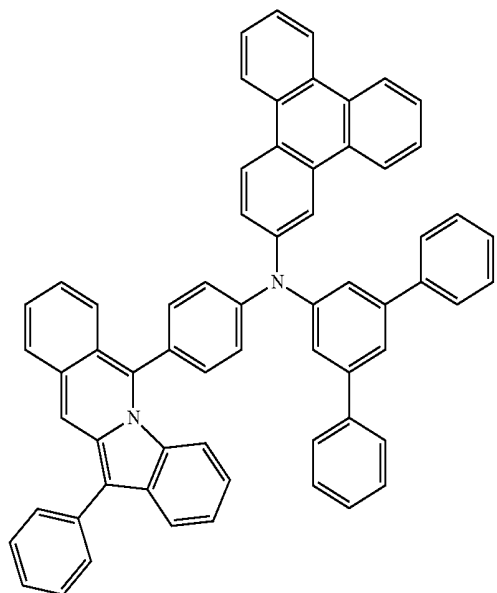


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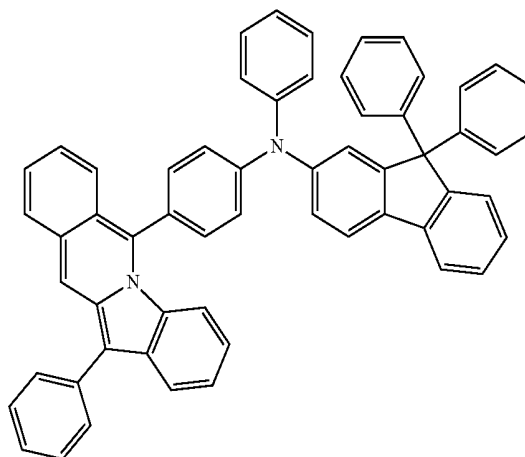
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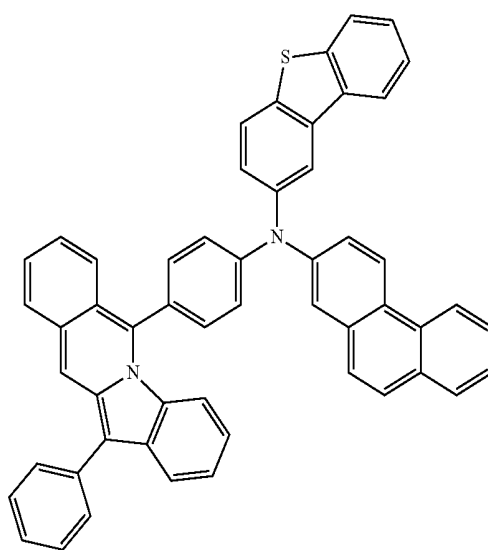
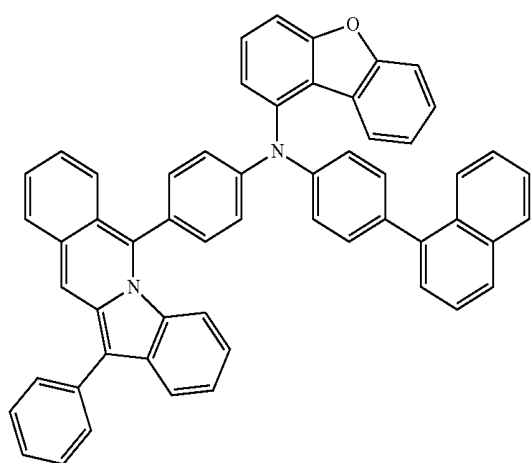
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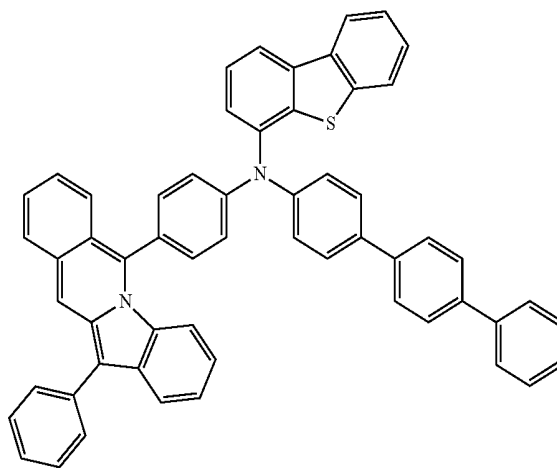
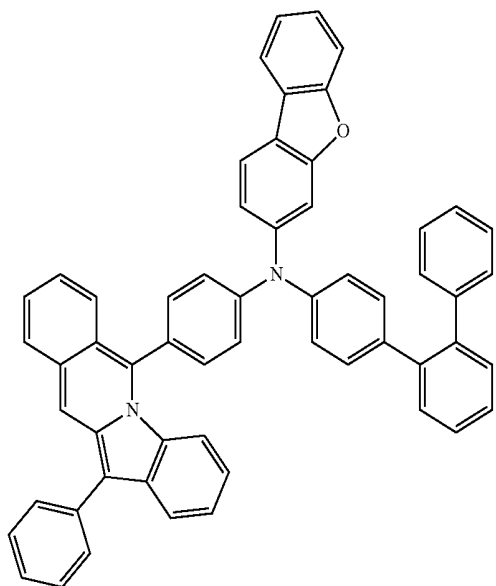
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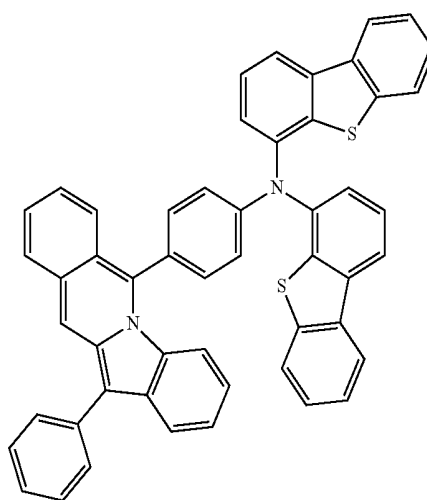
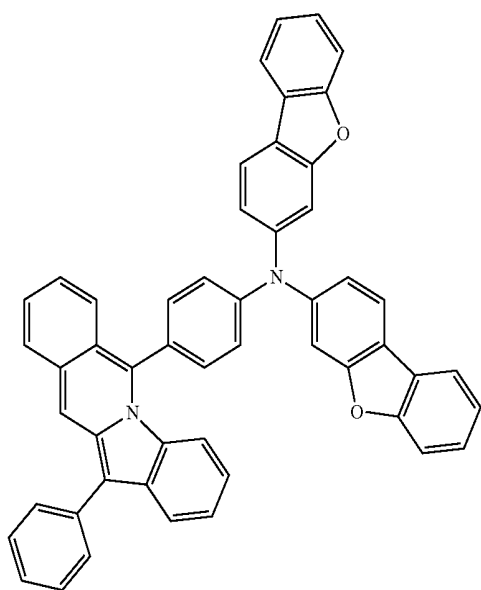
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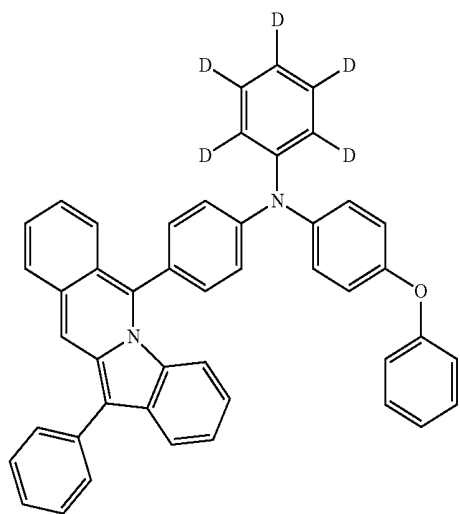
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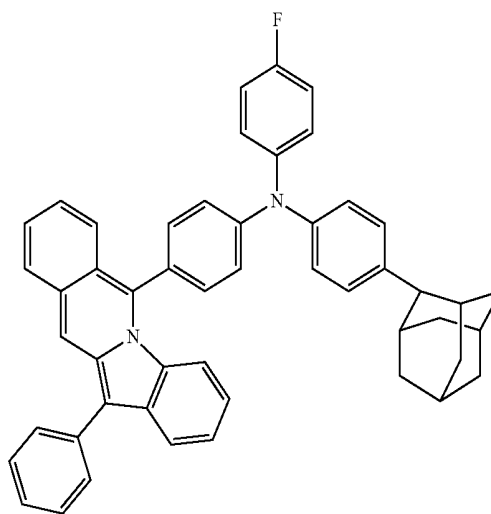


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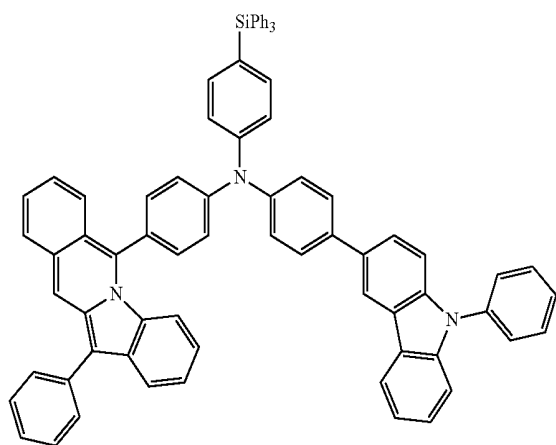
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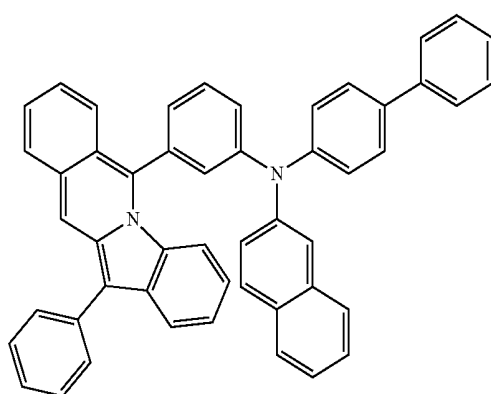
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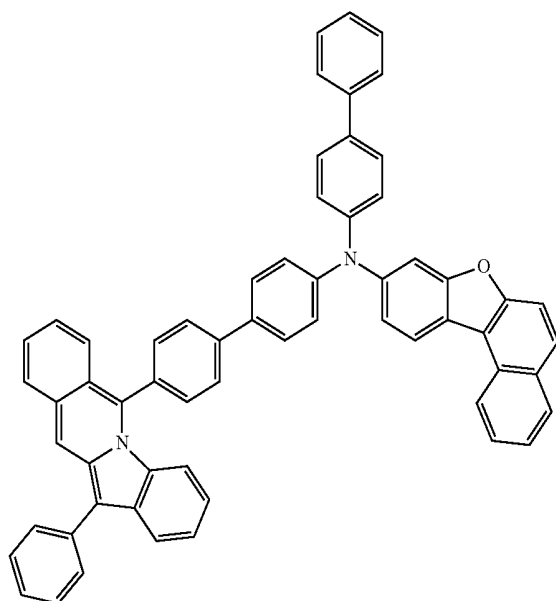
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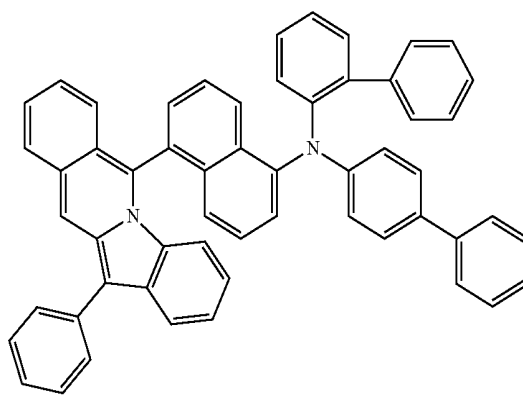
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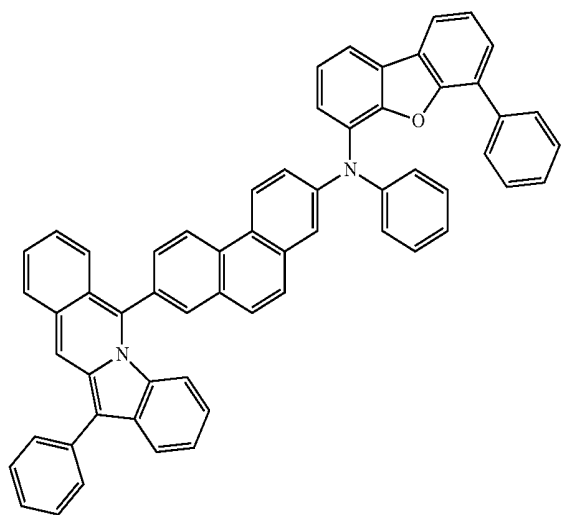


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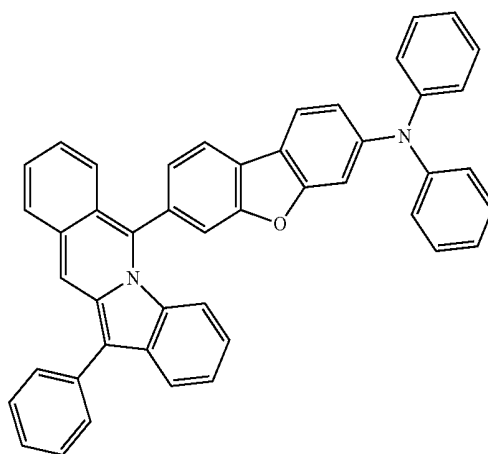


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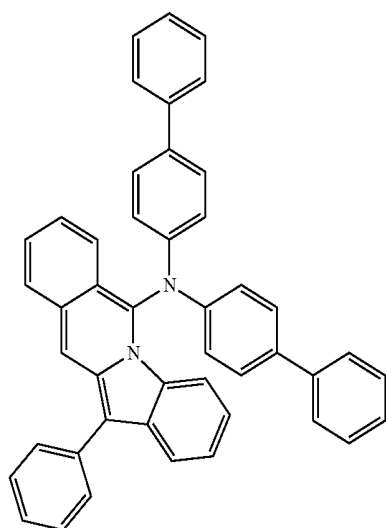
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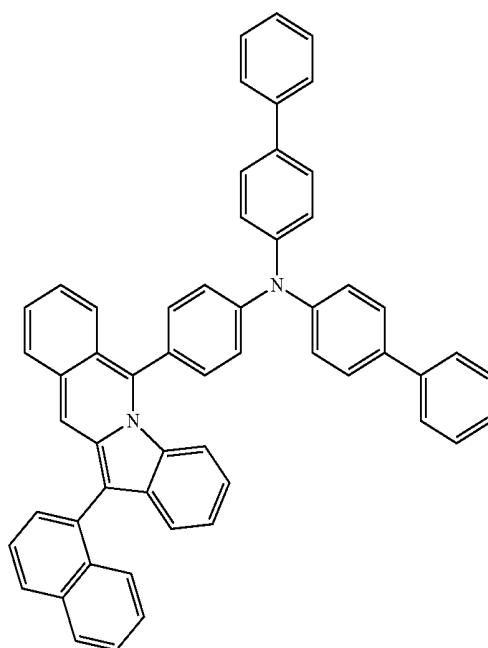
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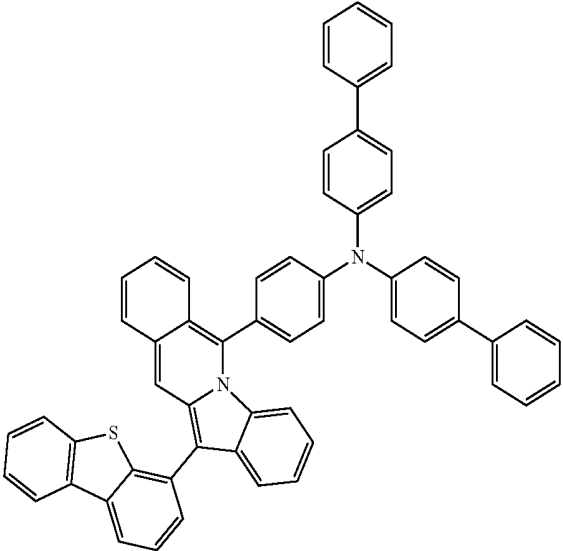
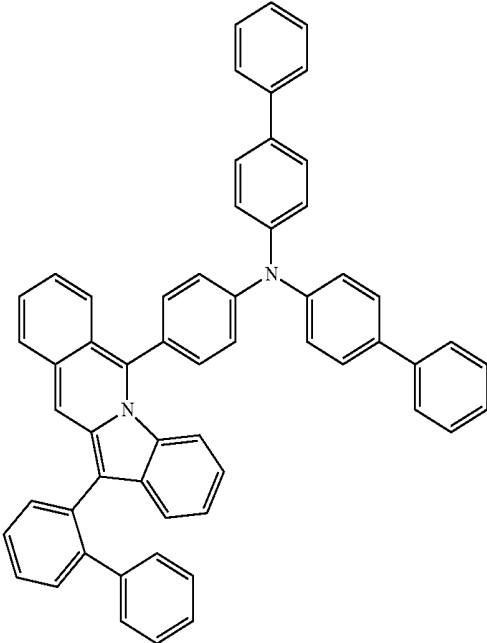
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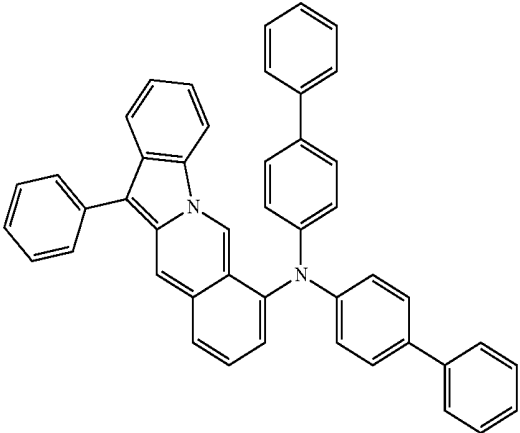
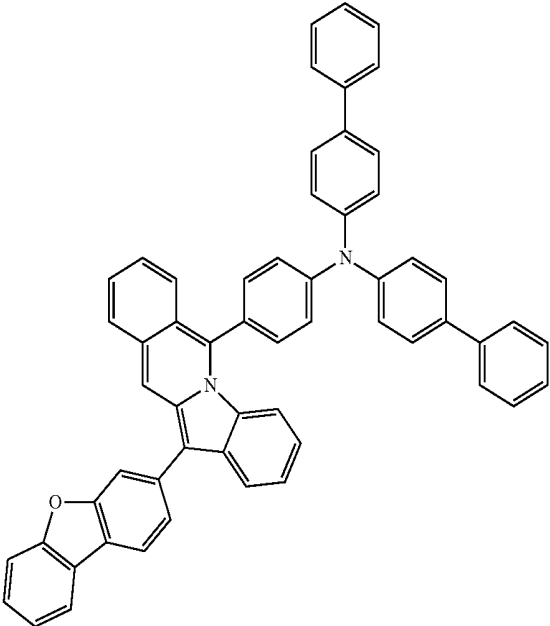
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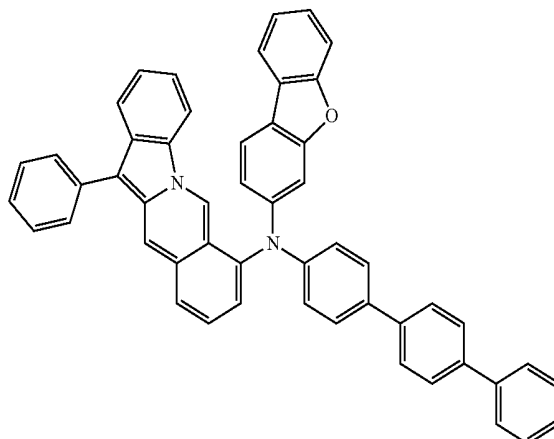
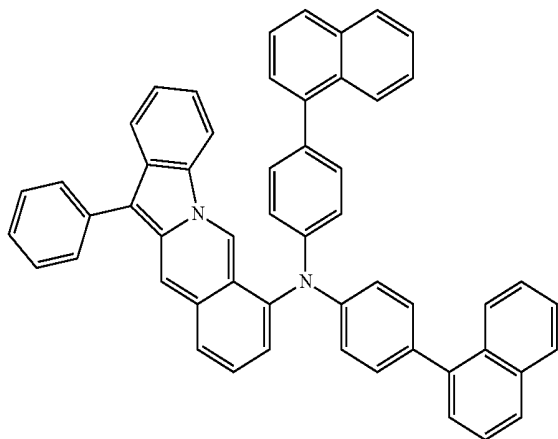
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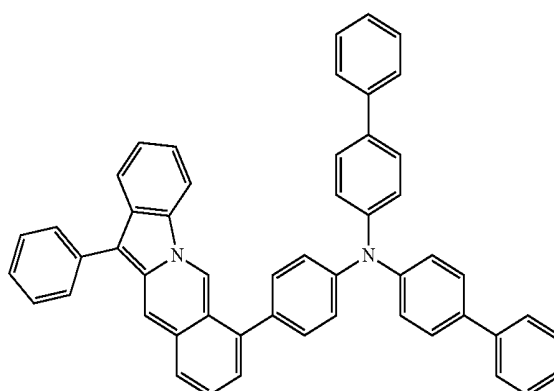
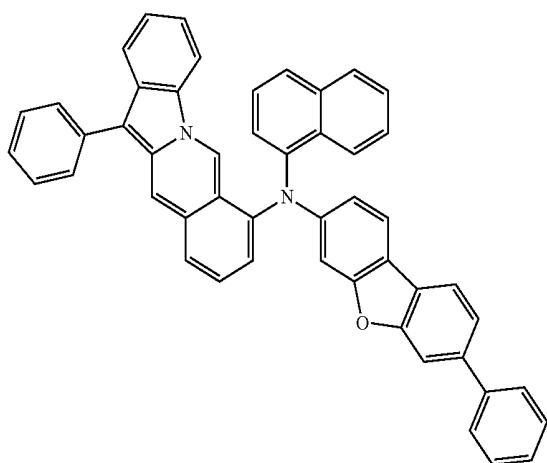
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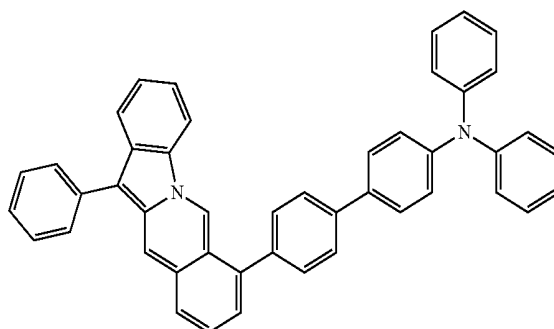
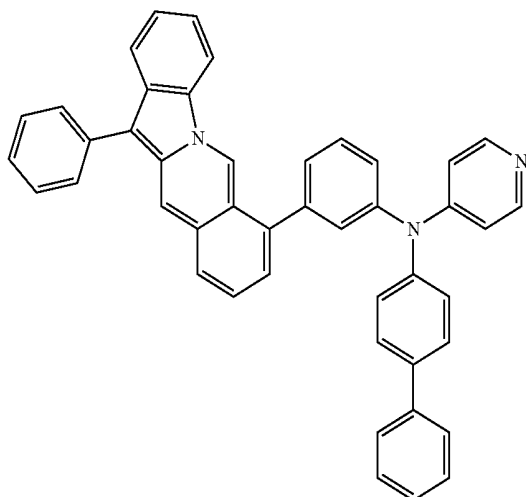
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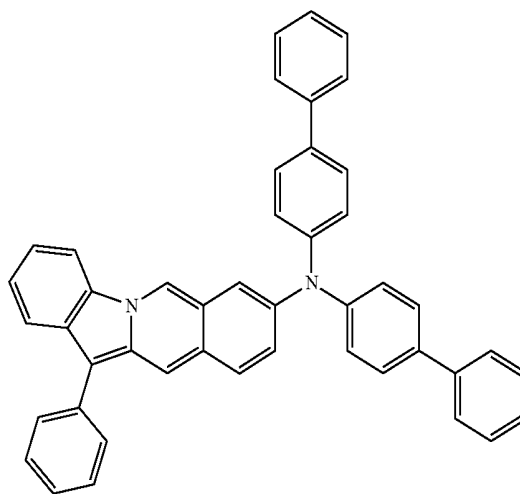
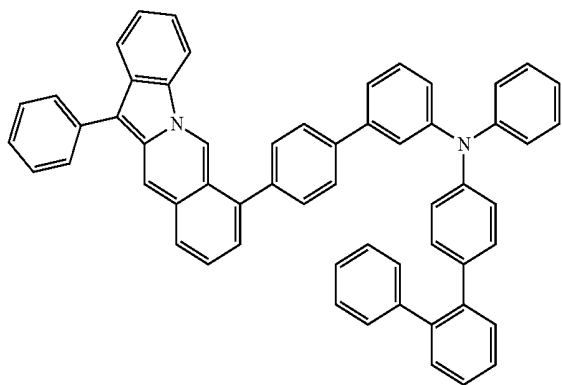
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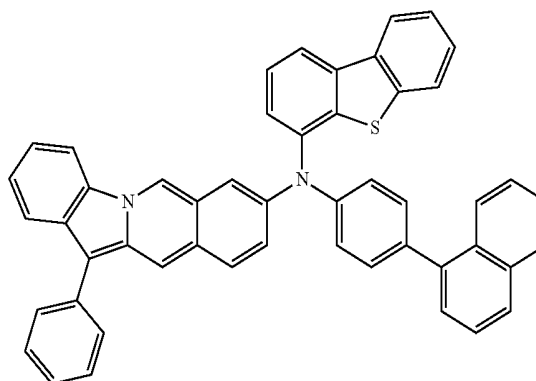
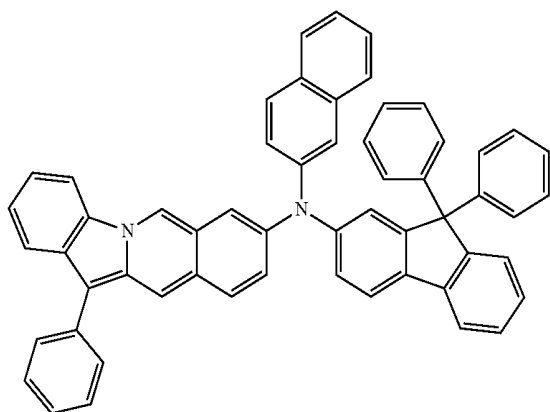
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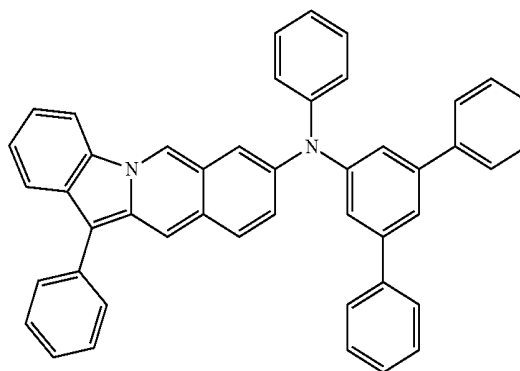
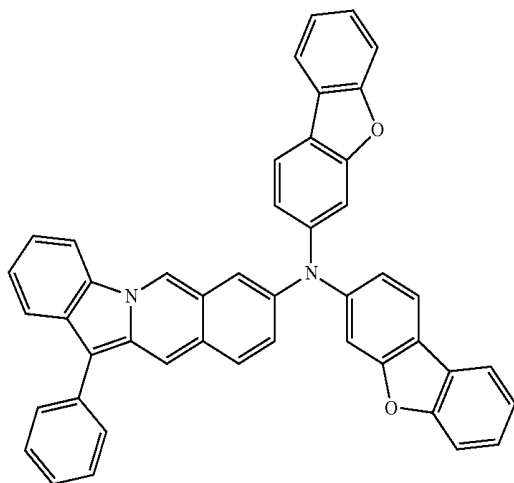
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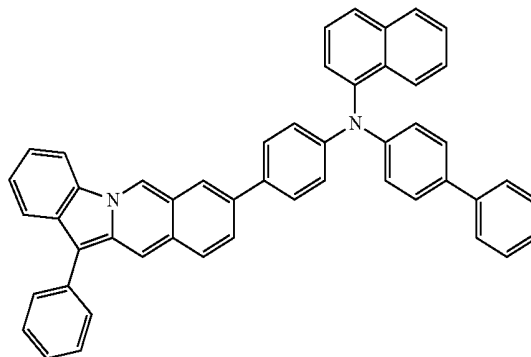
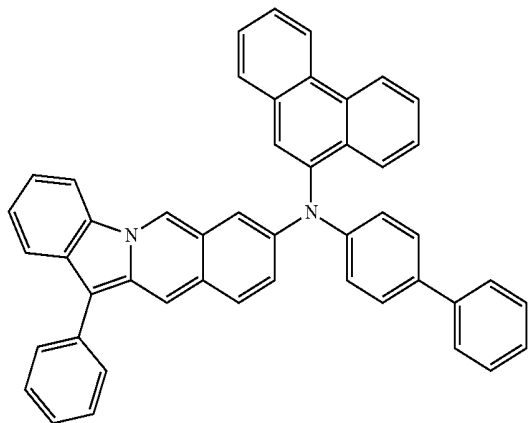
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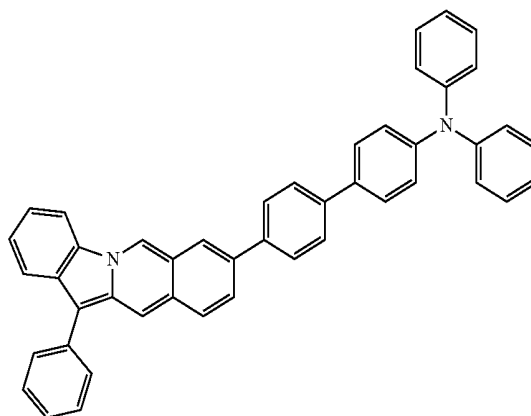
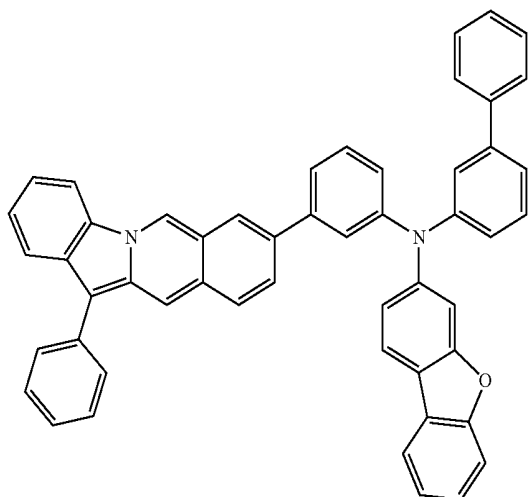
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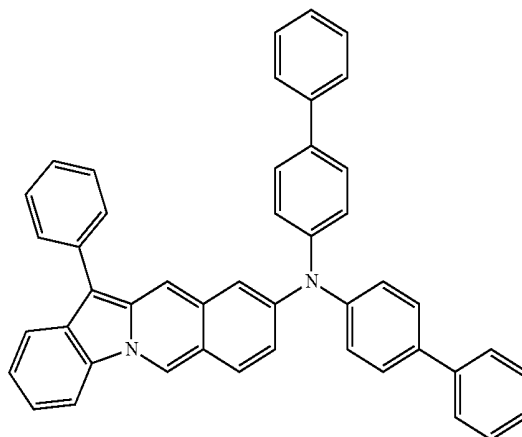
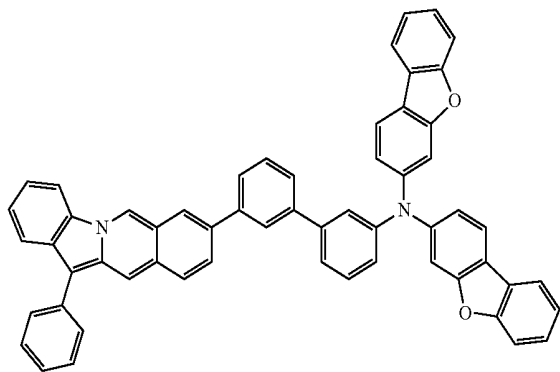
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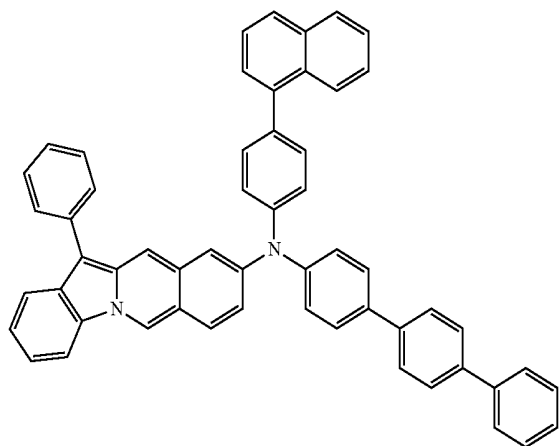
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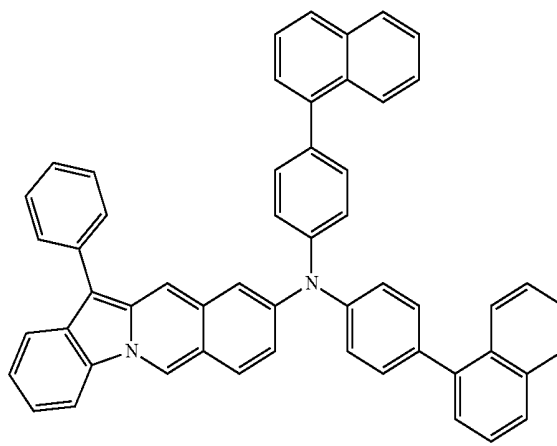


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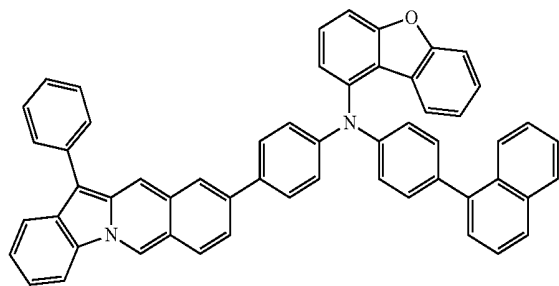
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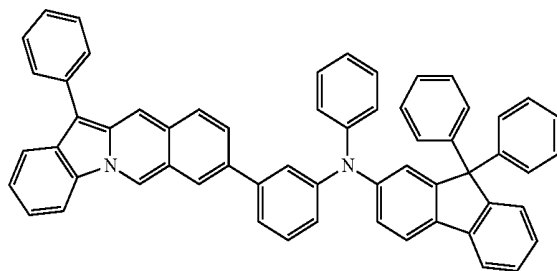
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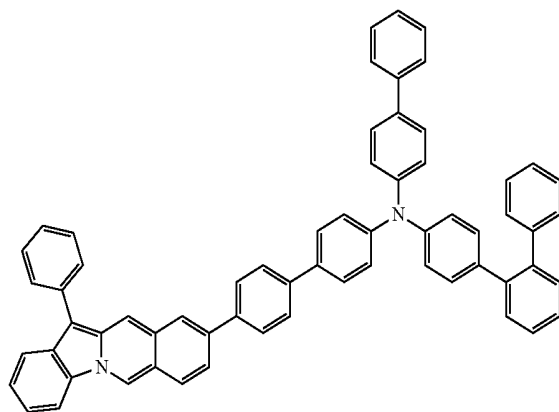
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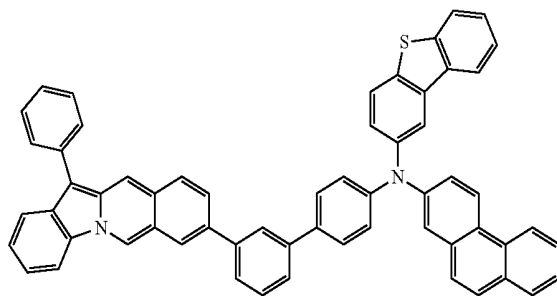
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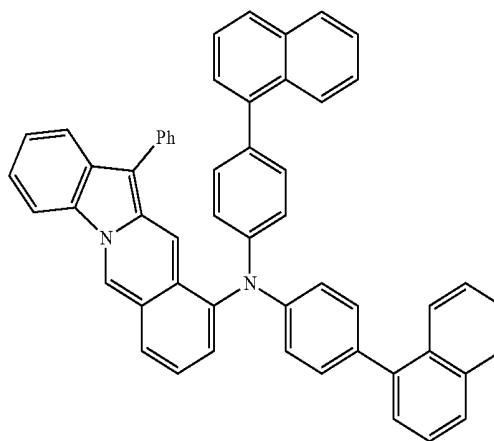
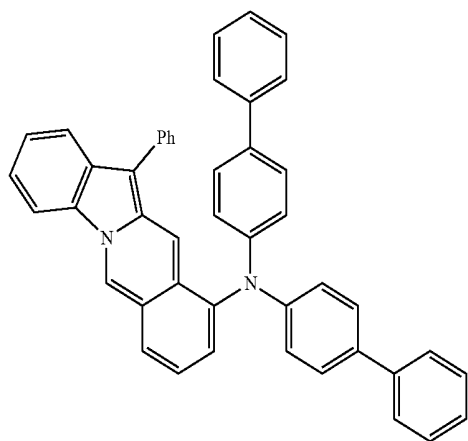
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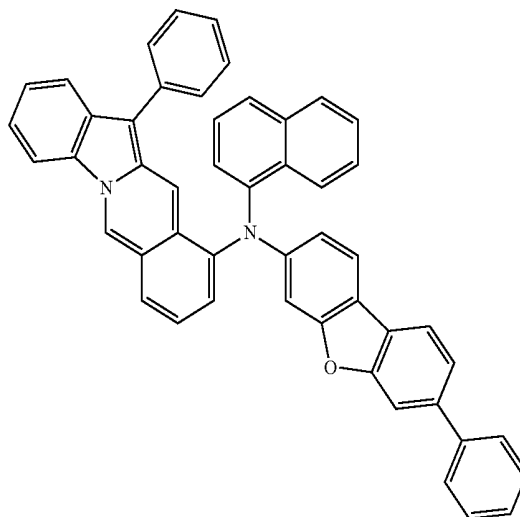
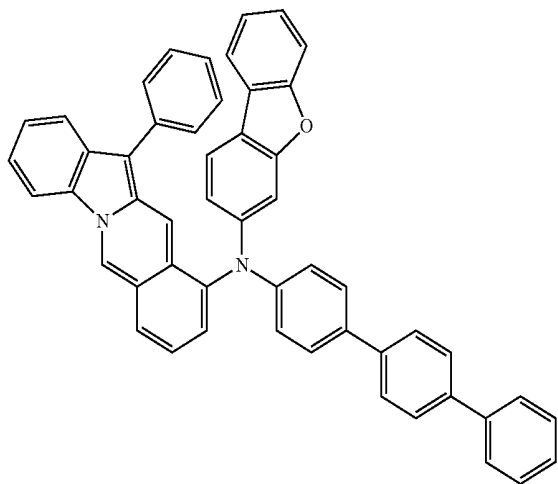
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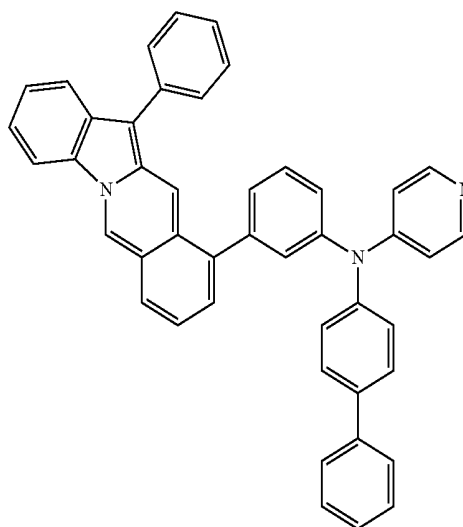
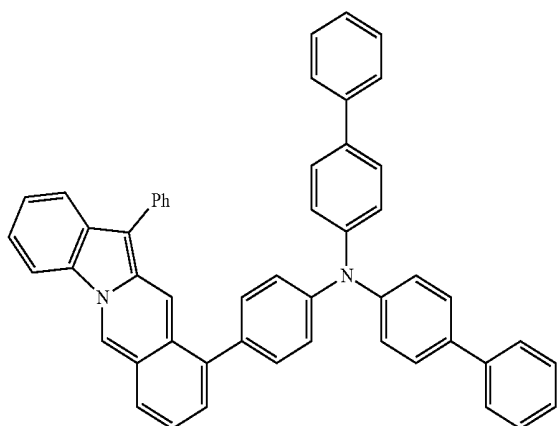
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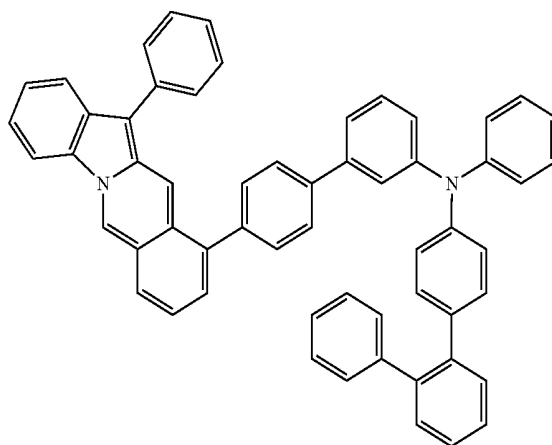
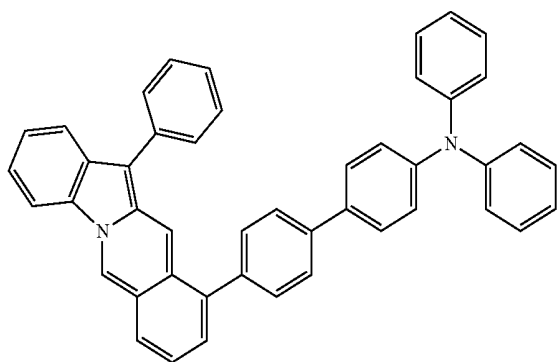
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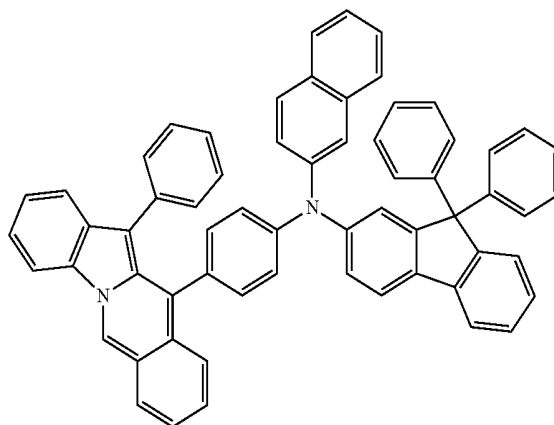
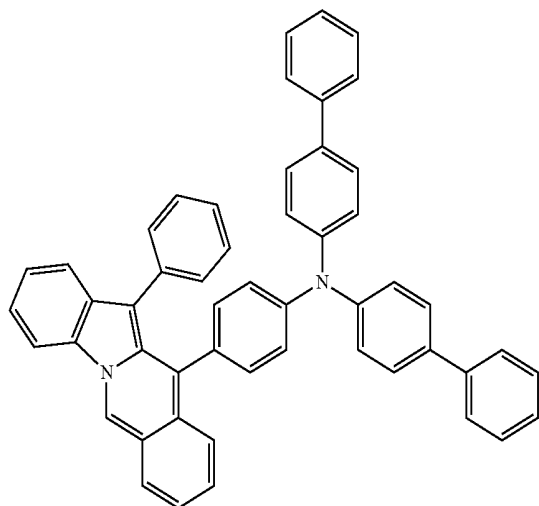
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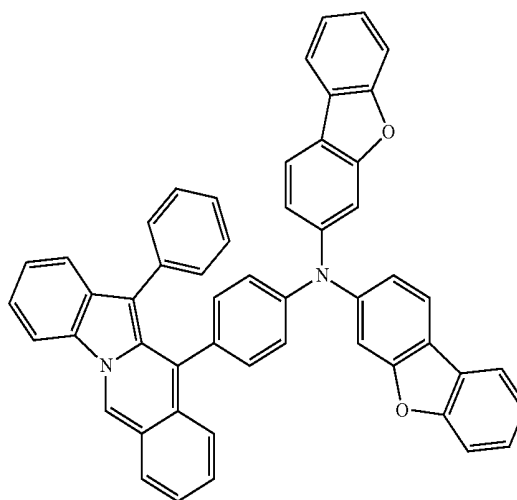
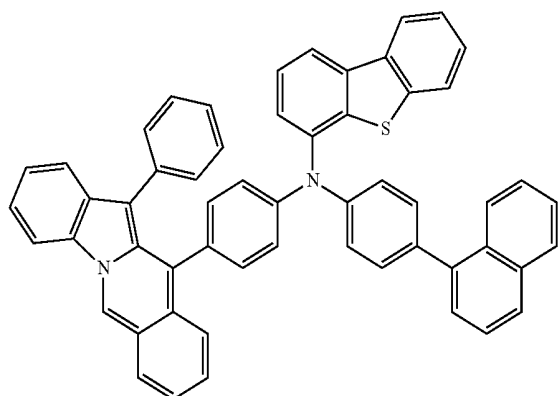
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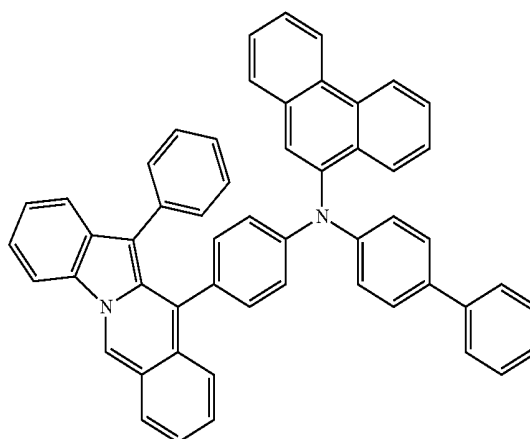
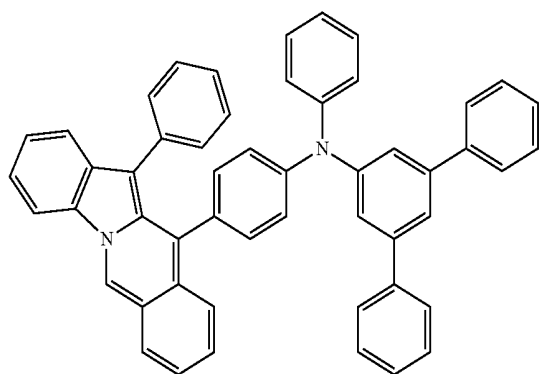
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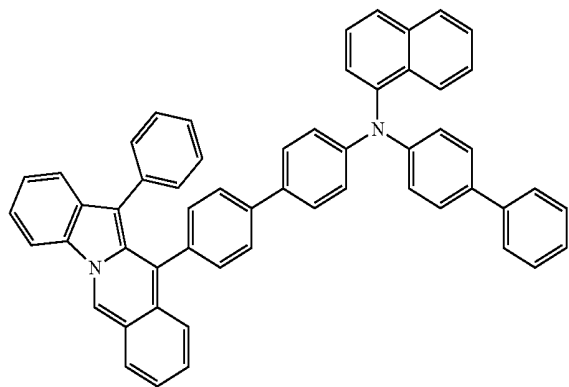


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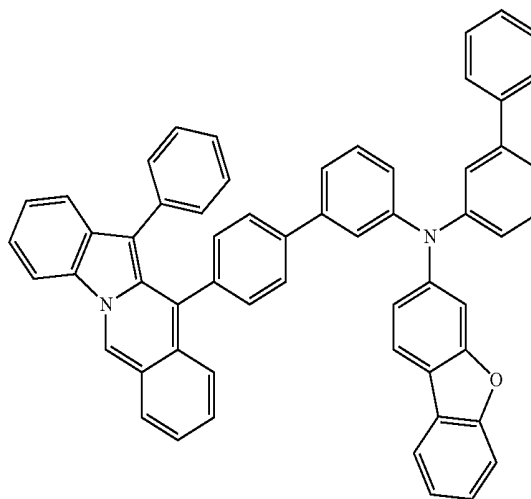
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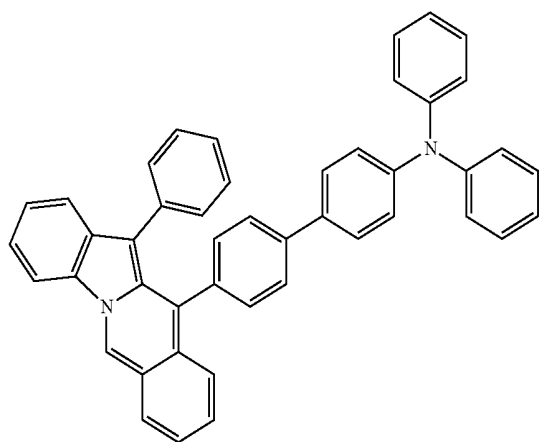
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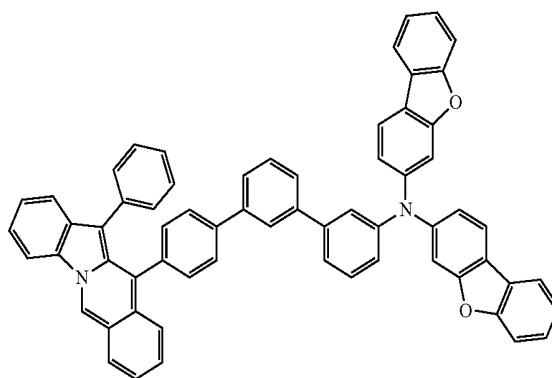
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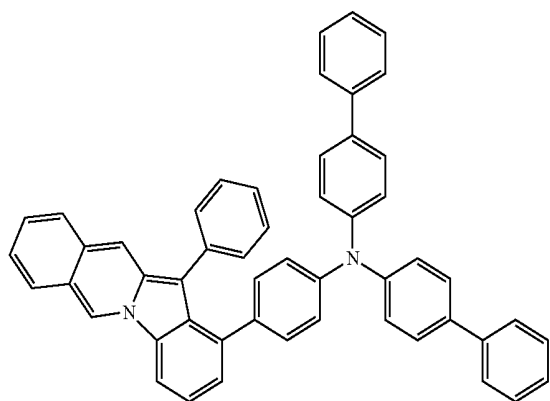
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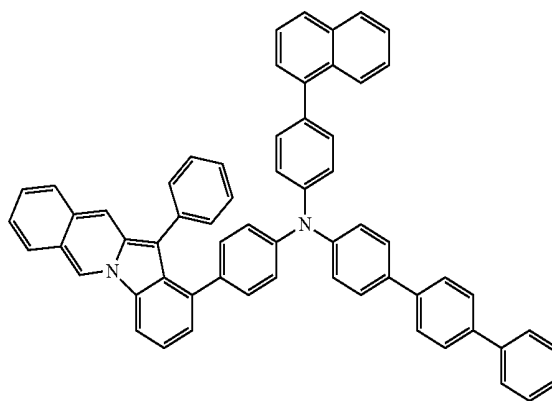
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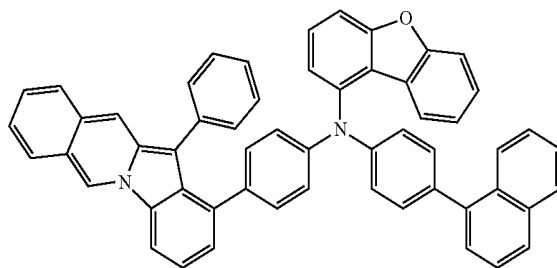
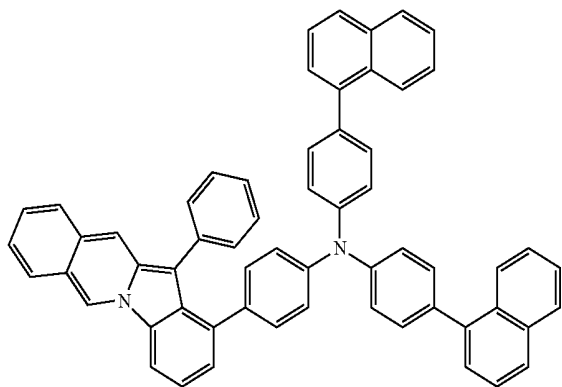
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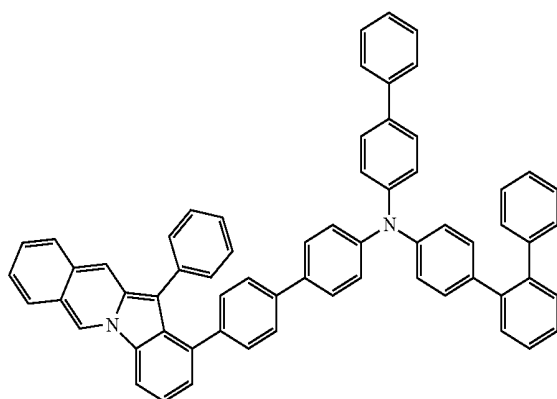
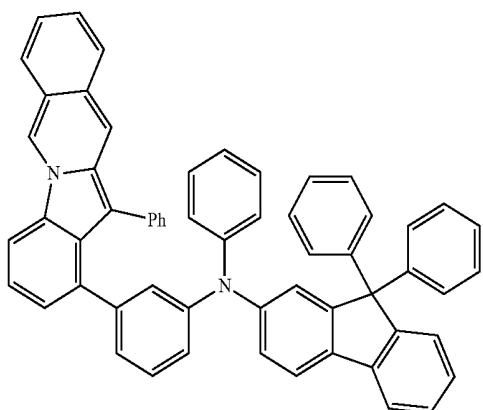
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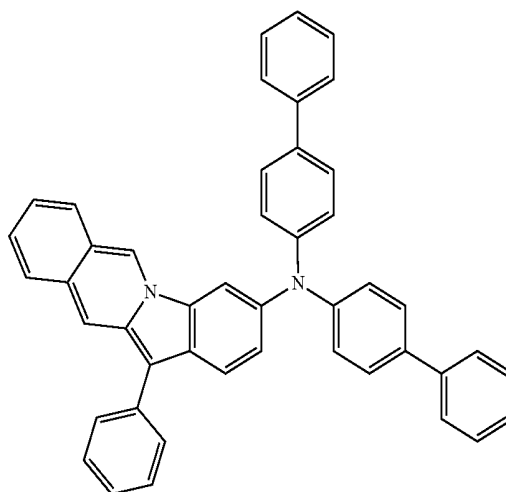
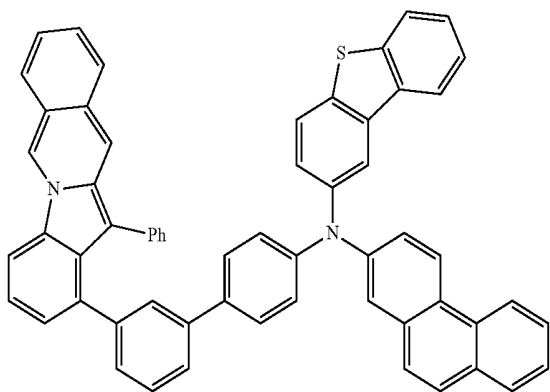
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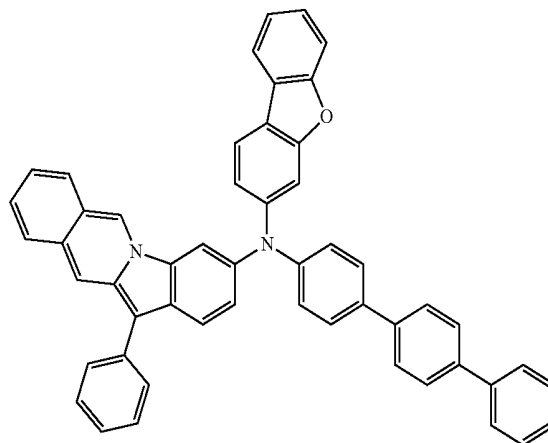
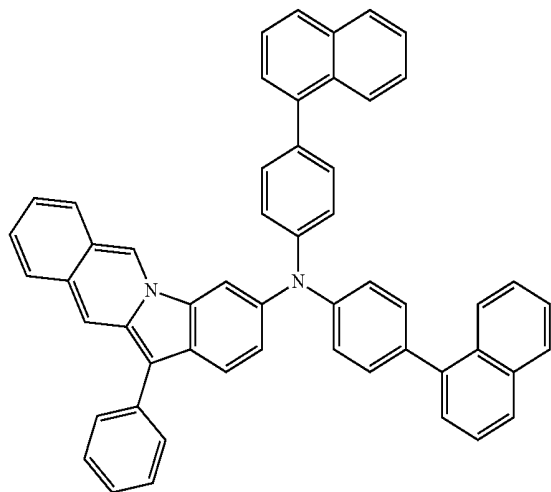
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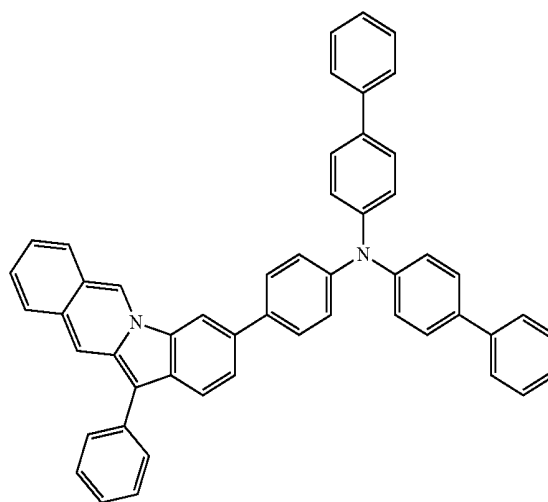
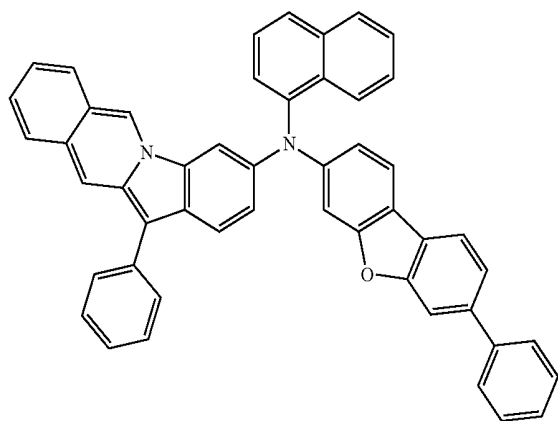
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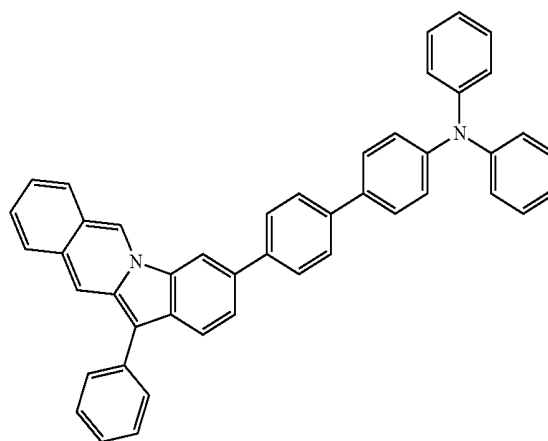
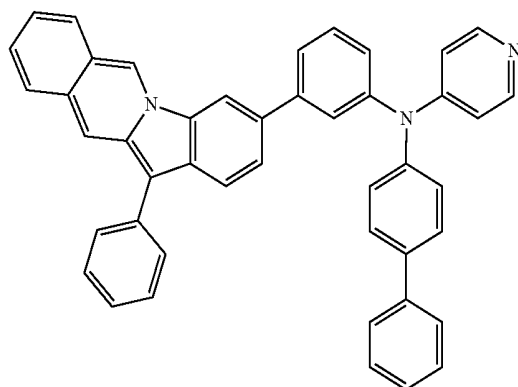
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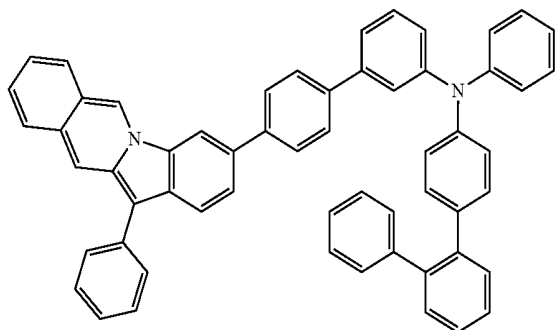
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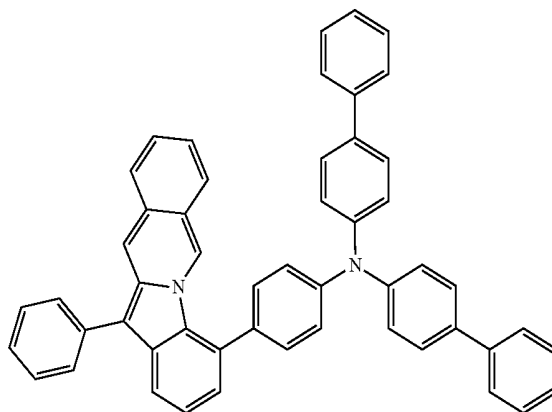


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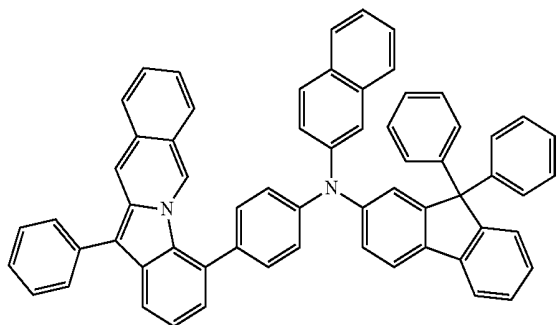
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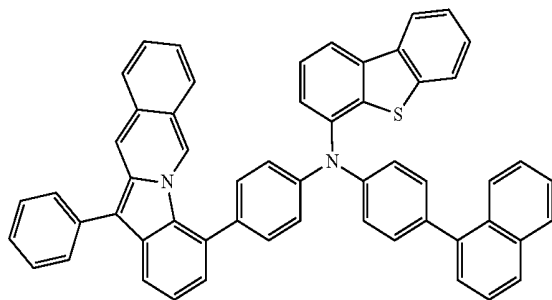
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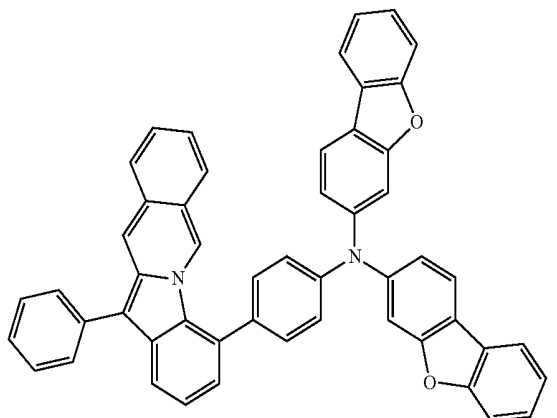
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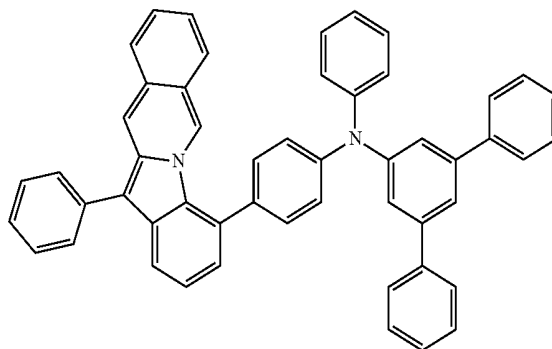
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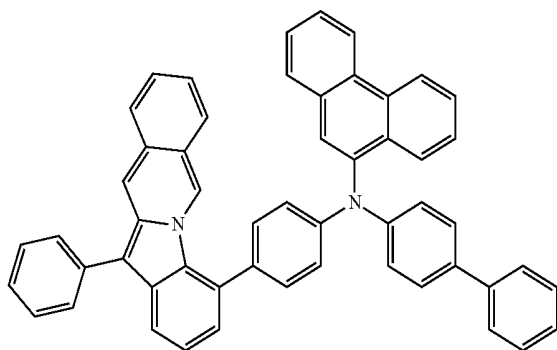
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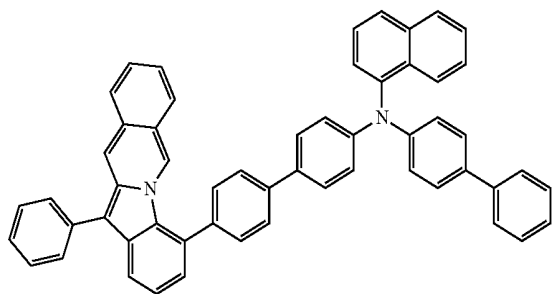
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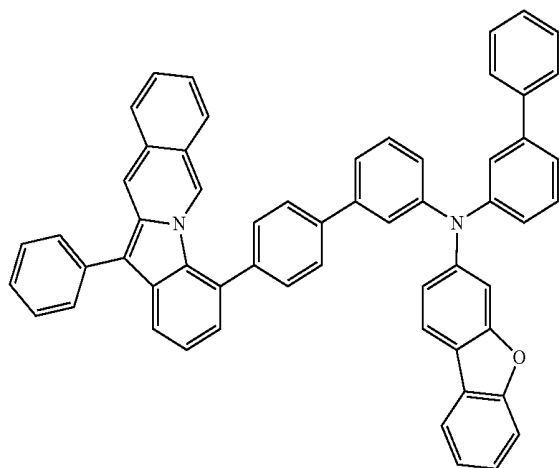
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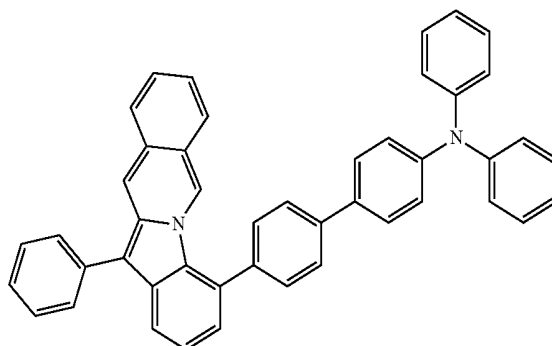
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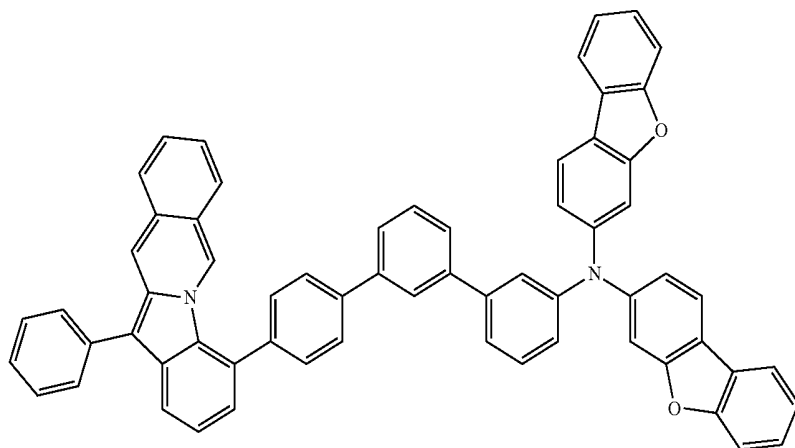
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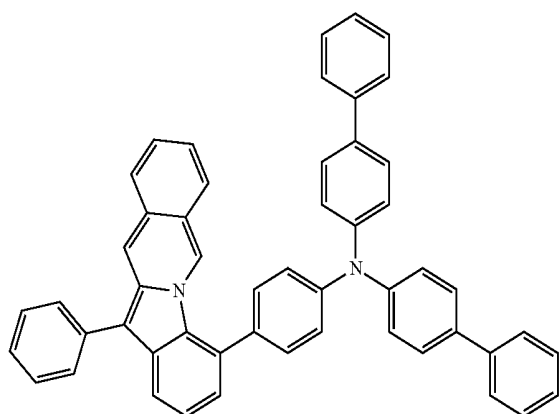
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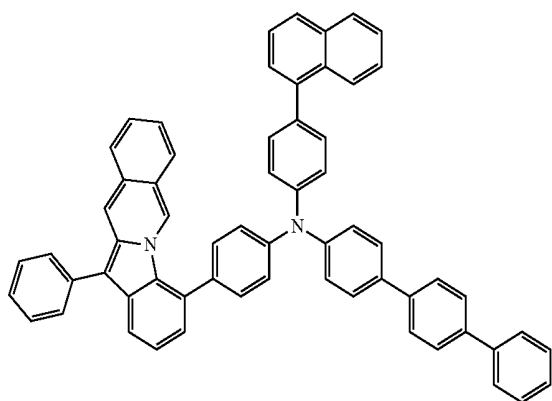
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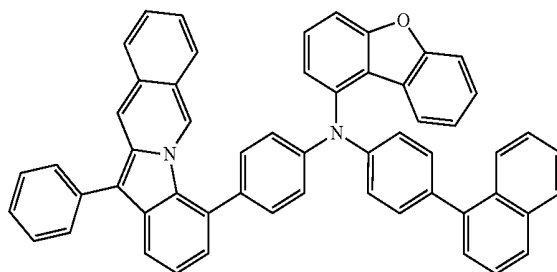
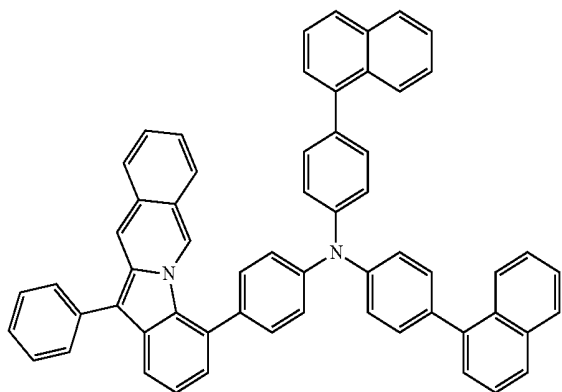


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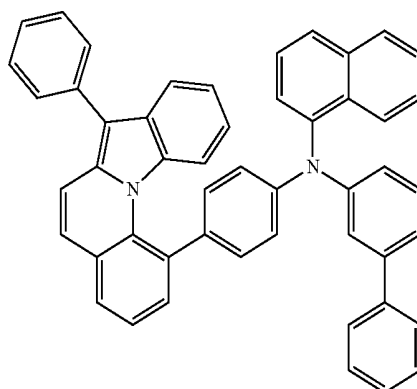
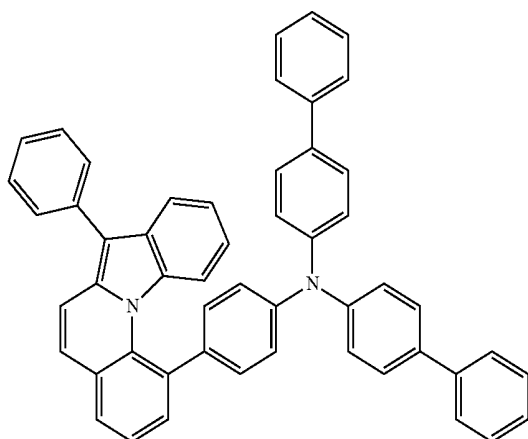
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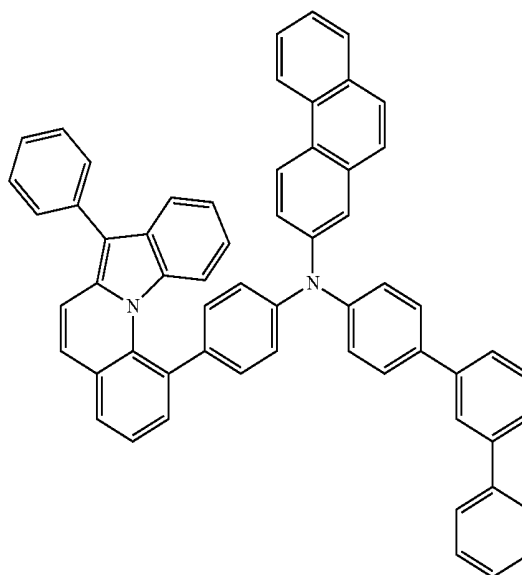
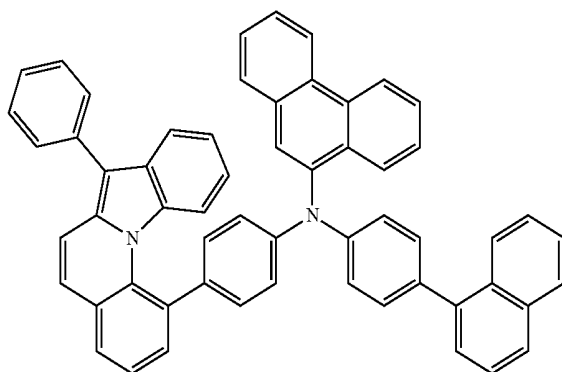
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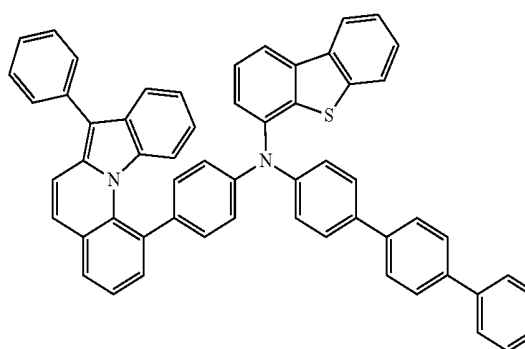
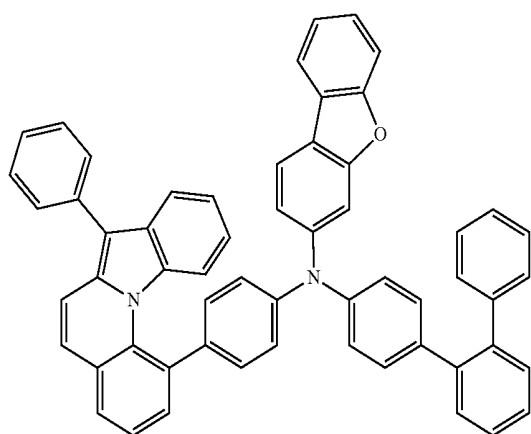
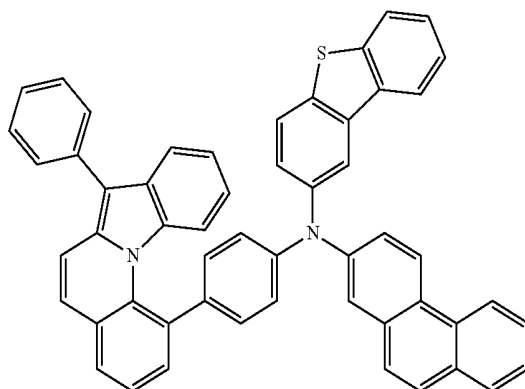
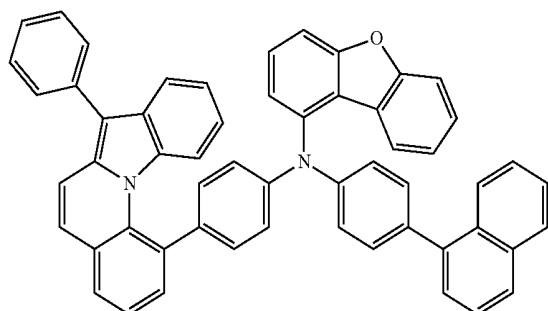
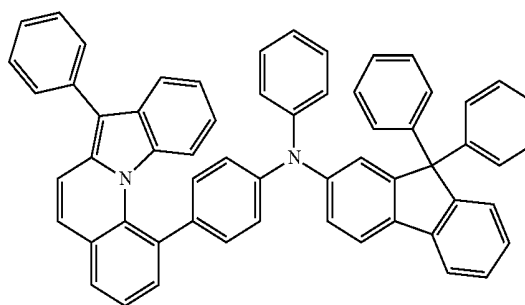
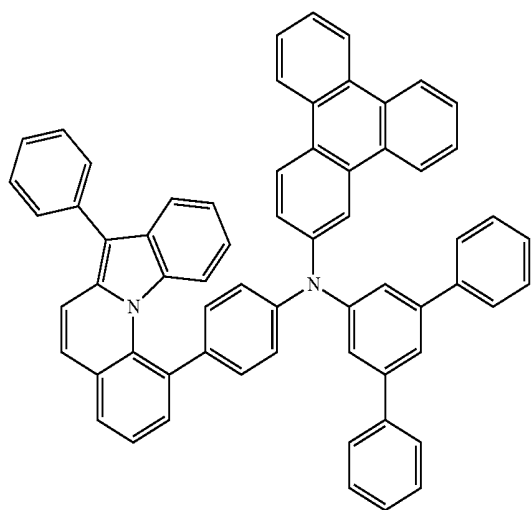


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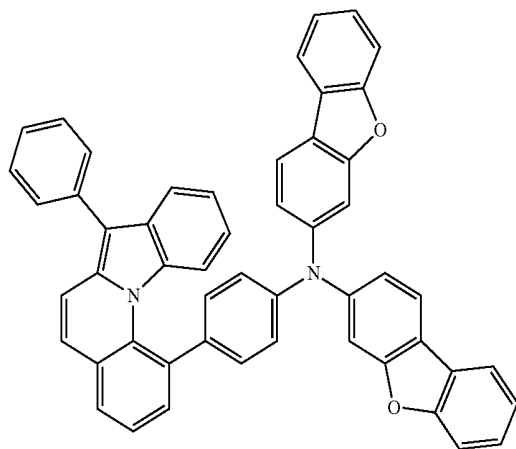


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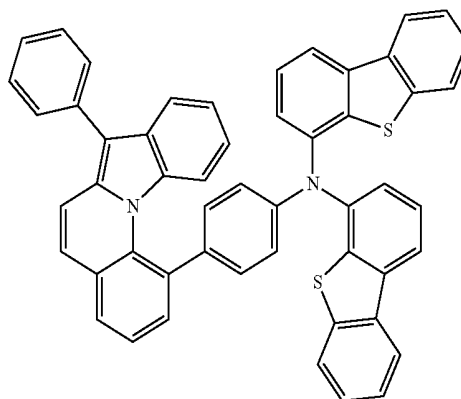


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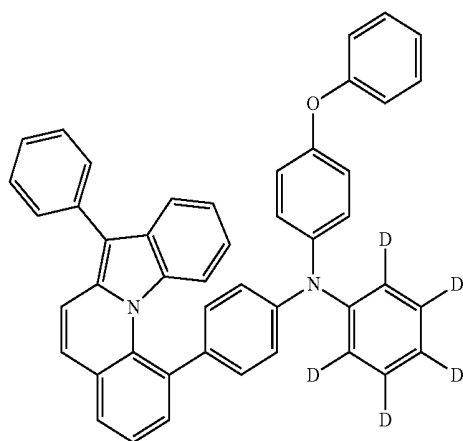
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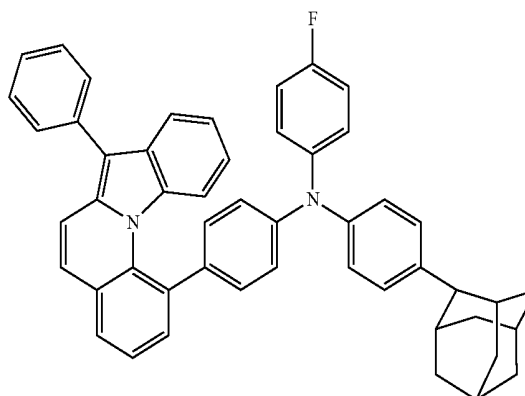
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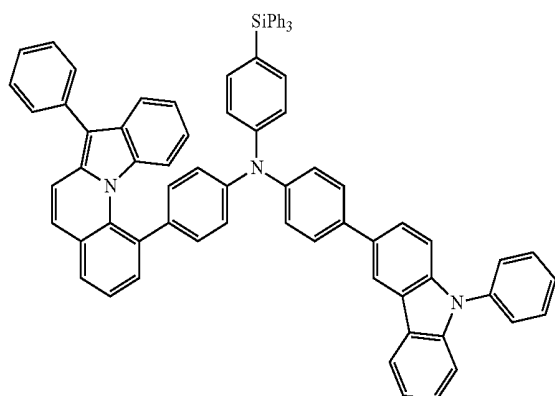
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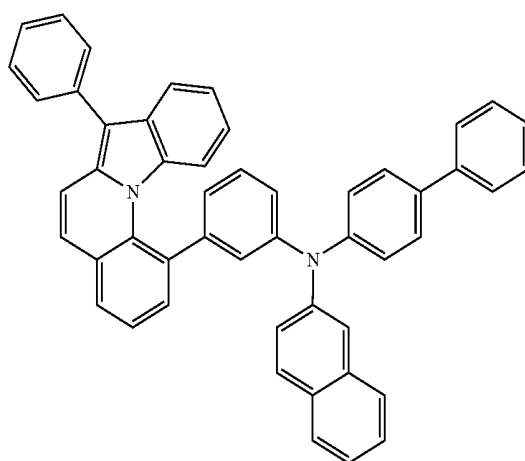
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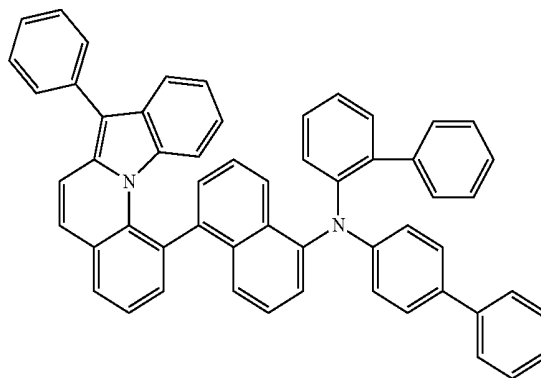
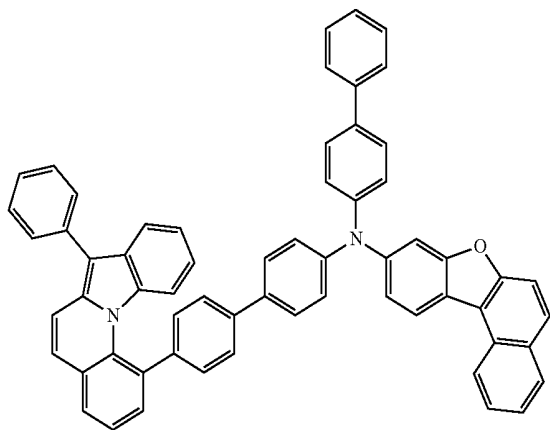
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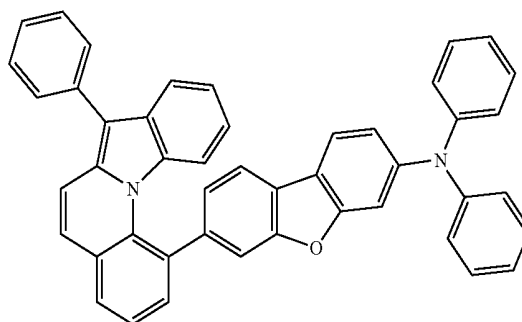
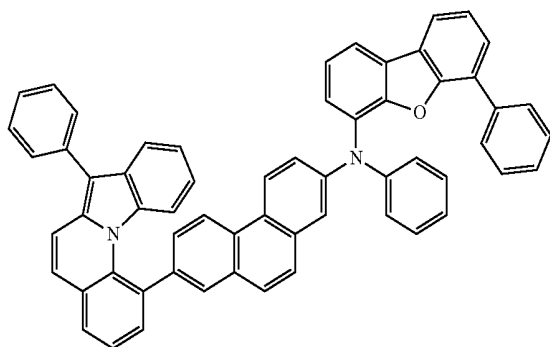
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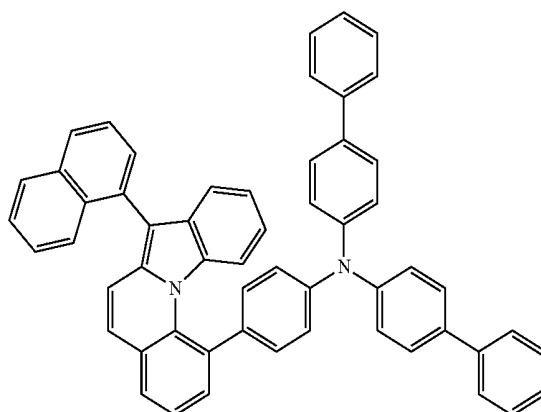
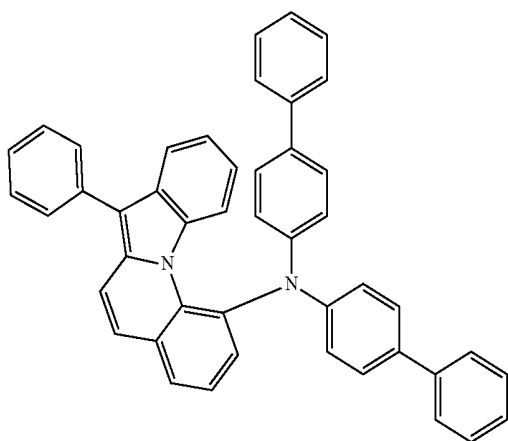
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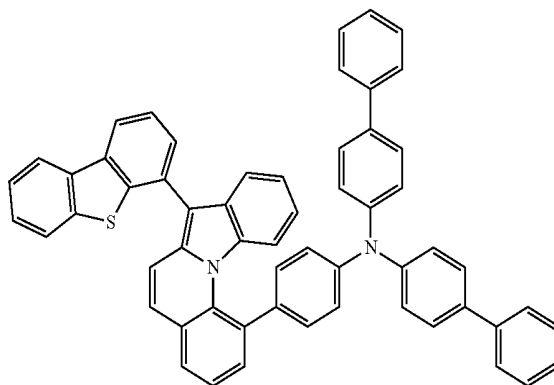
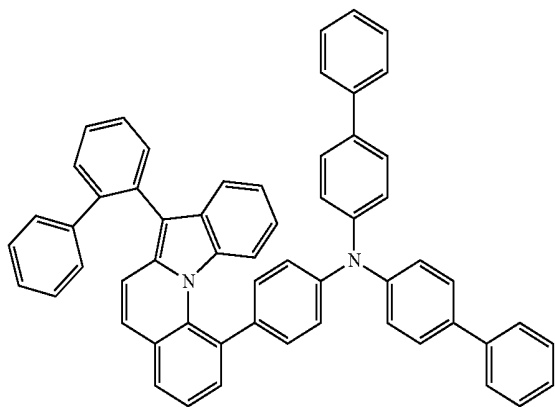
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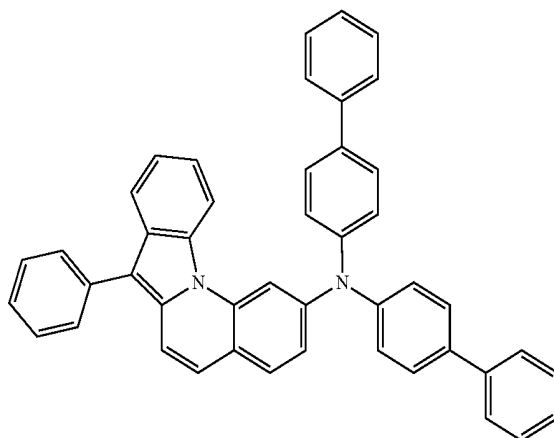
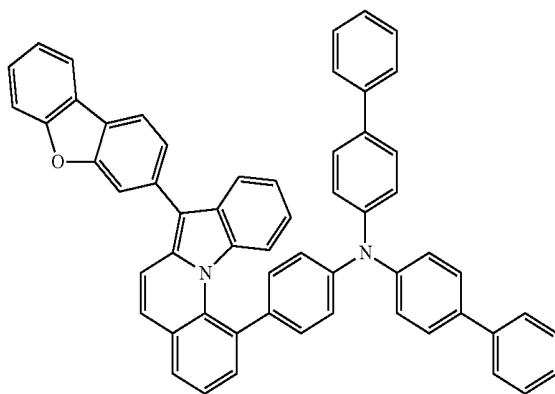
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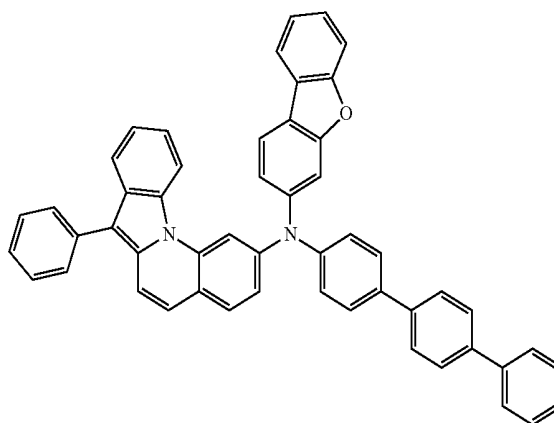
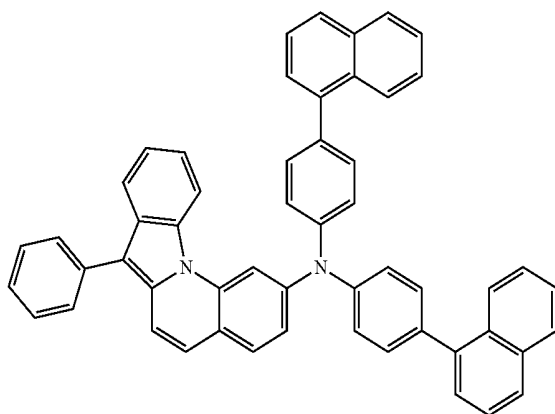
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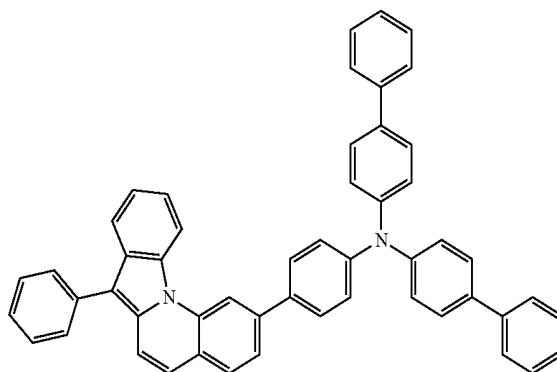
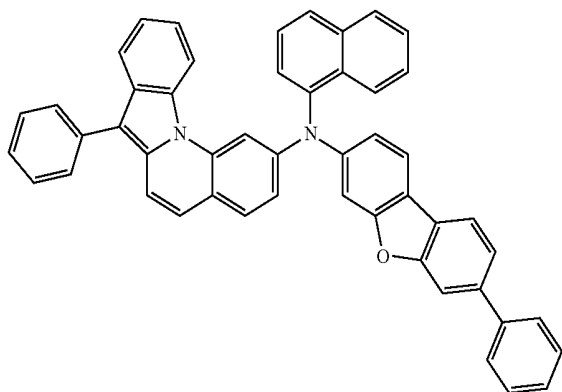
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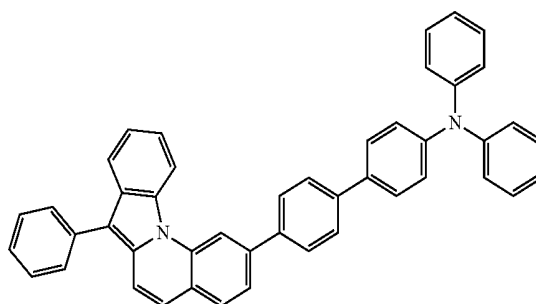
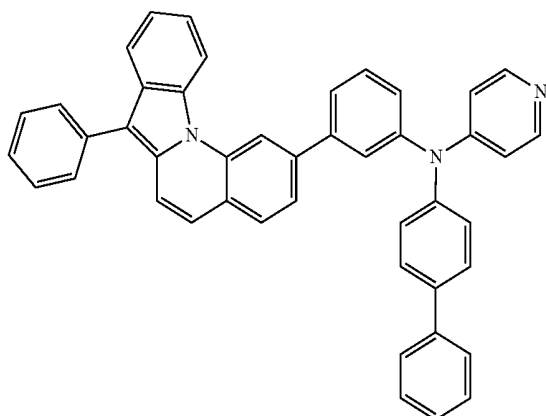
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C30



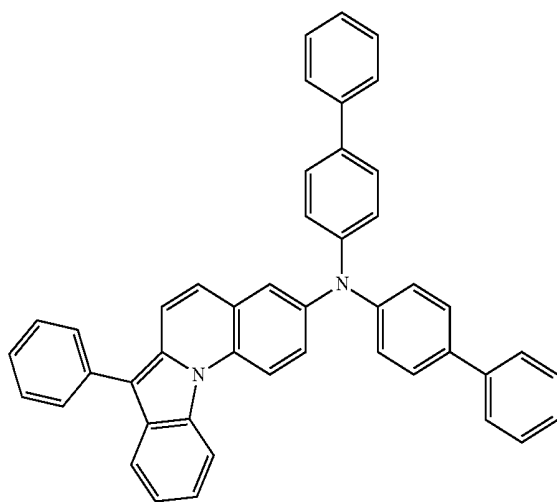
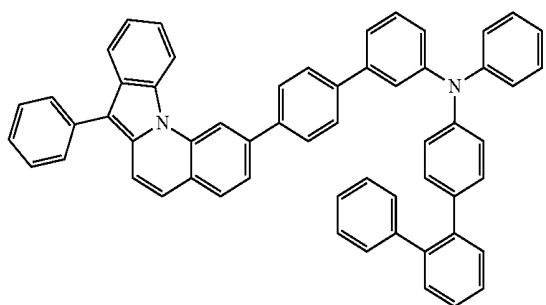
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C32



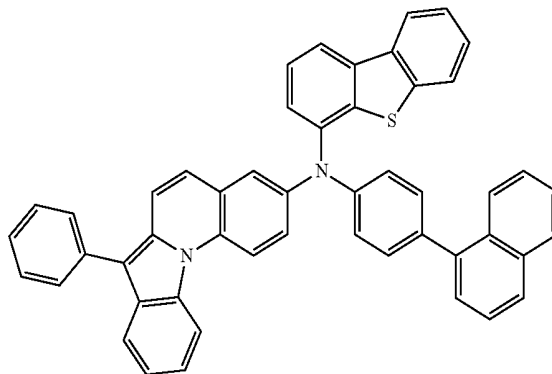
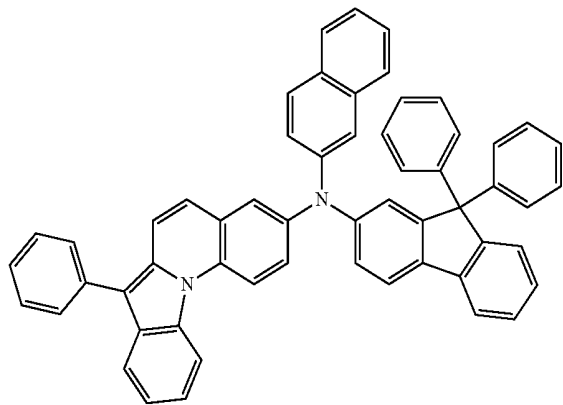
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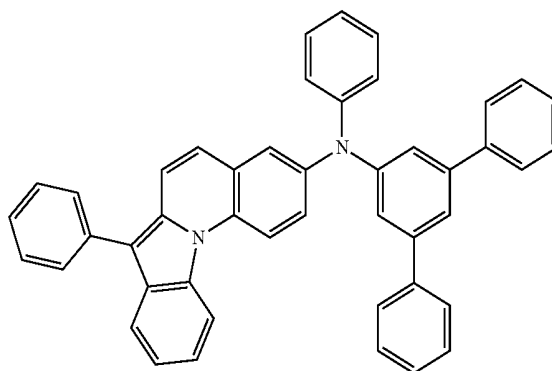
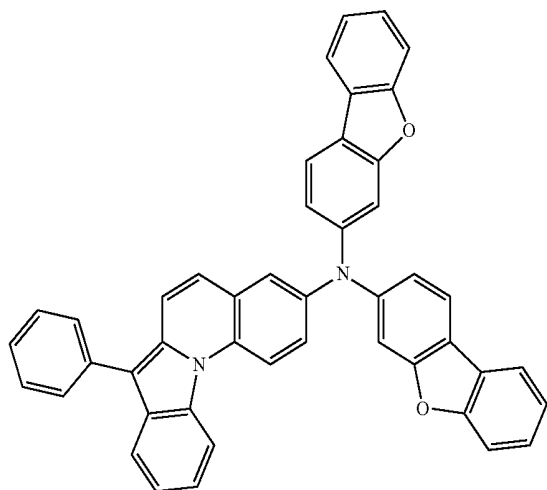
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C36



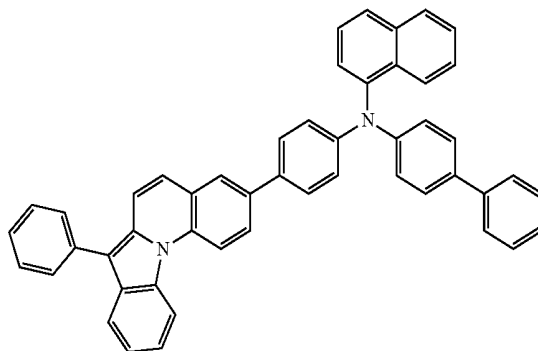
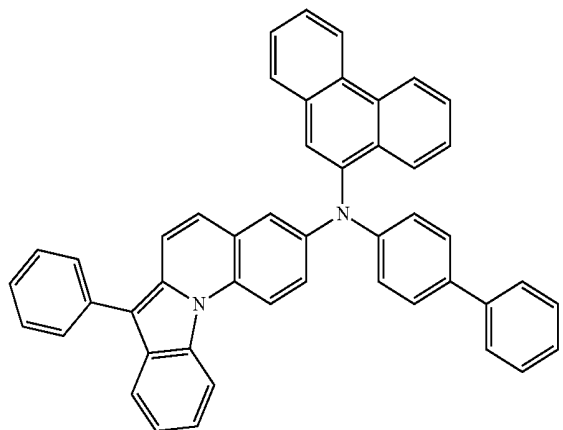
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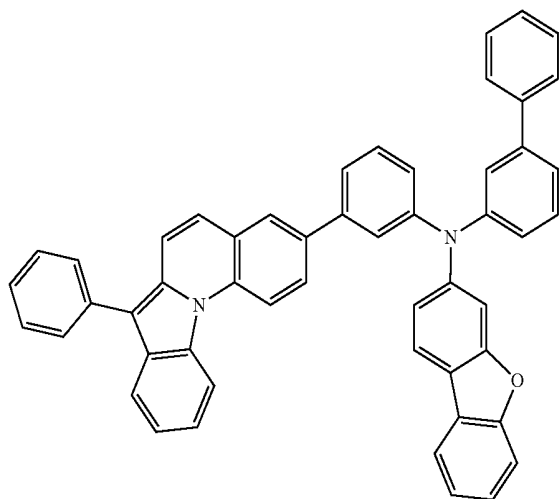
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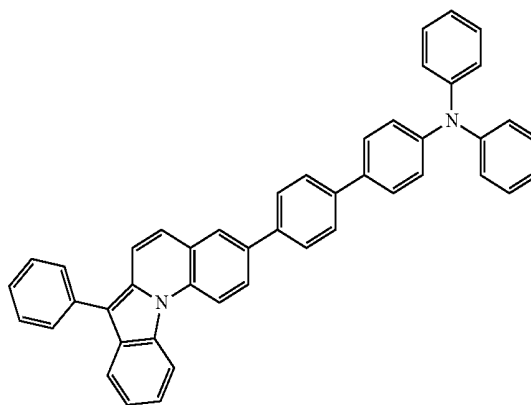


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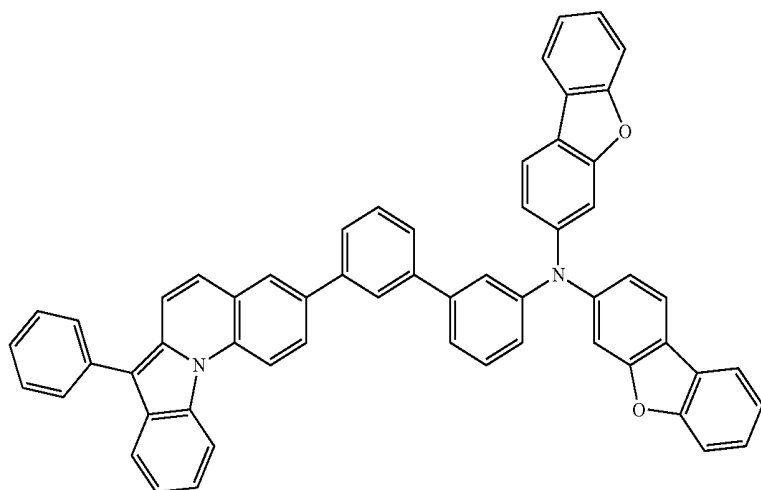
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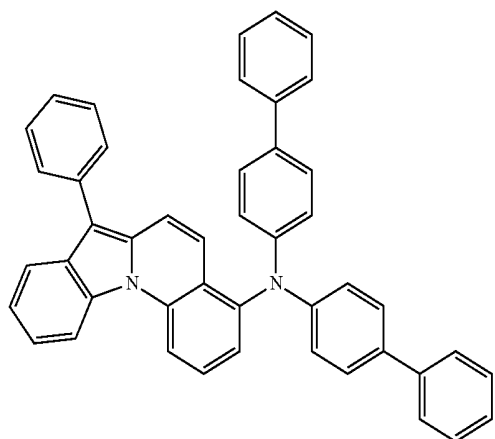
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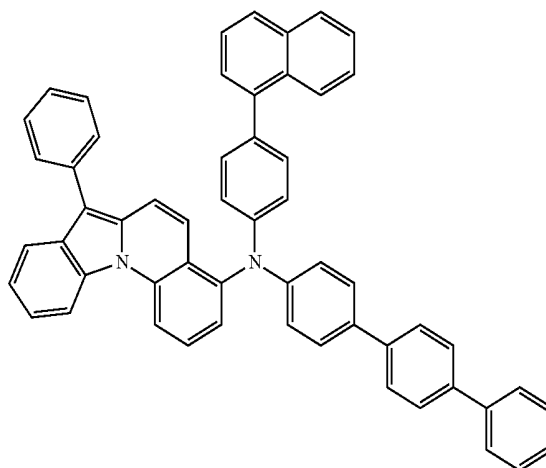
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C44



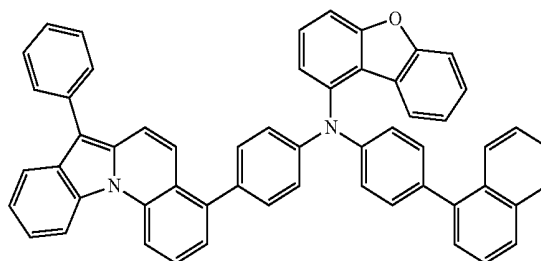
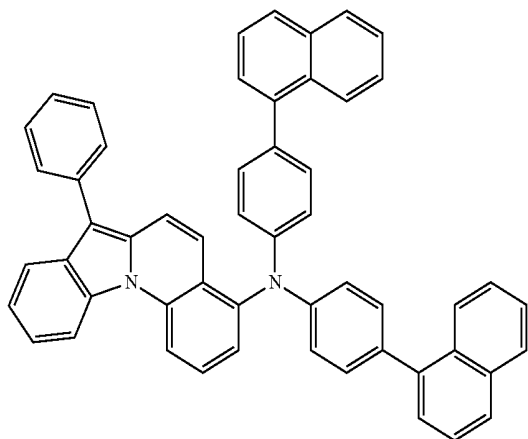
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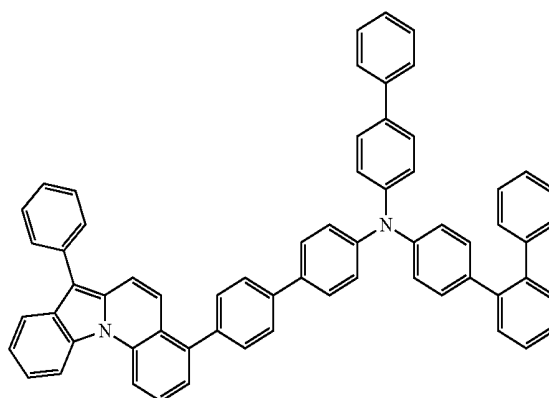
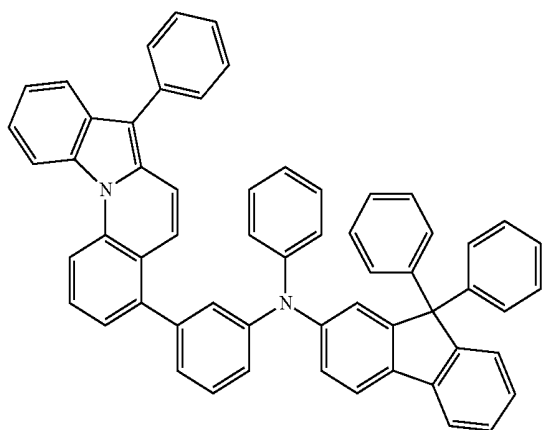
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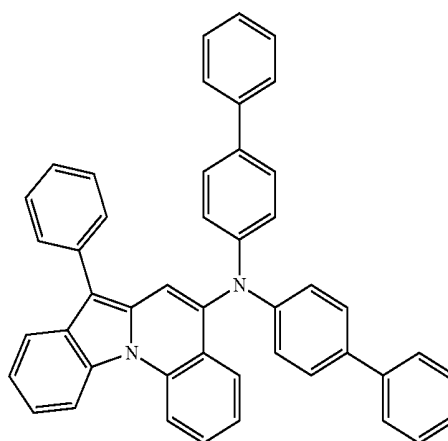
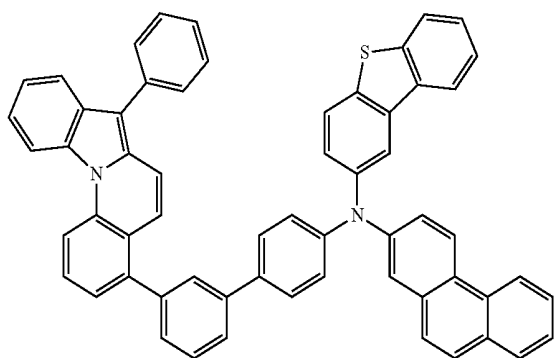
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C49



C50

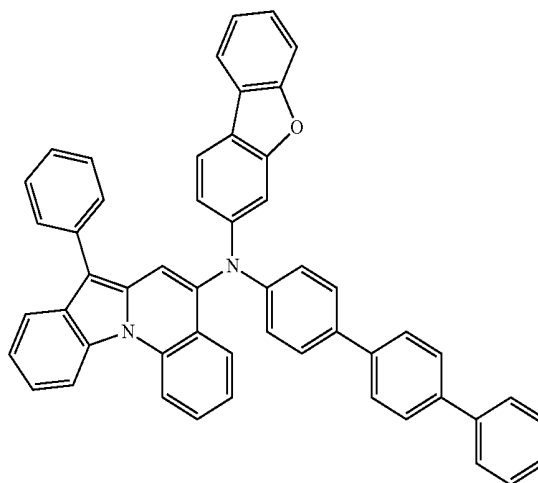
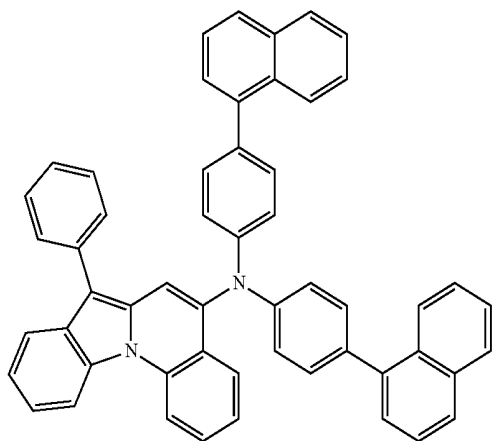
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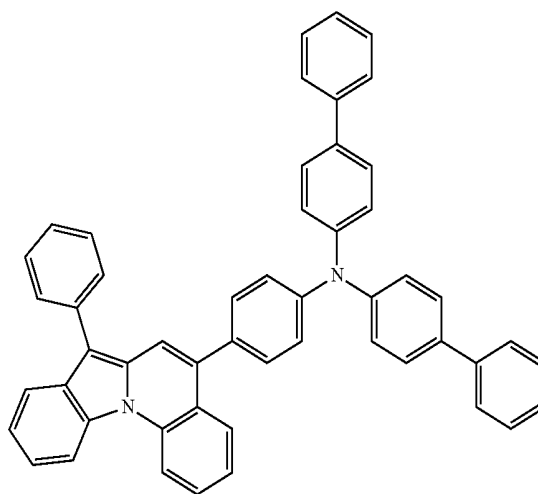
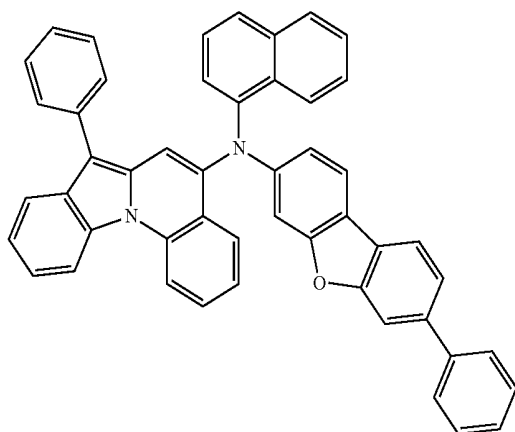
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C53



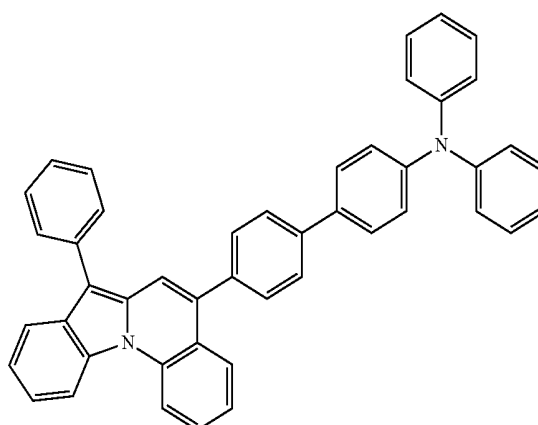
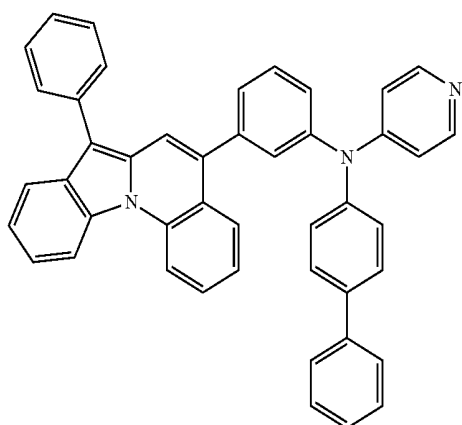
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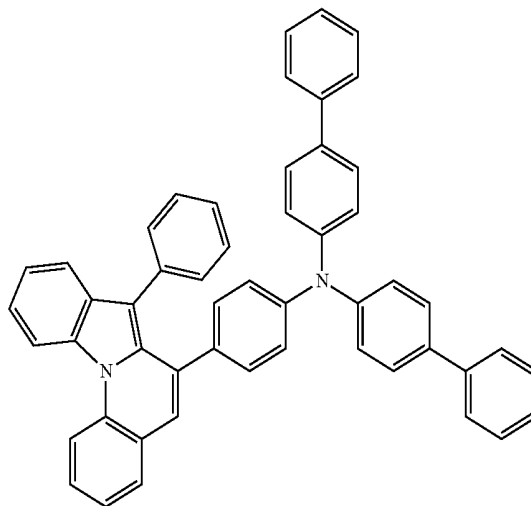
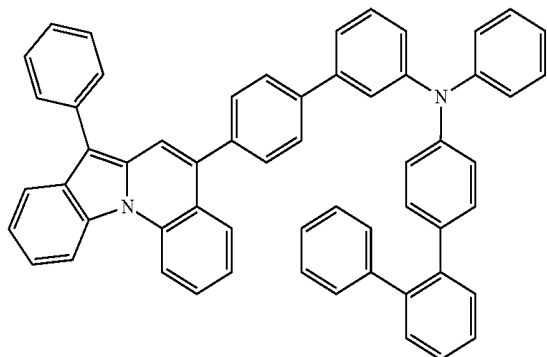
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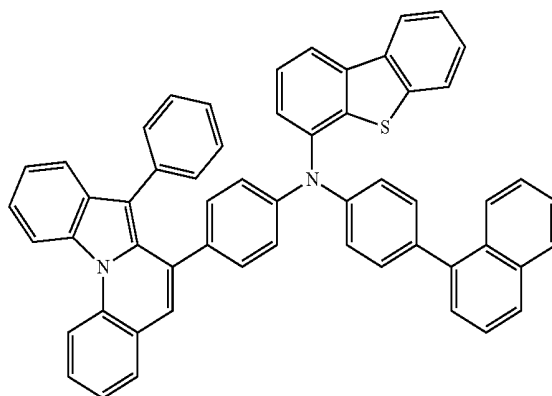
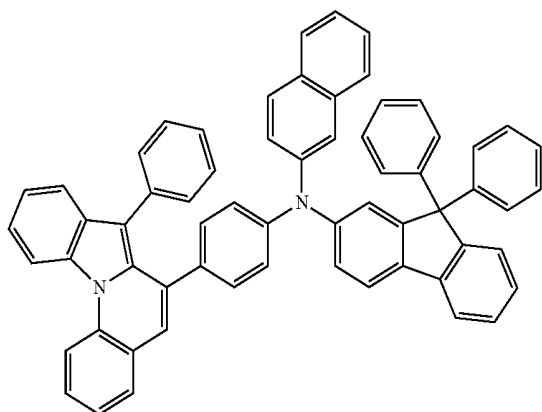
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C59



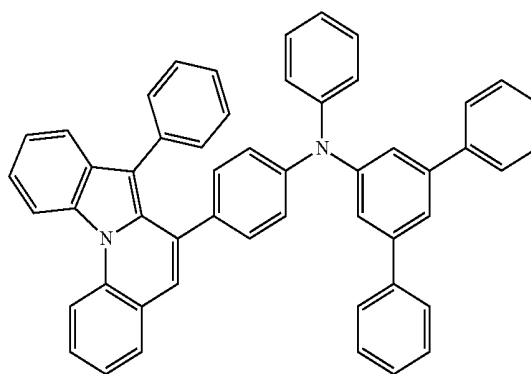
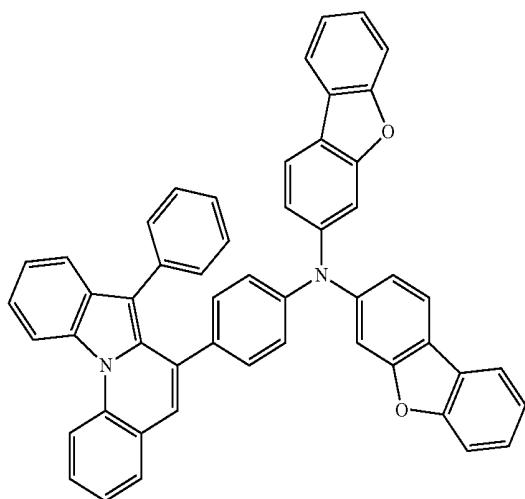
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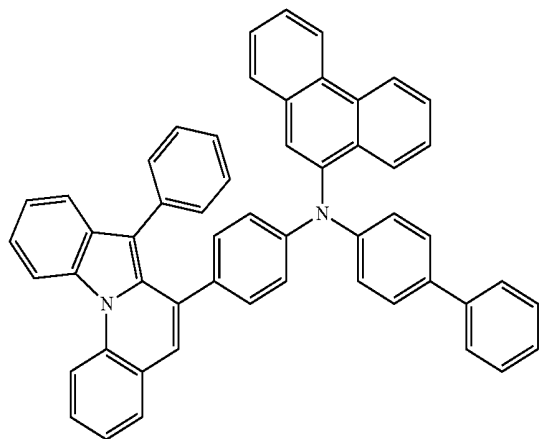
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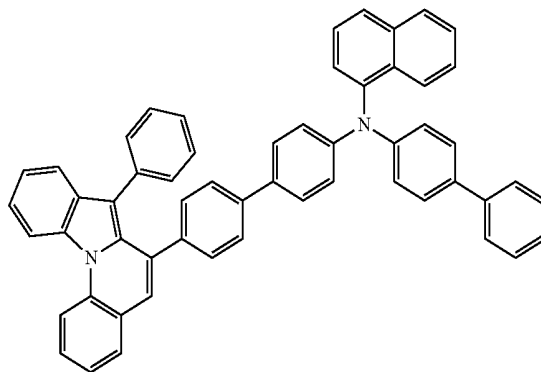


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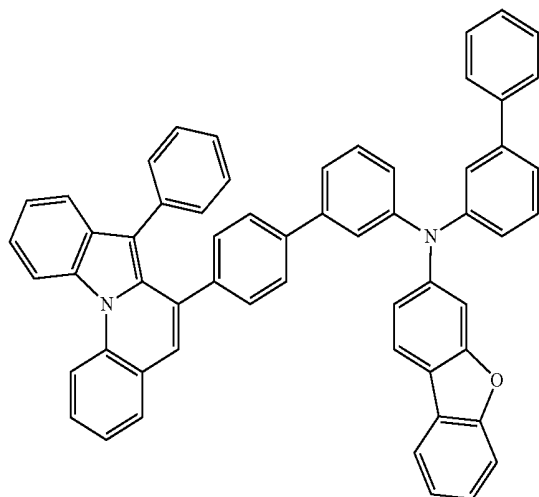
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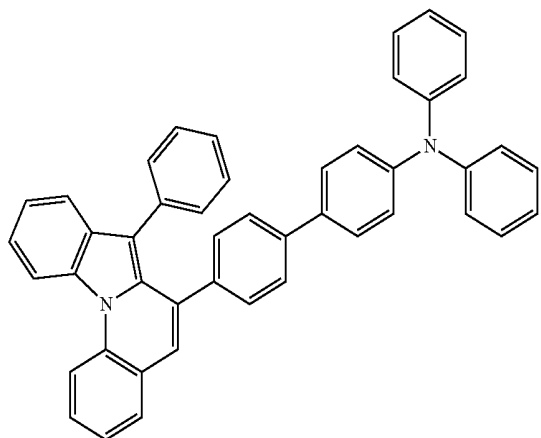
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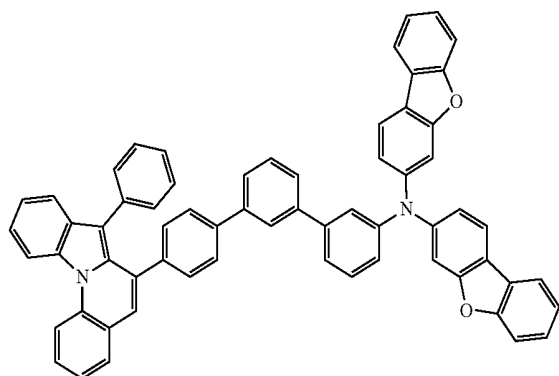
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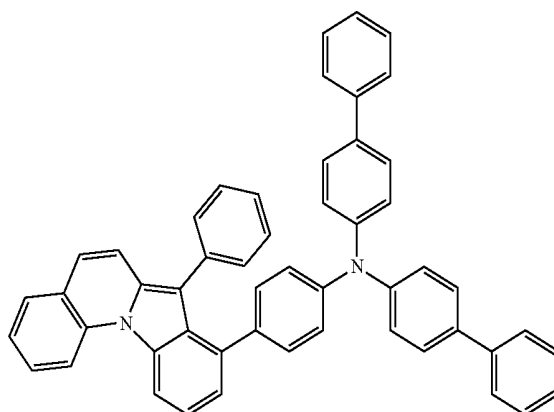
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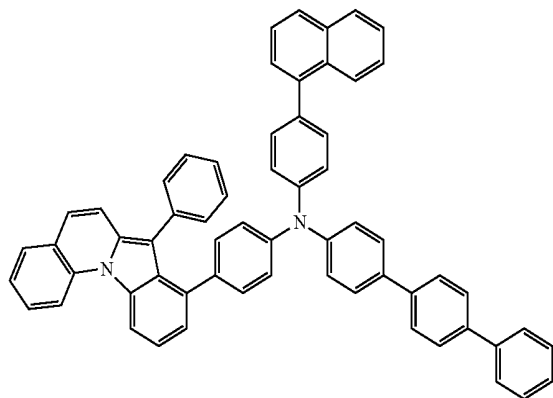
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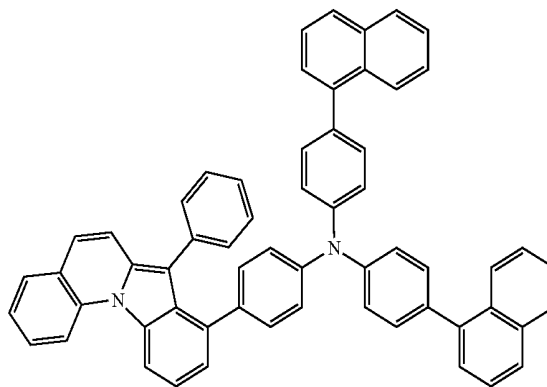
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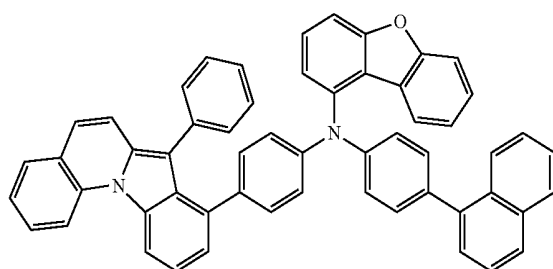
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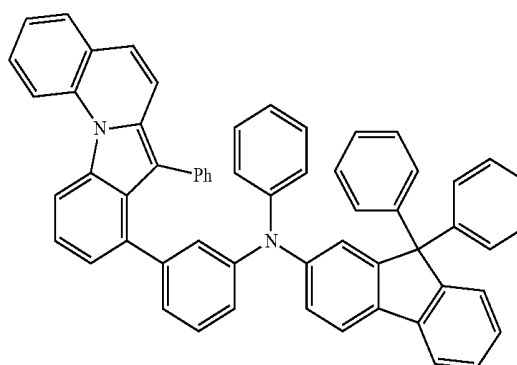
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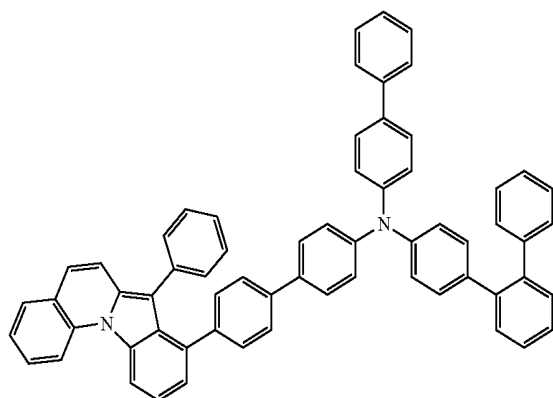
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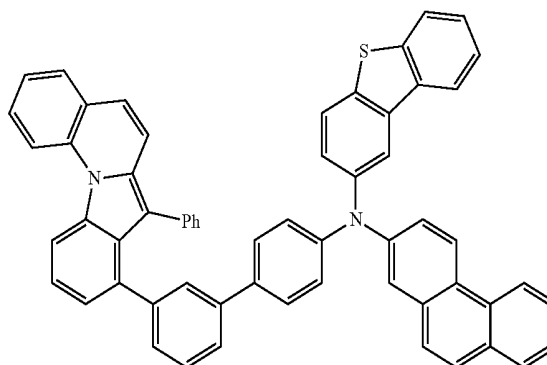
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C74

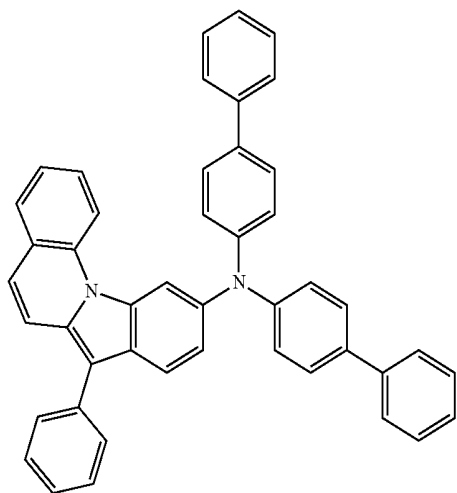


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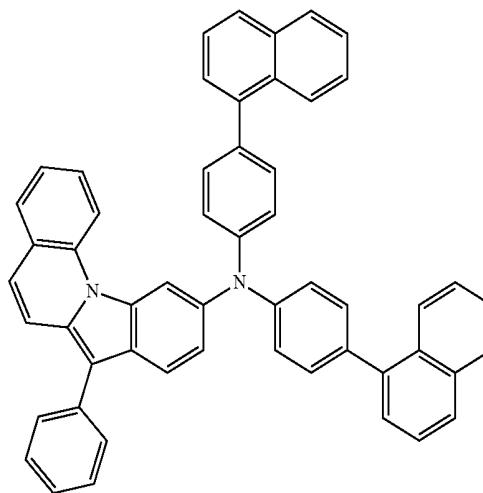


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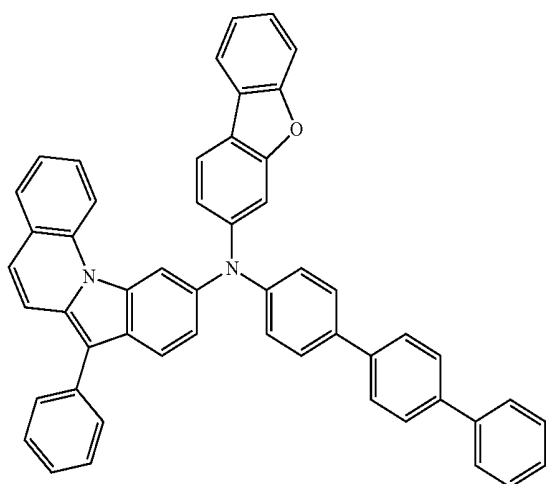
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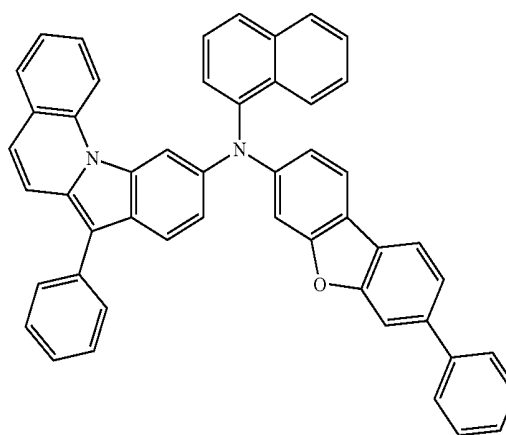
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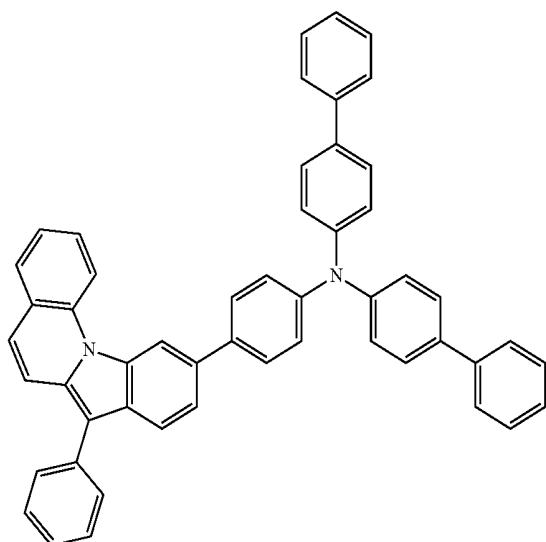
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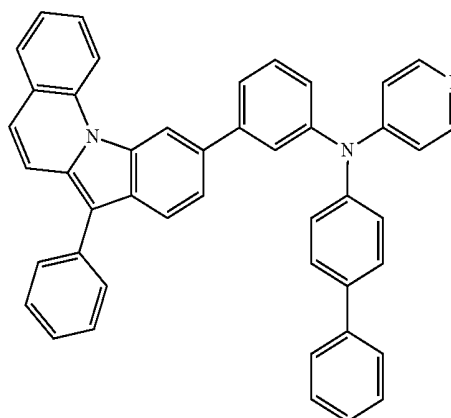
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C80

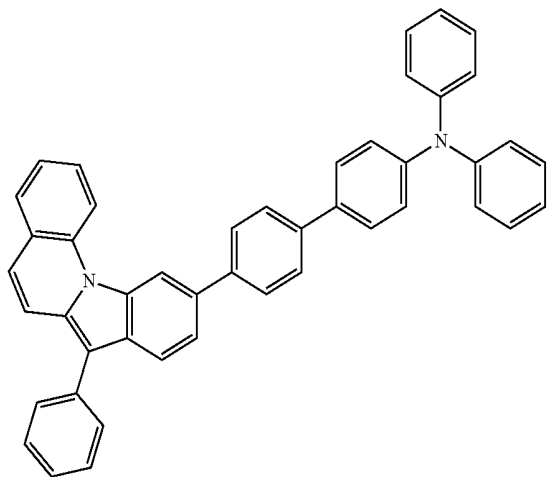


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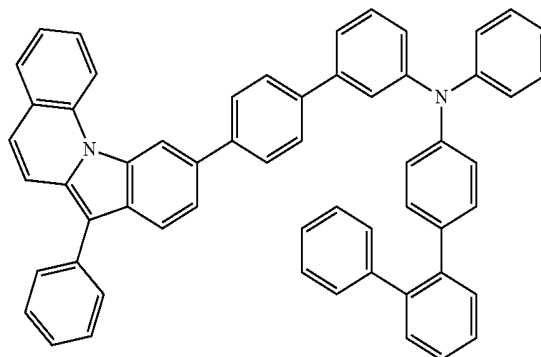


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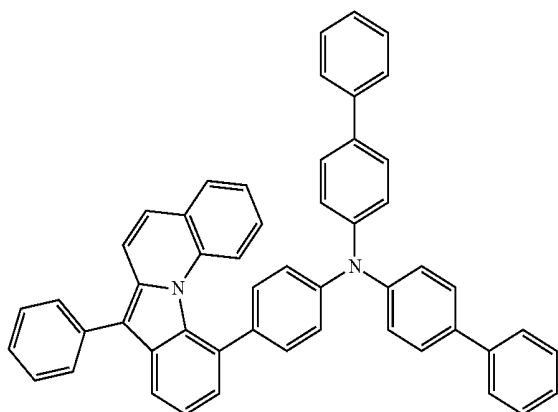
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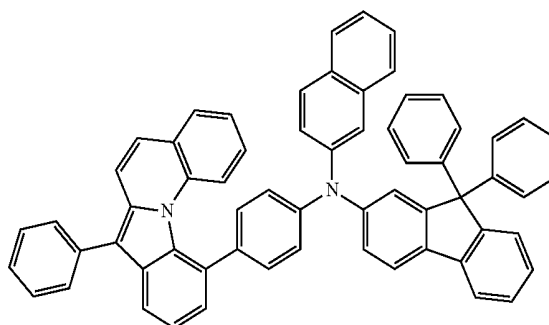
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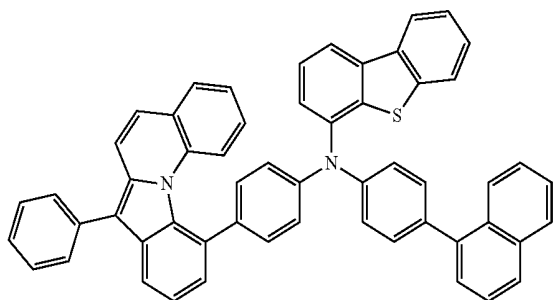
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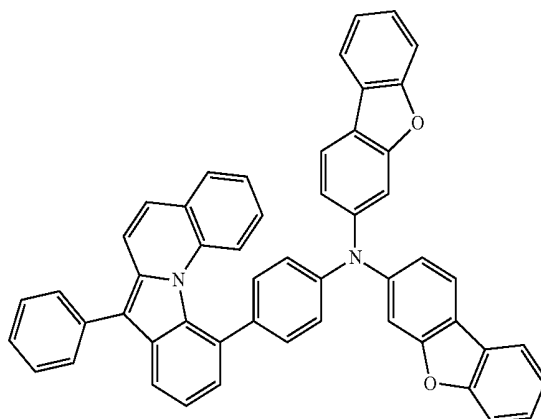
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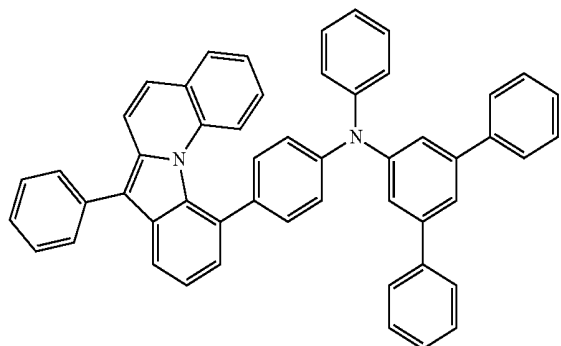
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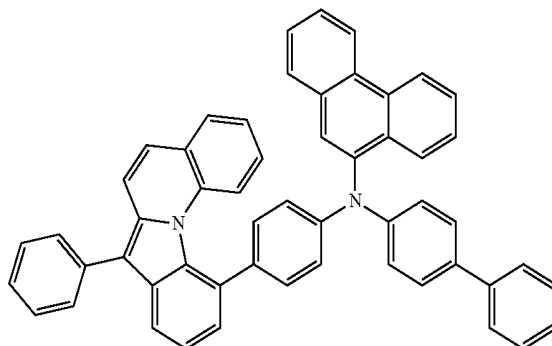
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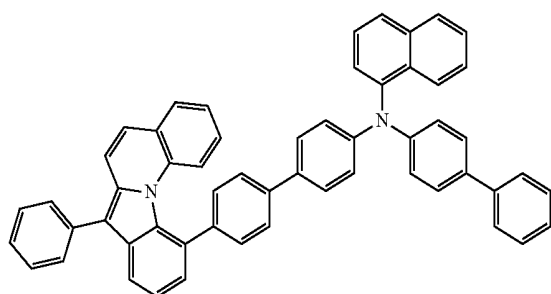
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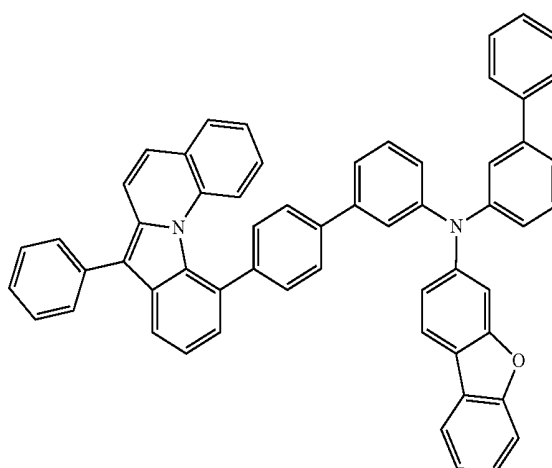
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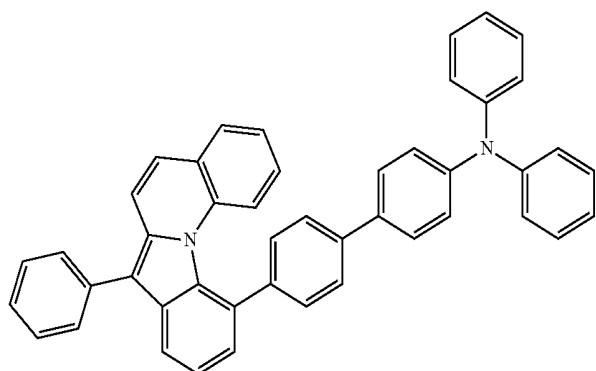
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C91

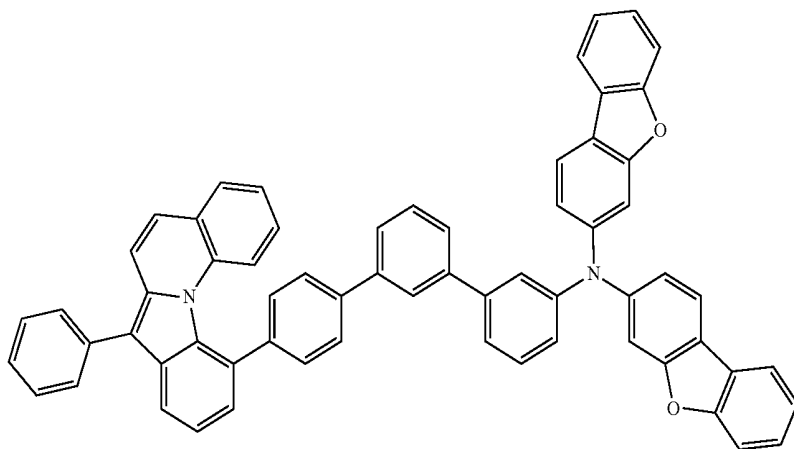


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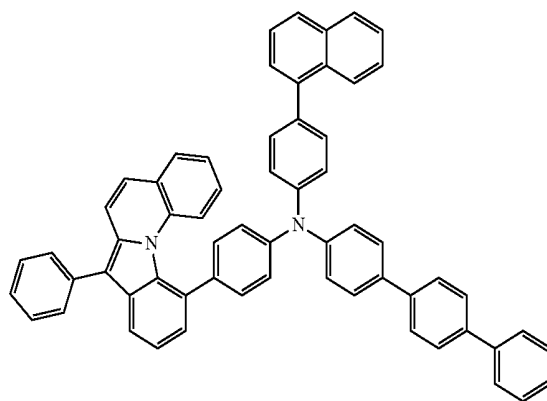
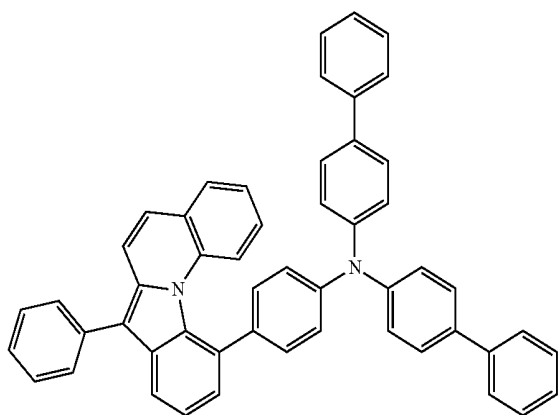
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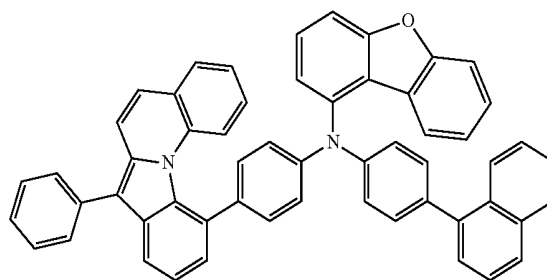
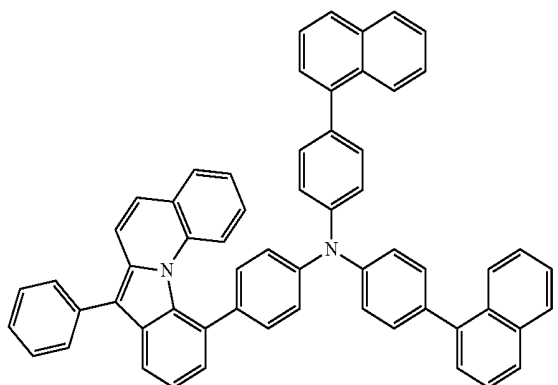
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C95

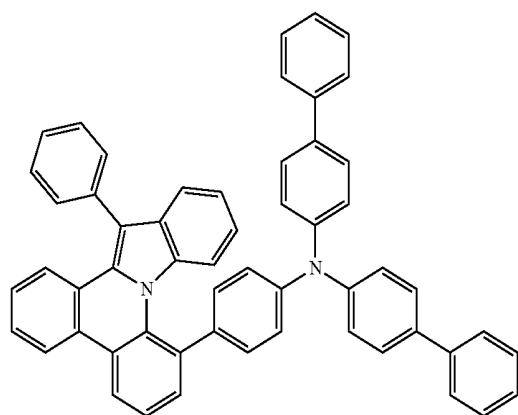


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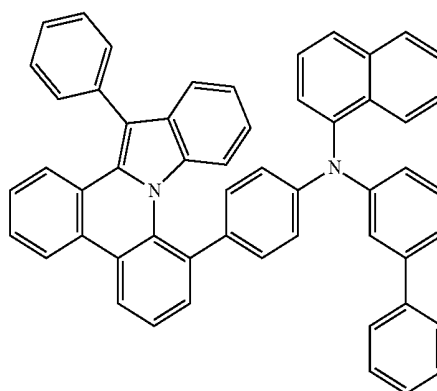
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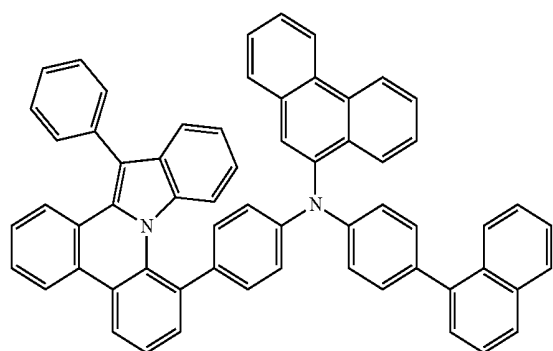
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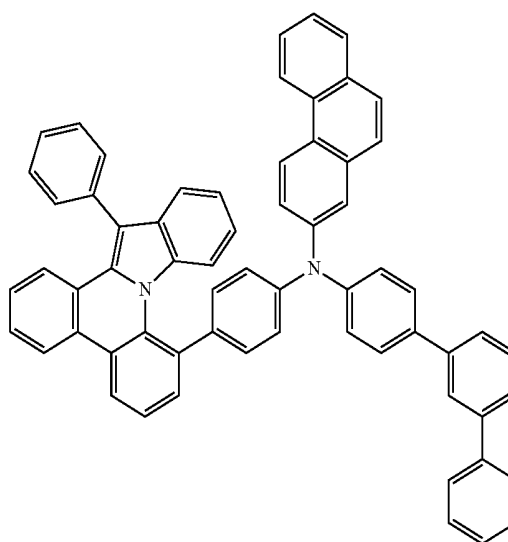
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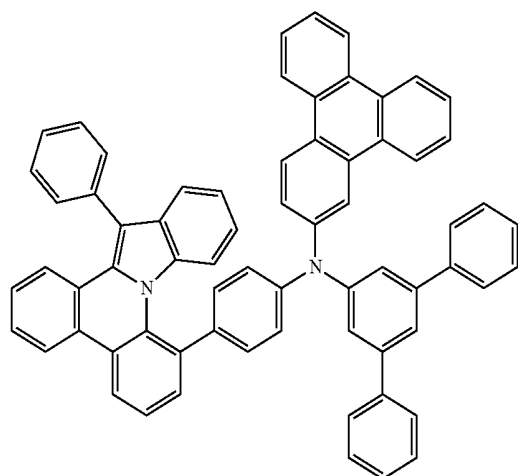
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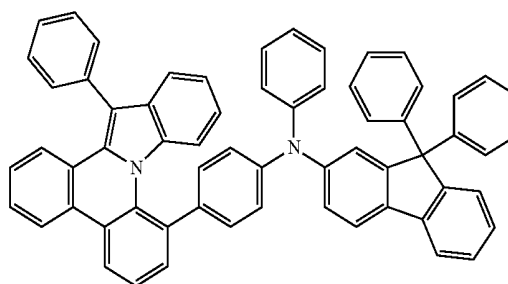
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D4

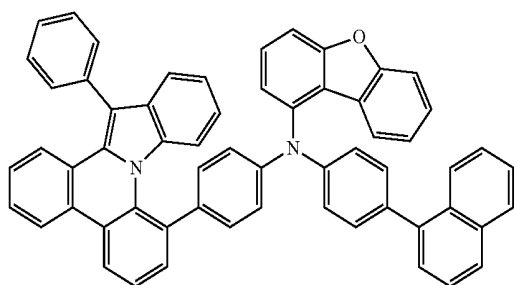


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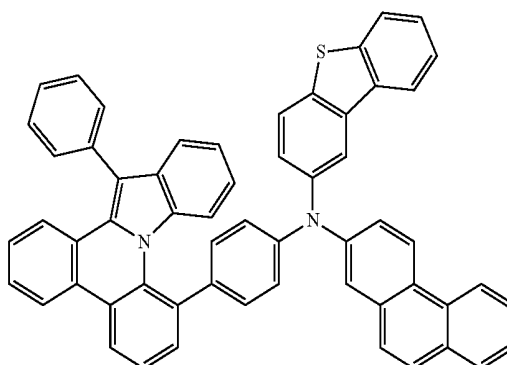


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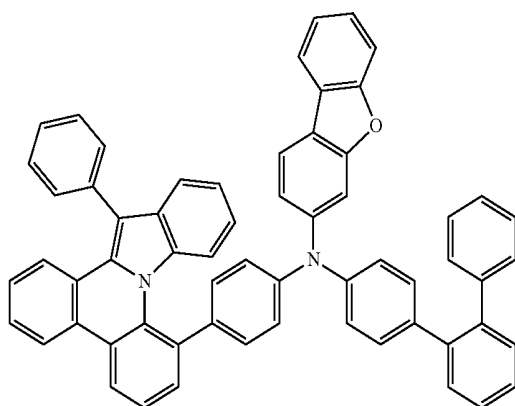
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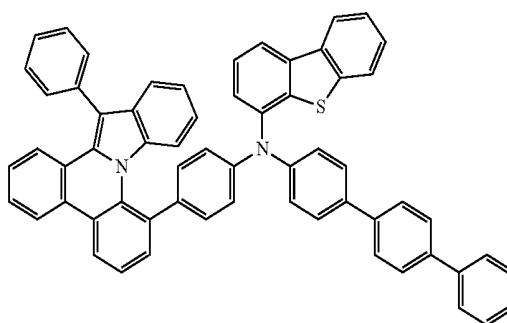
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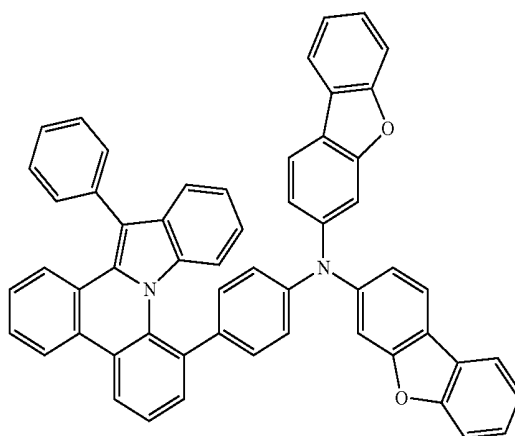
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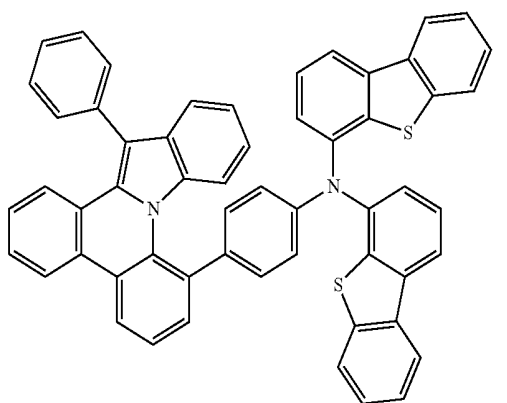
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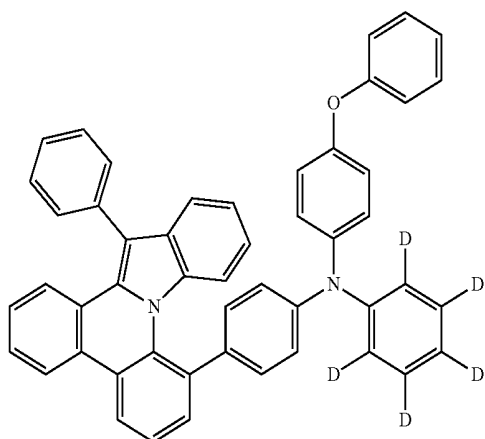
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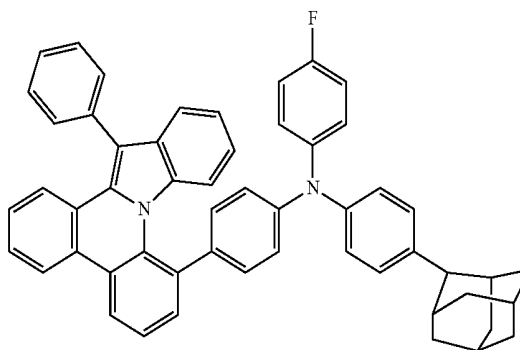
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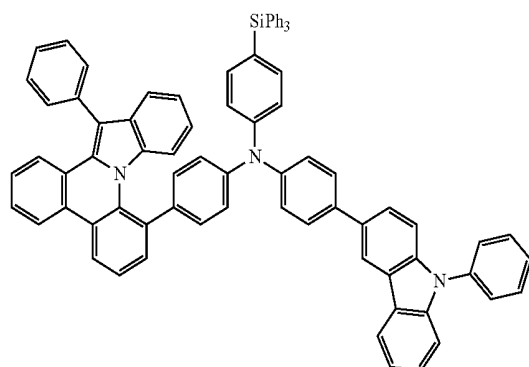
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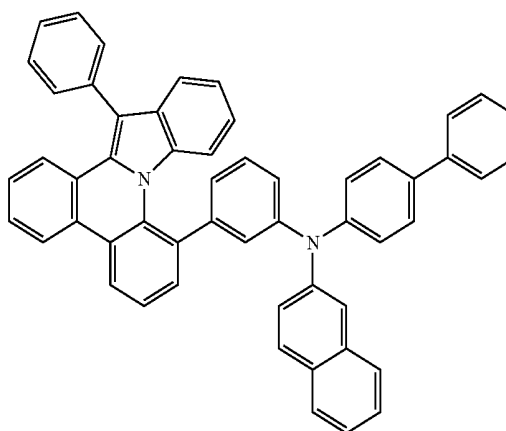
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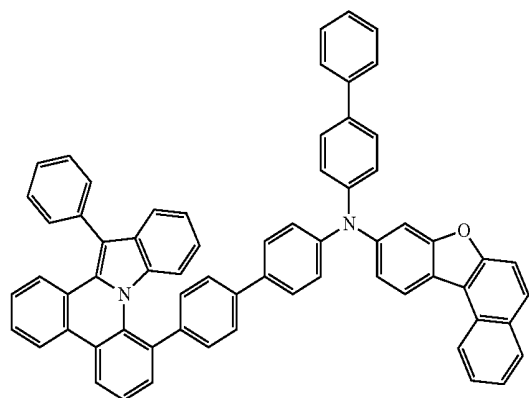
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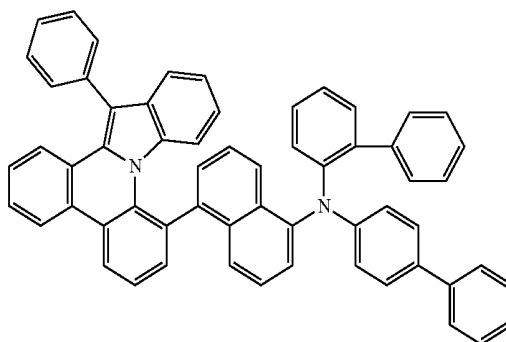
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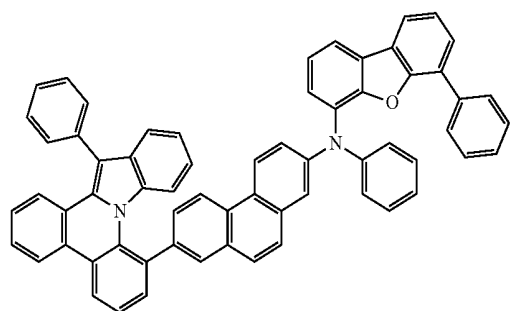
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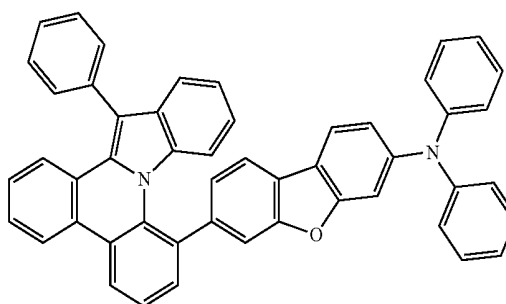
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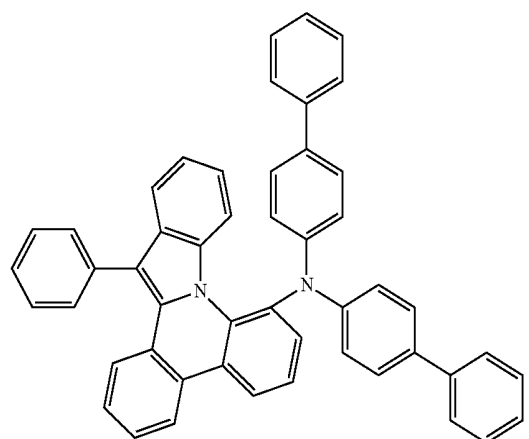
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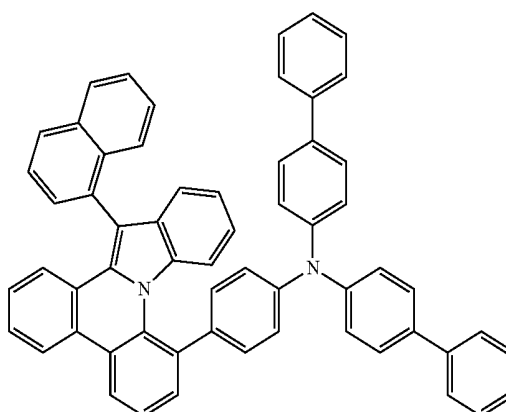
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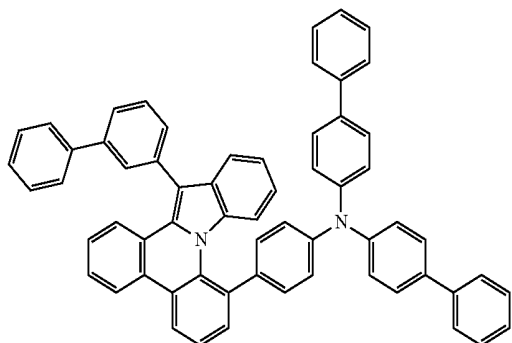
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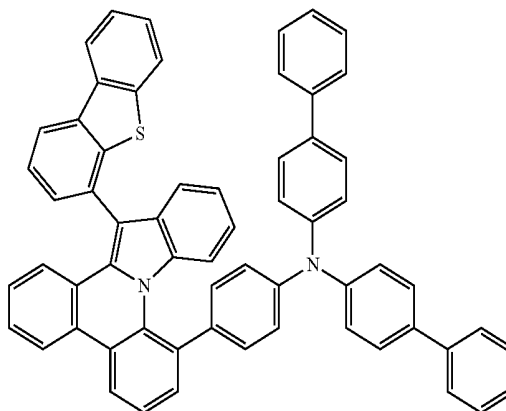
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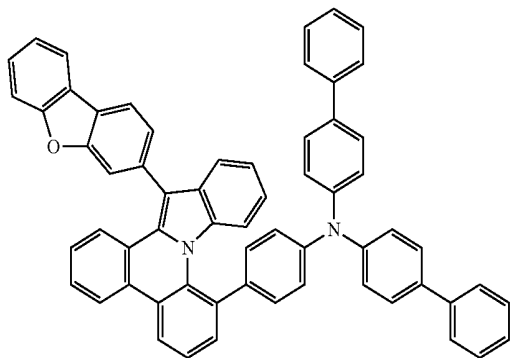
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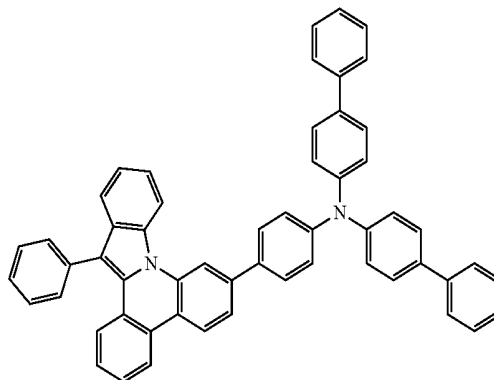
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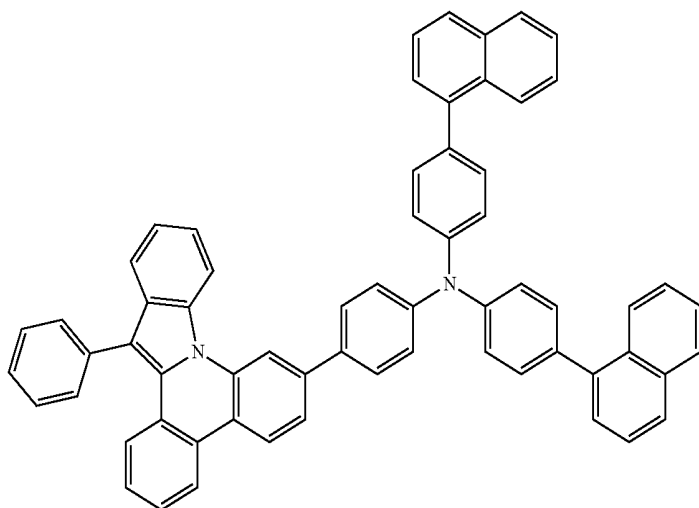
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D26

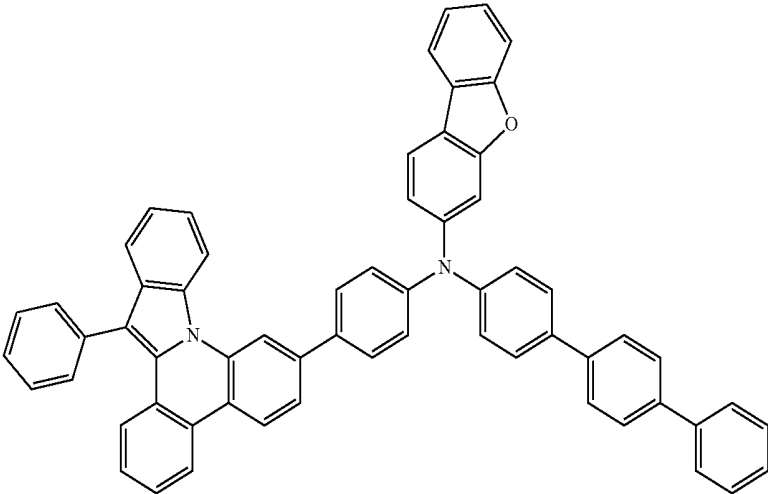


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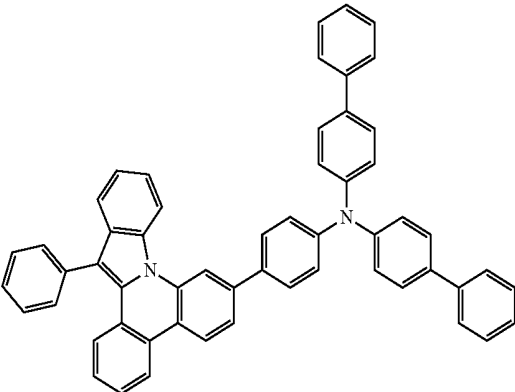
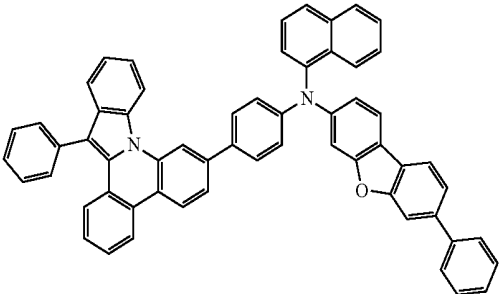
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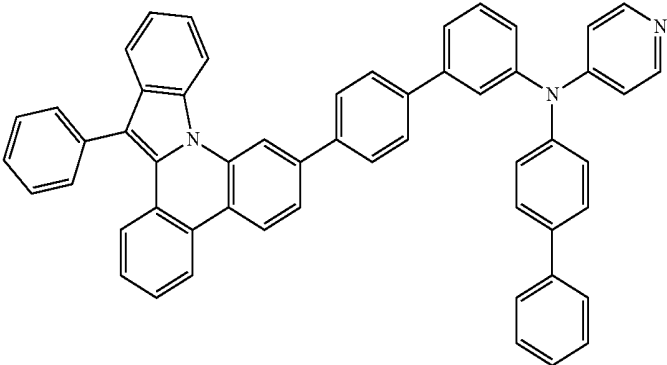


D29

D30

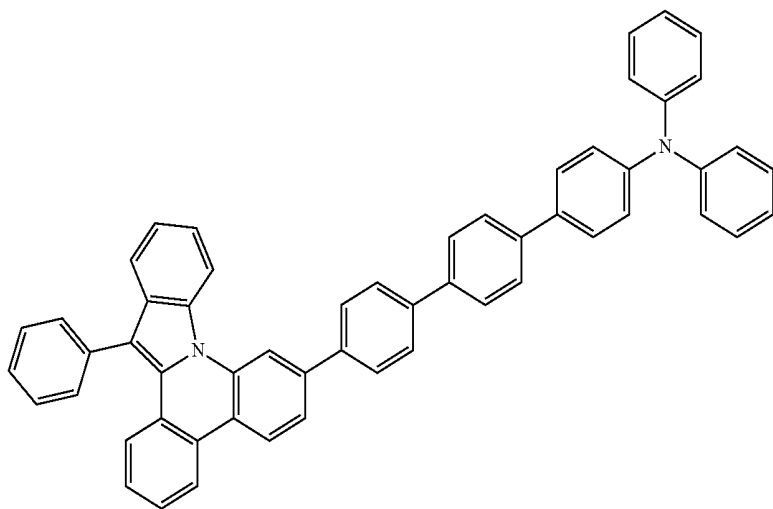


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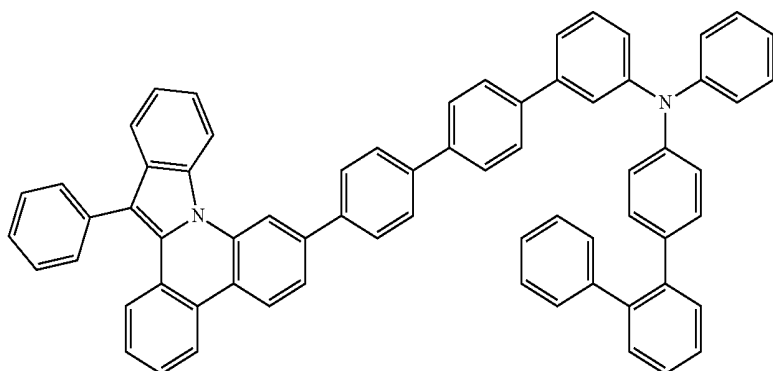


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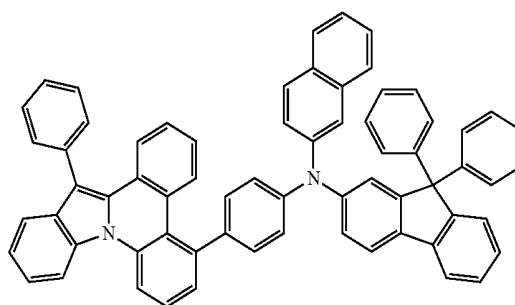
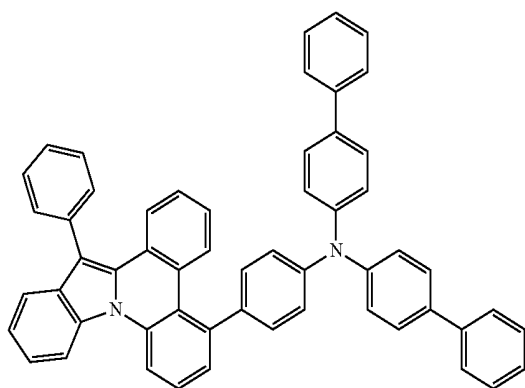


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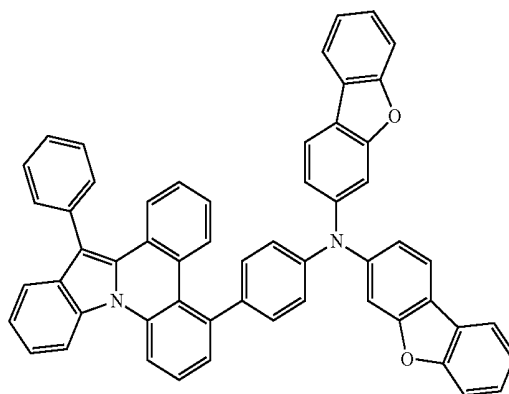
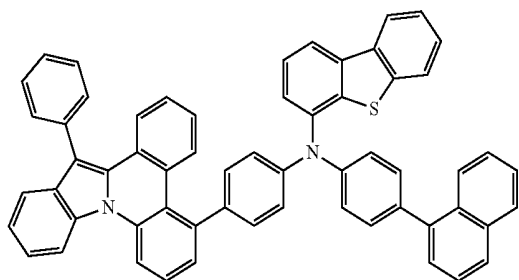
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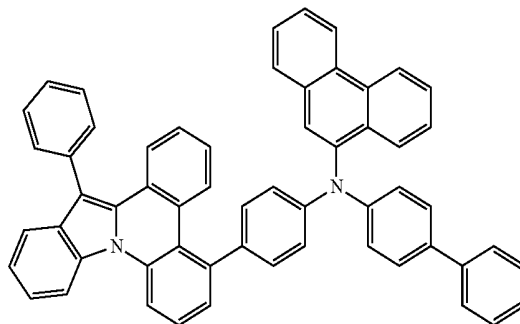
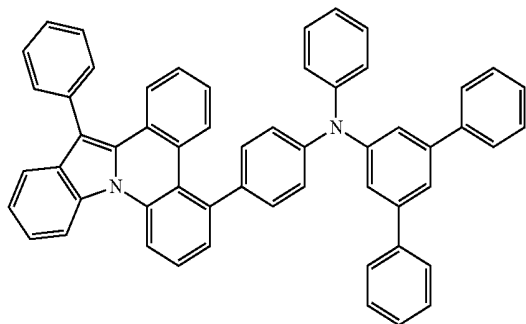
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D37



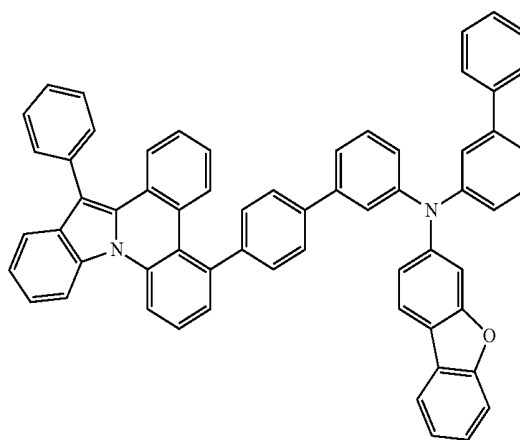
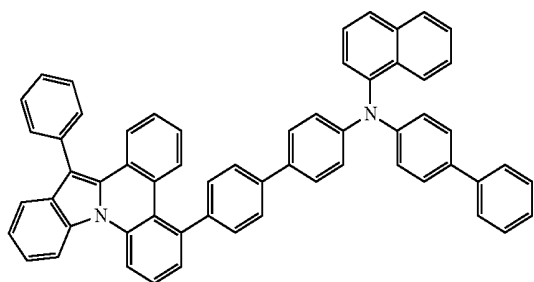
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D39

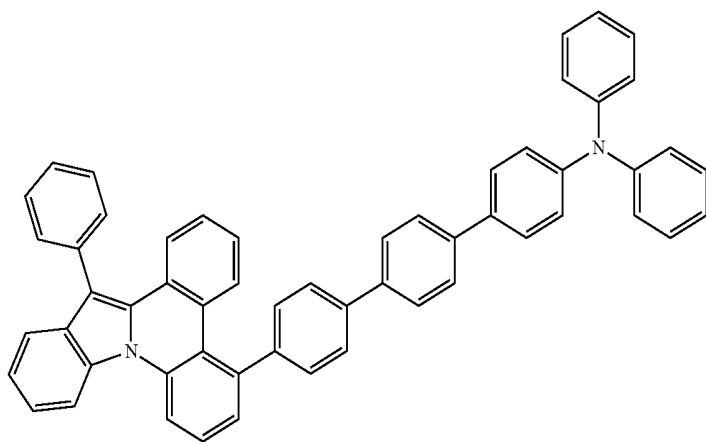


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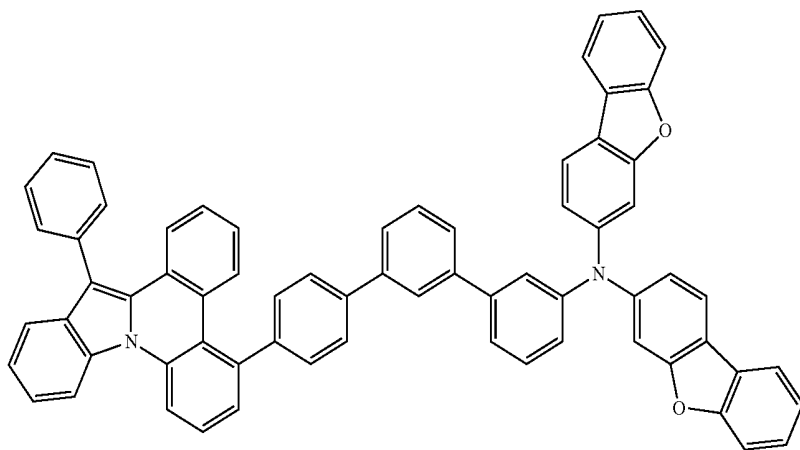
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D42



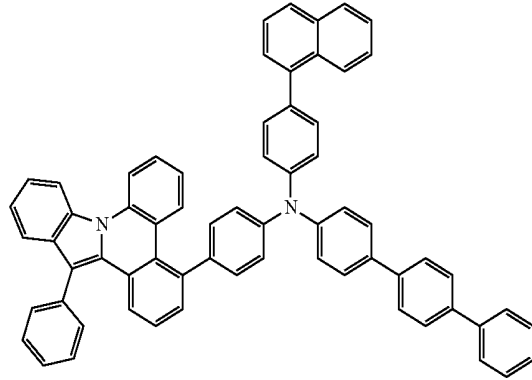
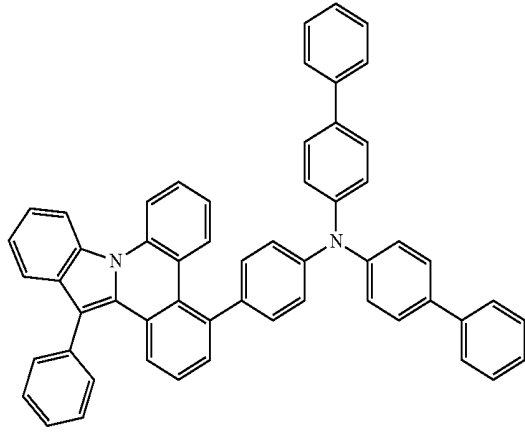
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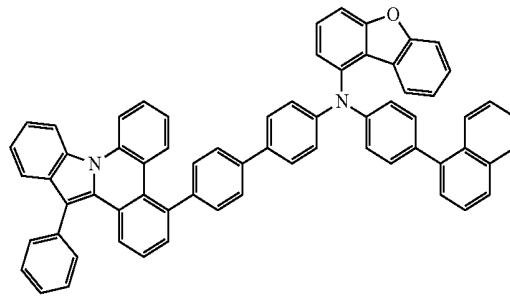
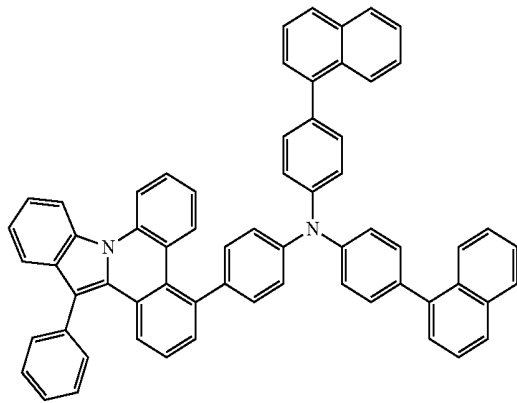
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D45

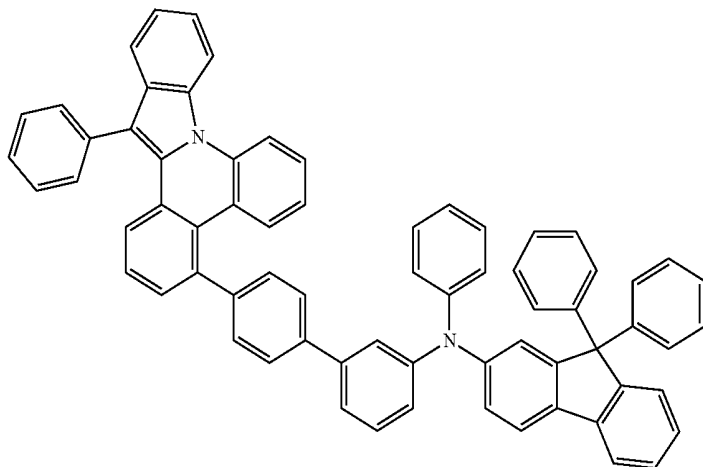


D46

D47

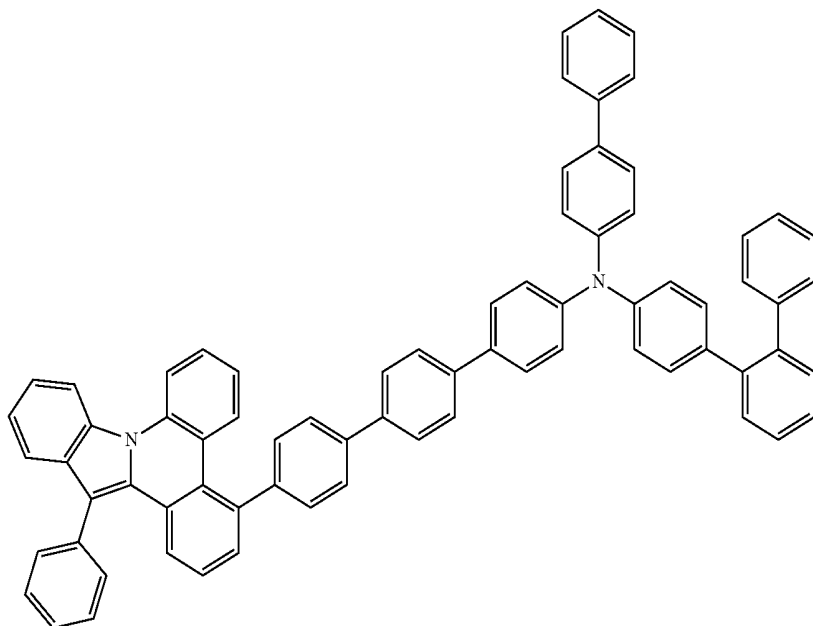


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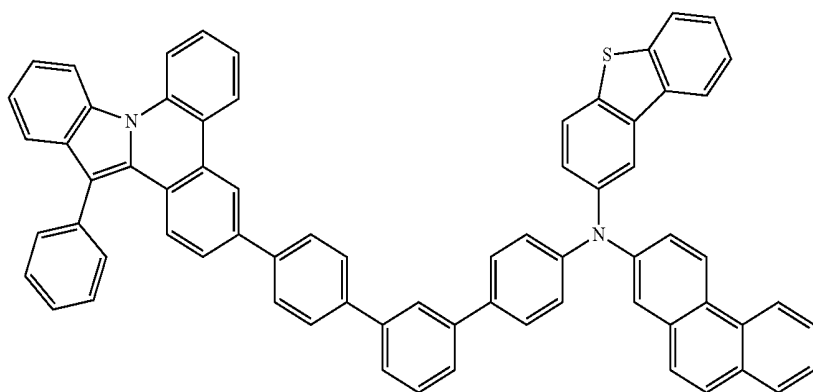


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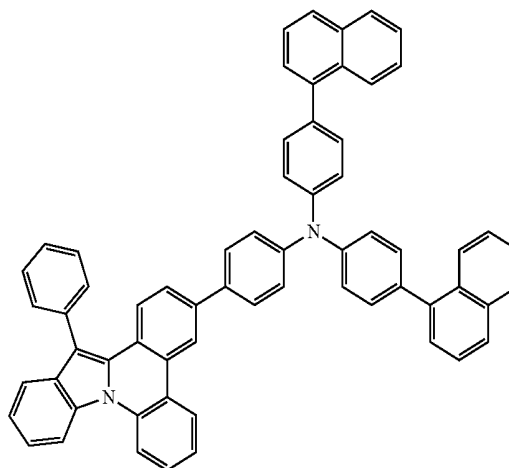
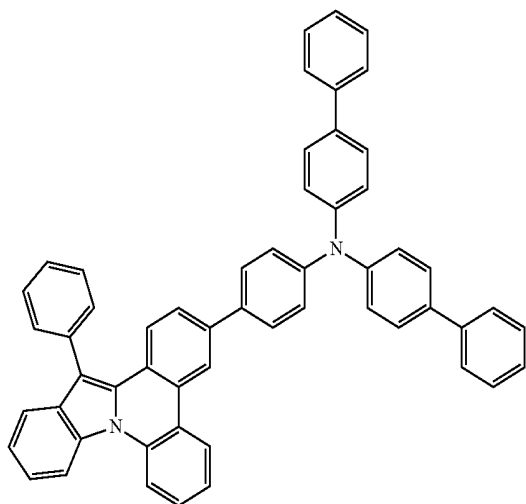


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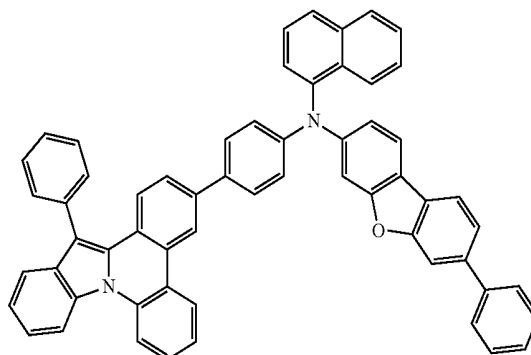
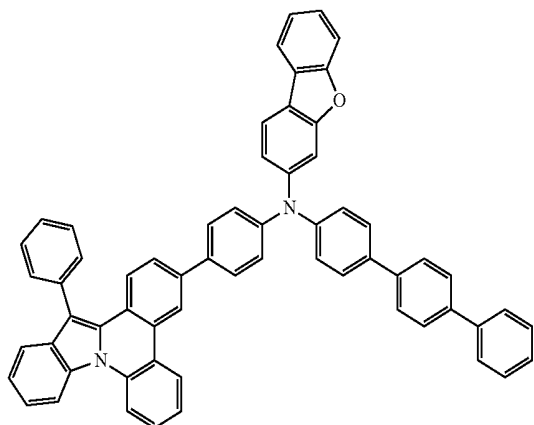
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D52



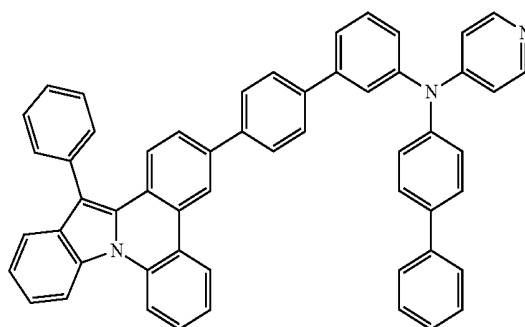
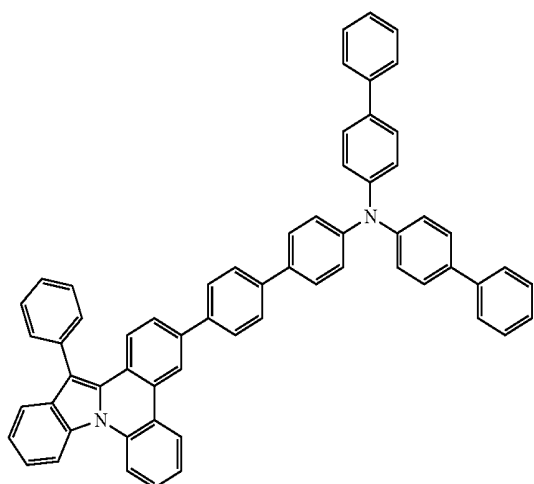
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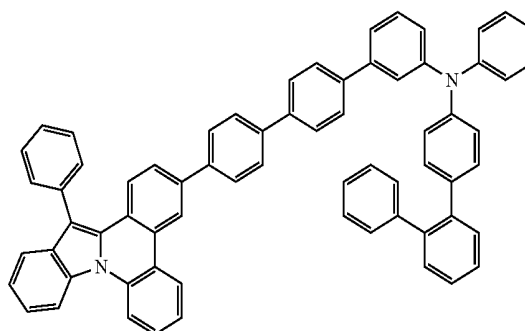
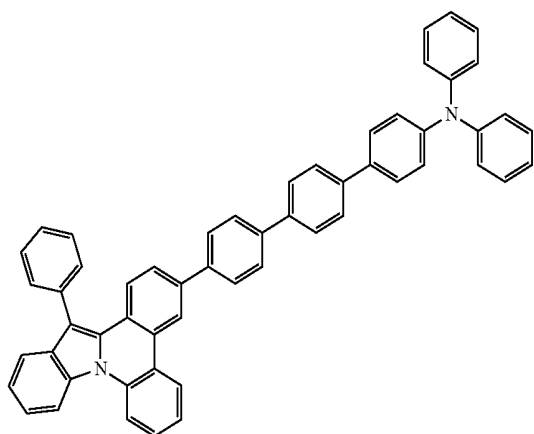
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D56



D57

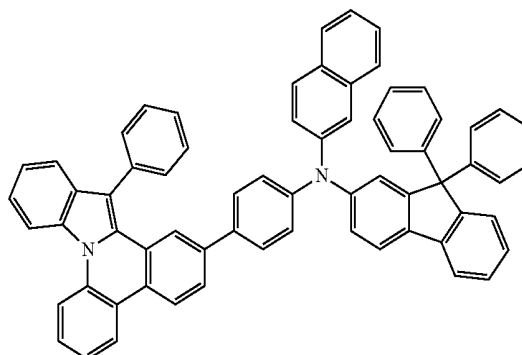
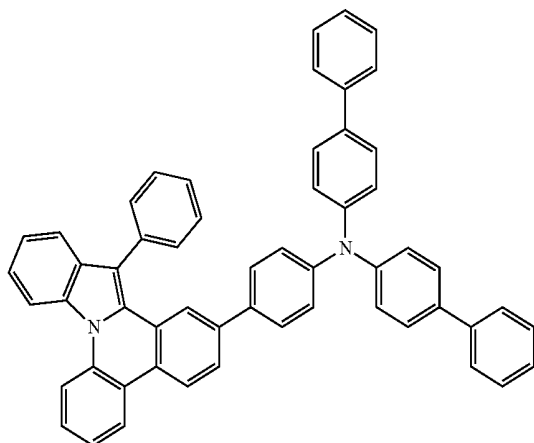
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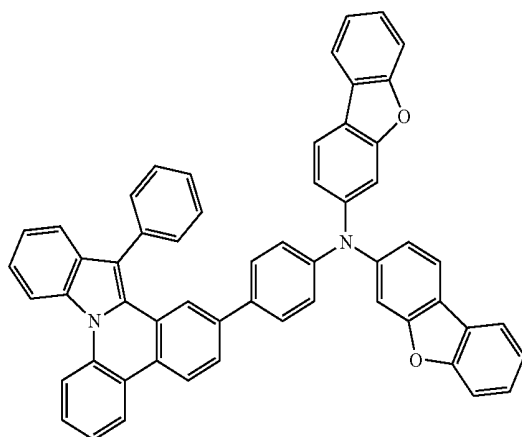
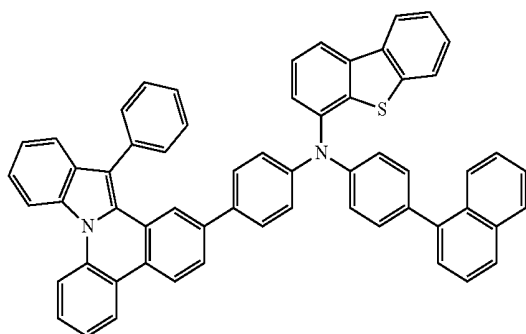
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D60



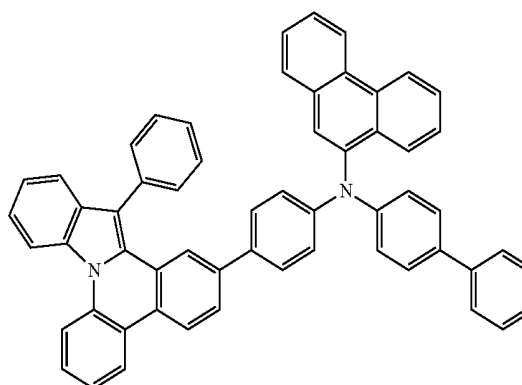
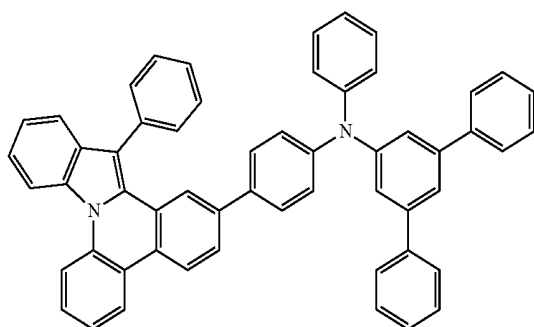
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D62

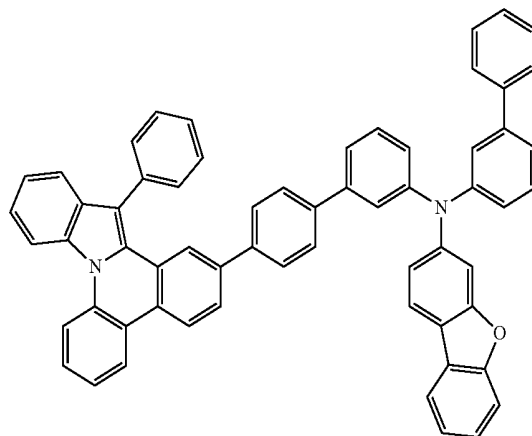
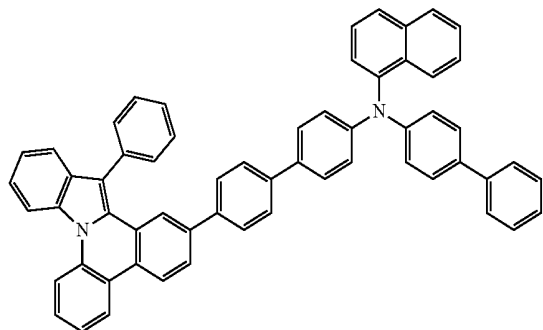


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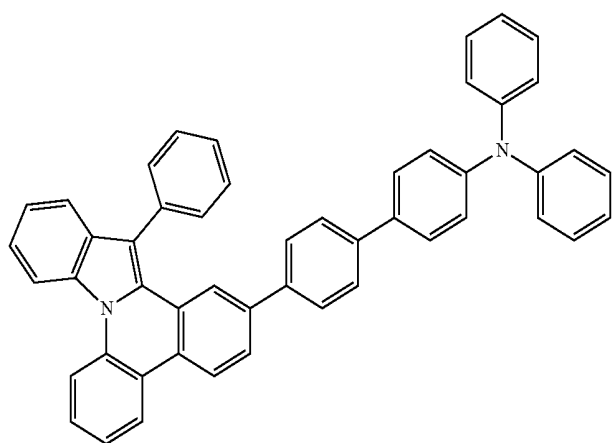
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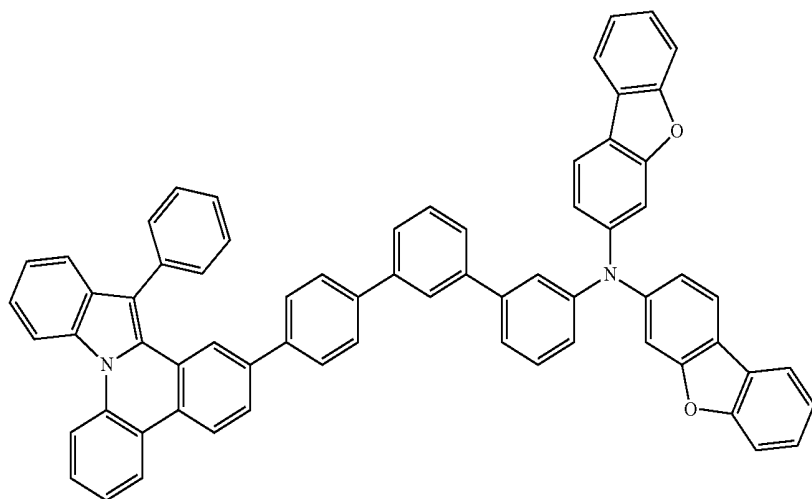
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D66



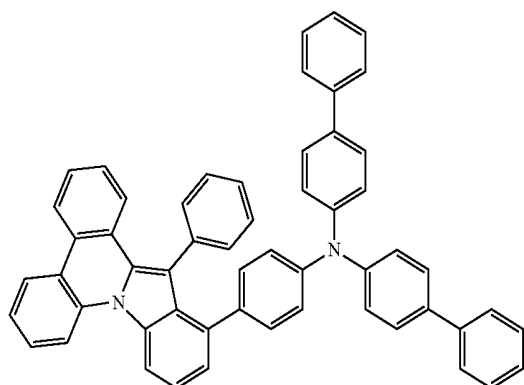
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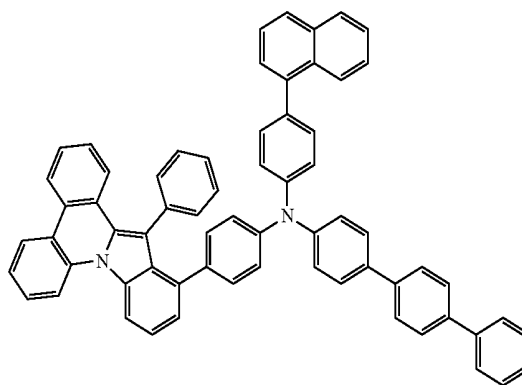
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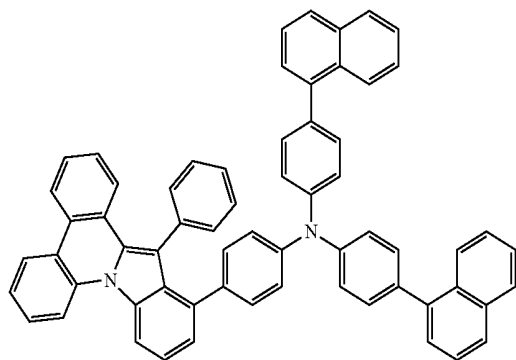
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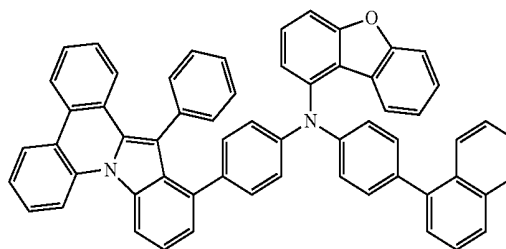
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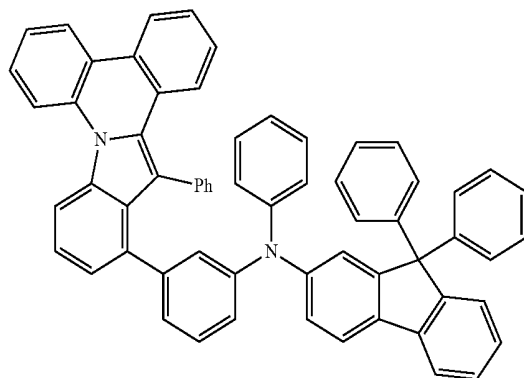
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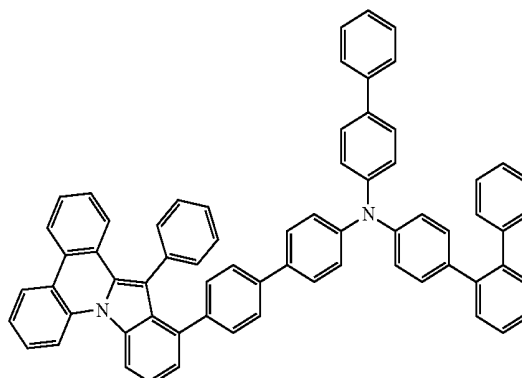
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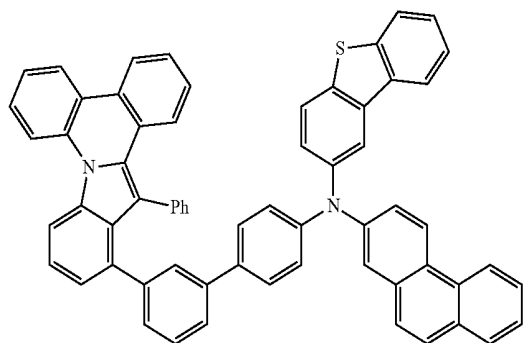
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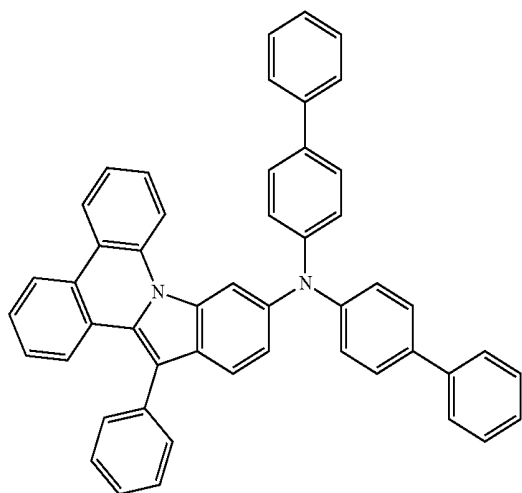
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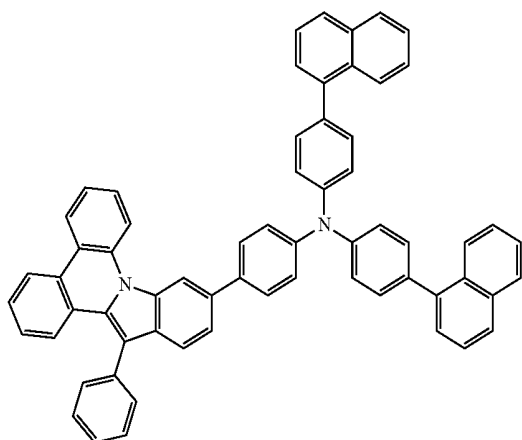
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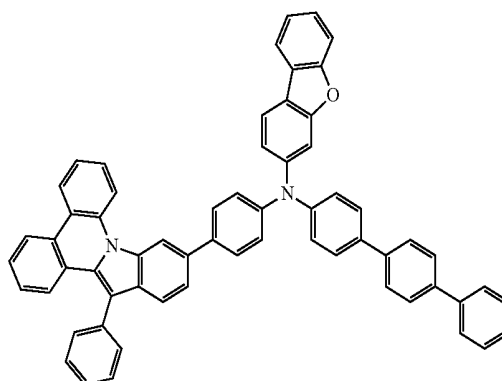
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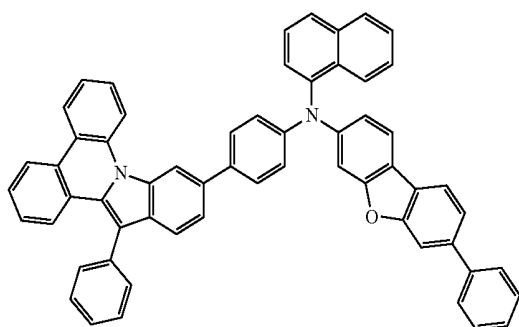
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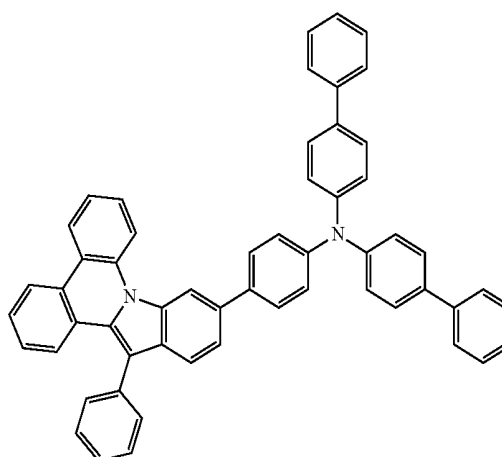
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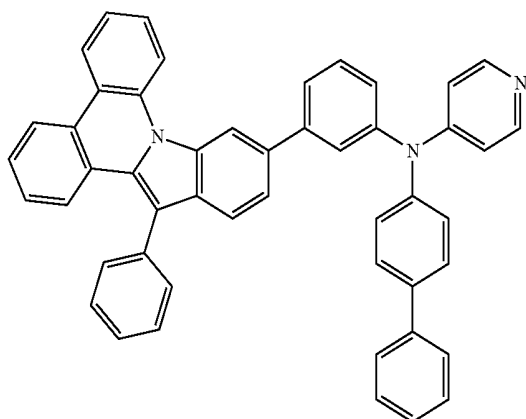
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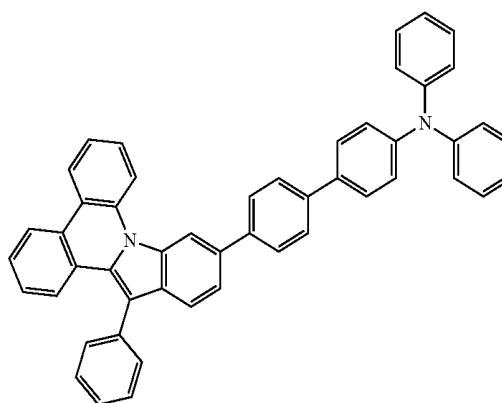
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D81

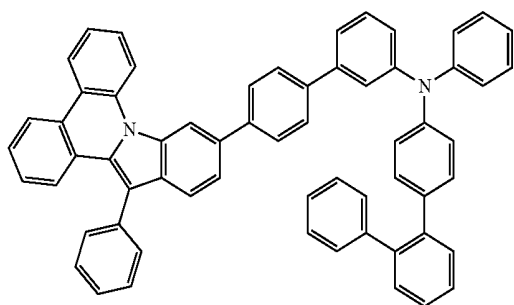


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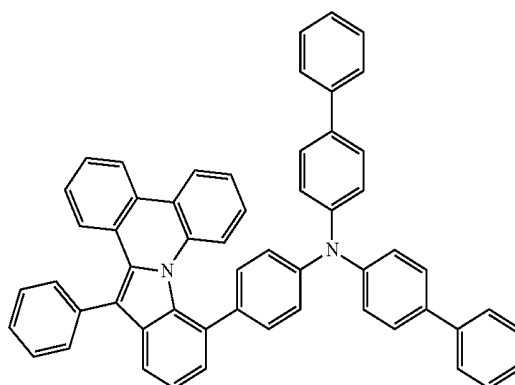


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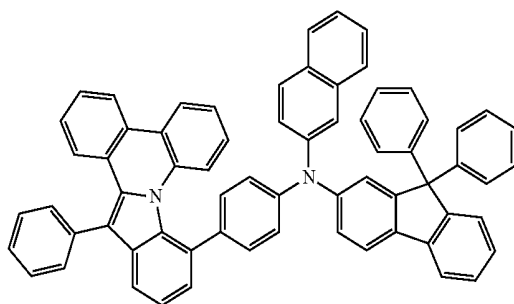
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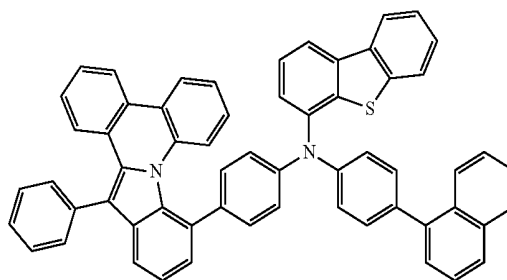
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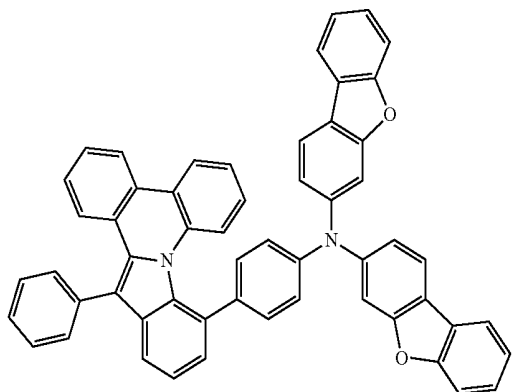
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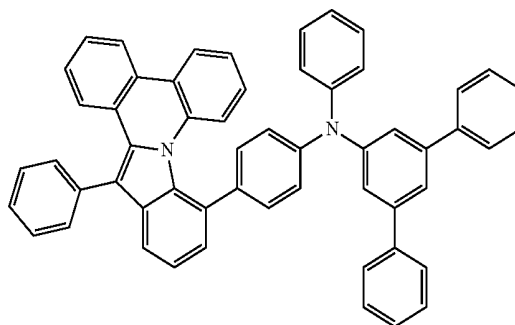
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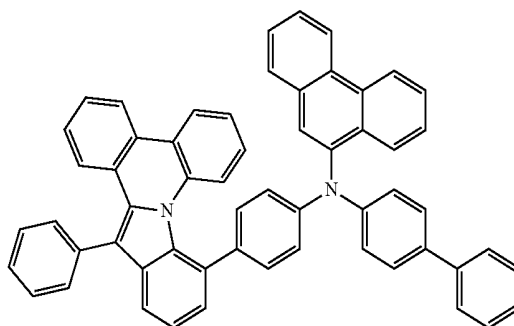
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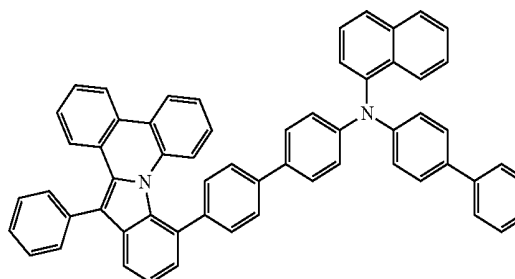
D88



D89

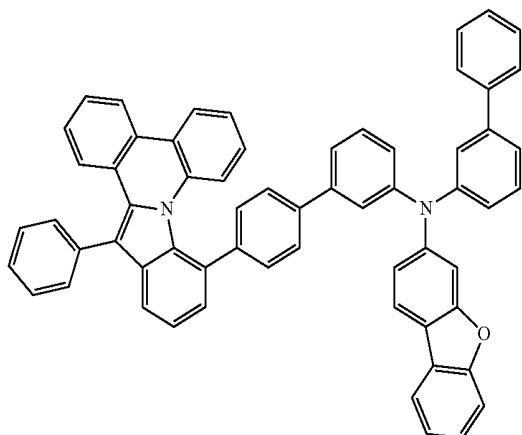


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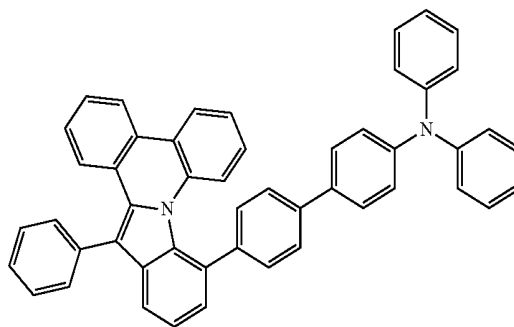


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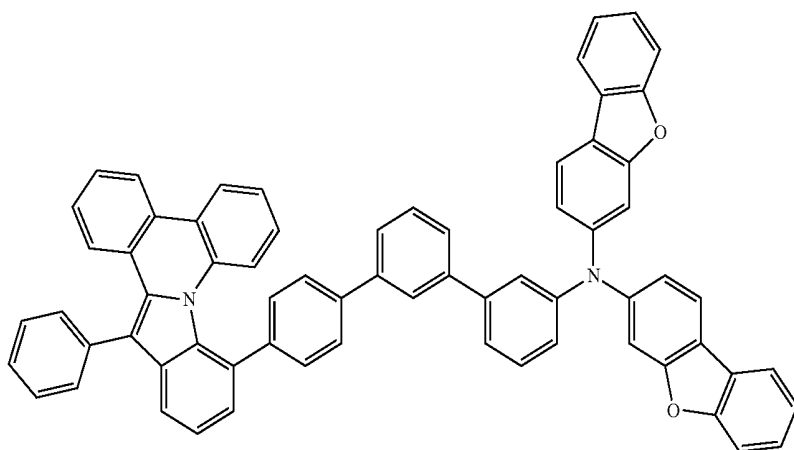
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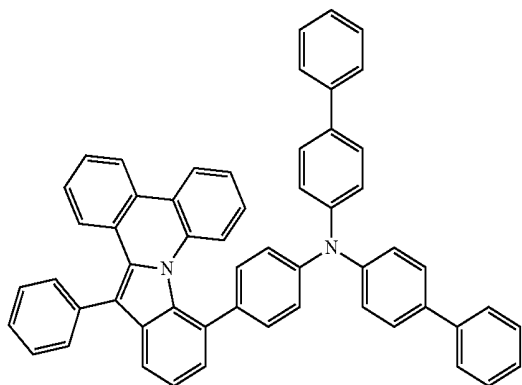
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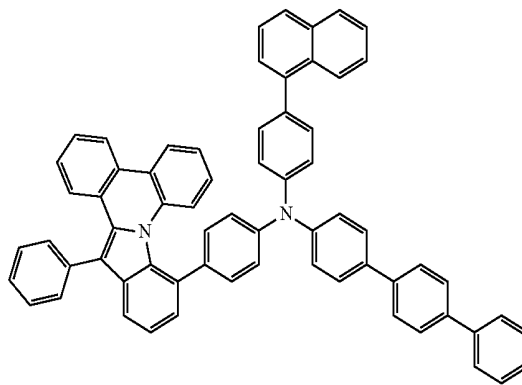
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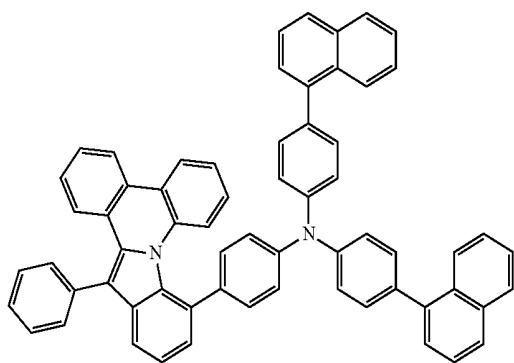
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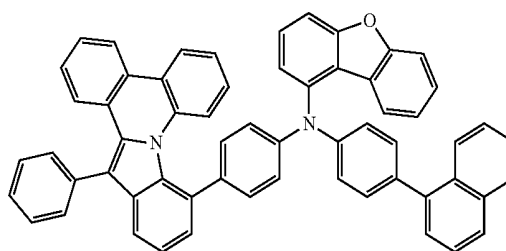
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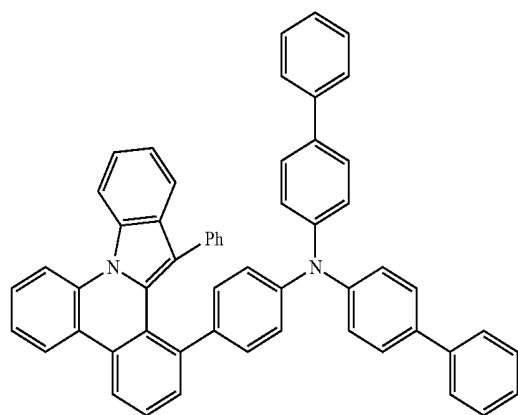
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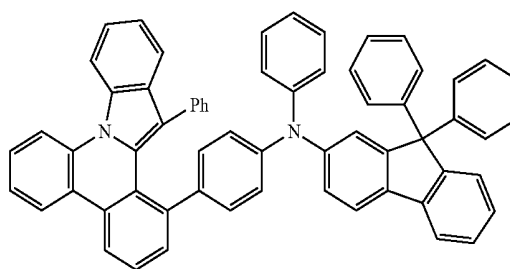
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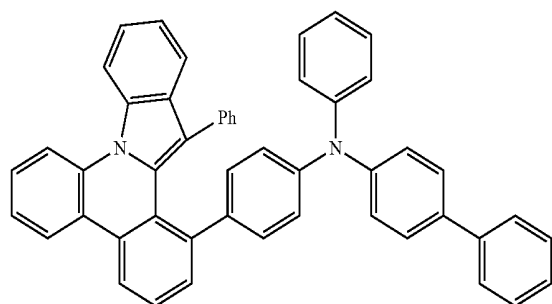
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D99

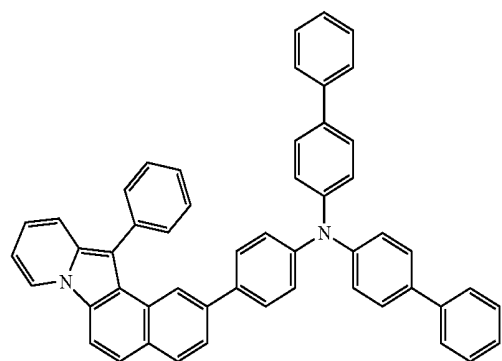


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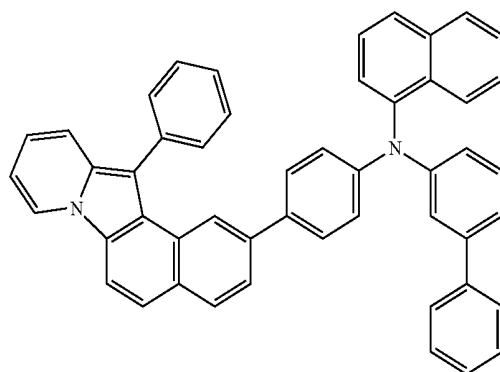


Compound Group 2

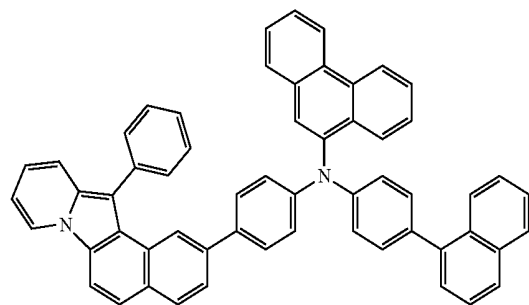
E1



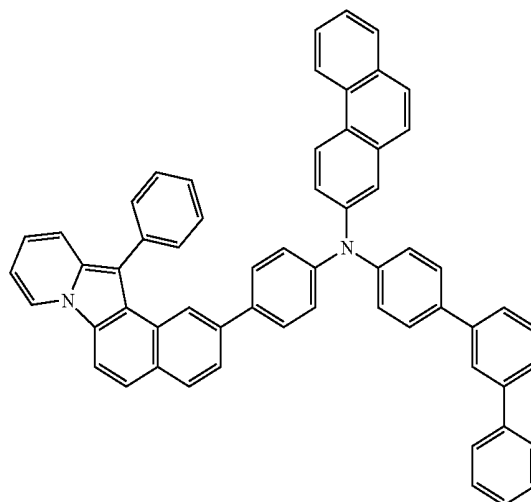
E2



E3

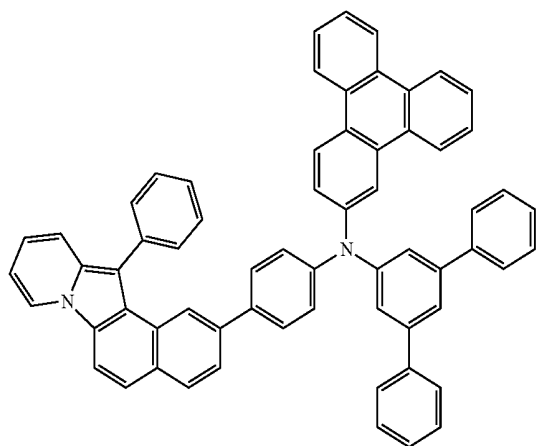


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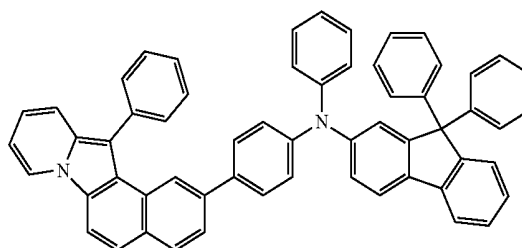


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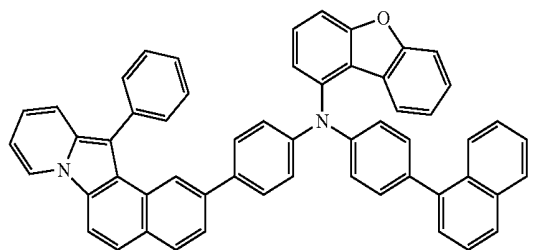
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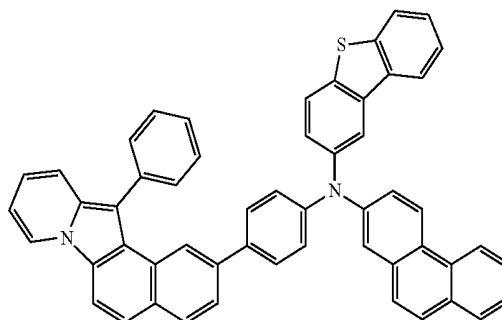
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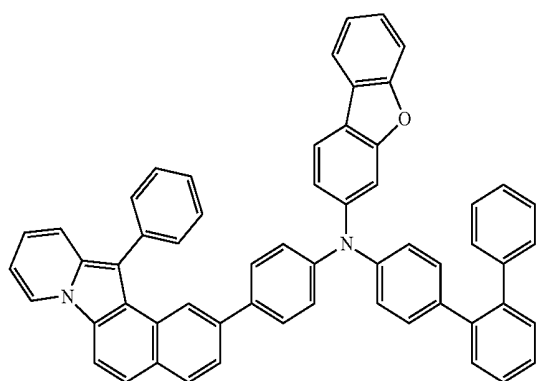
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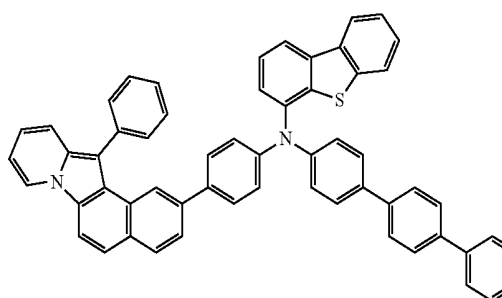
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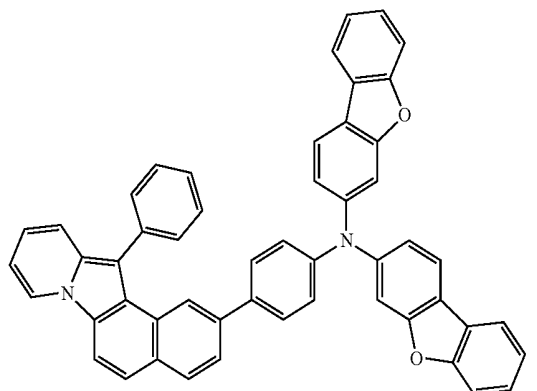
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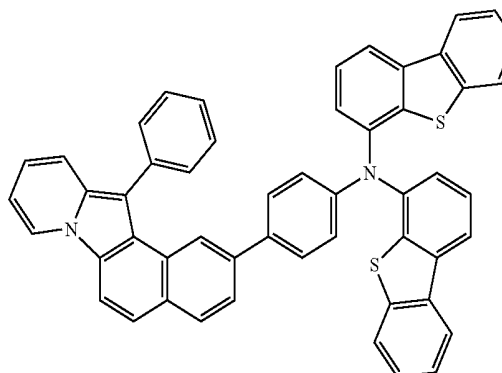
E10



E11

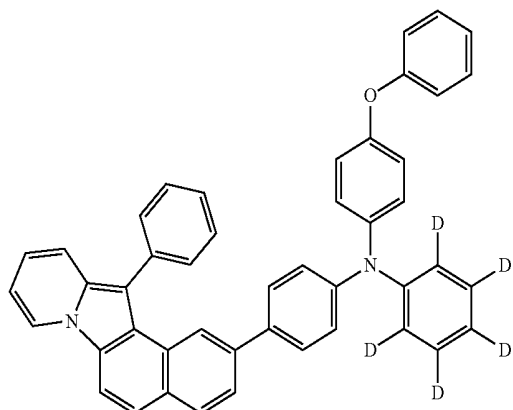


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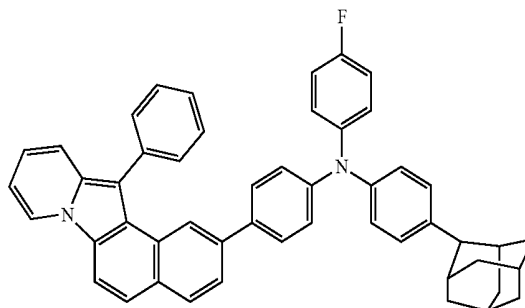


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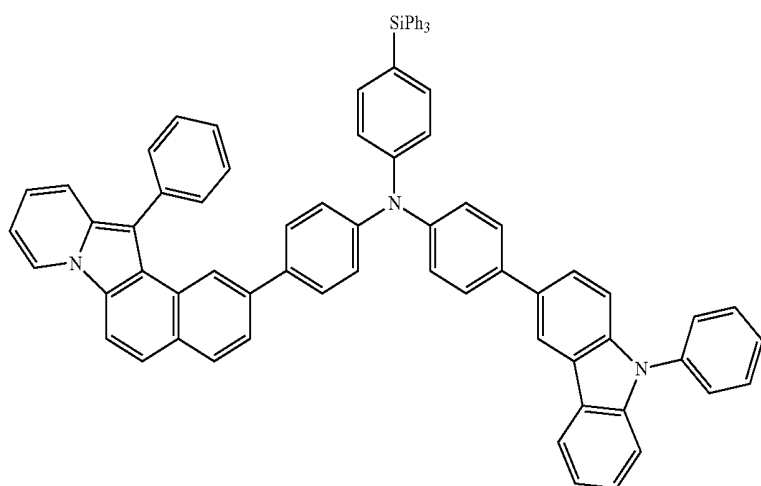
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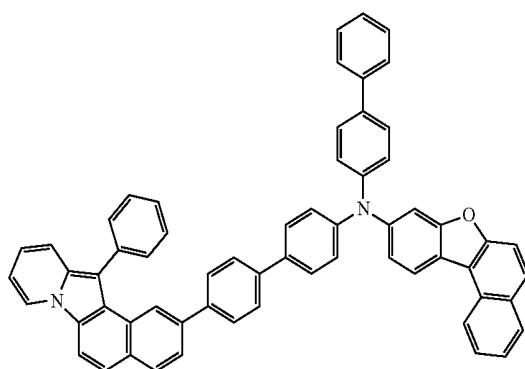
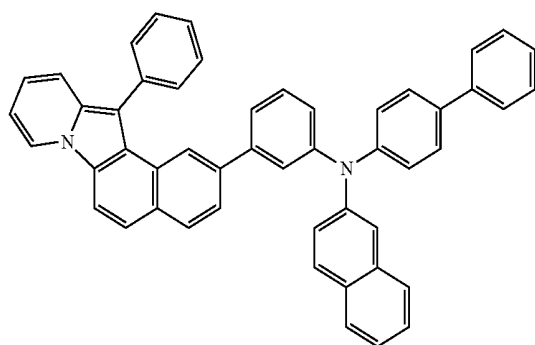


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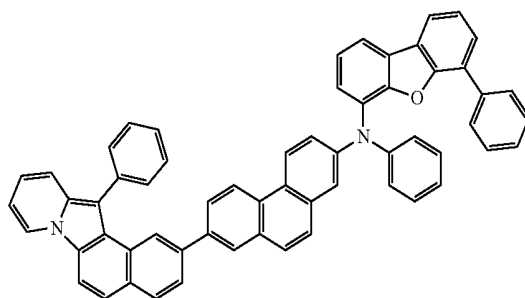
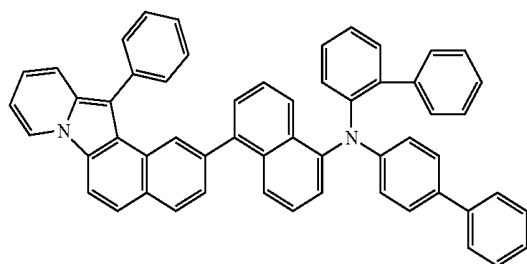
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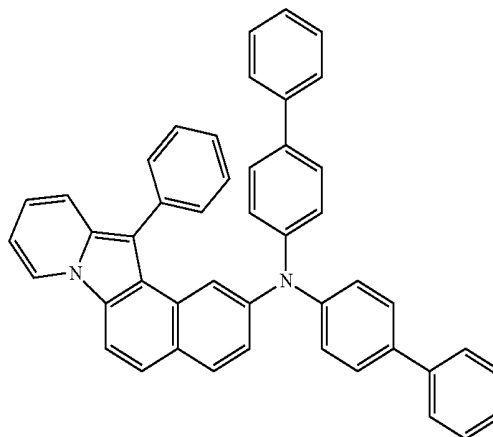
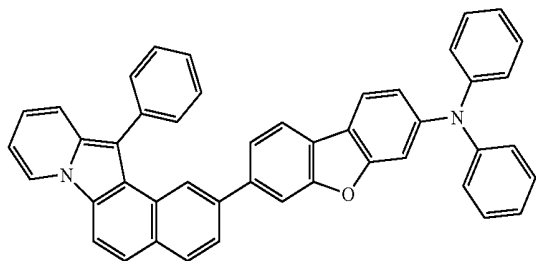
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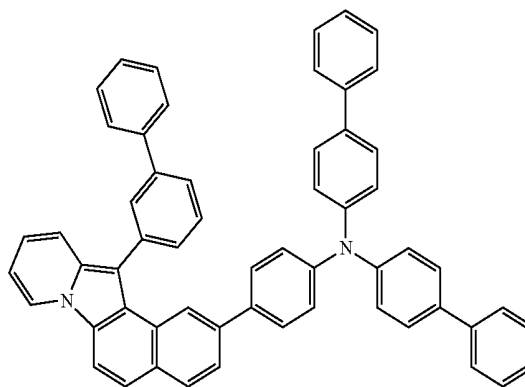
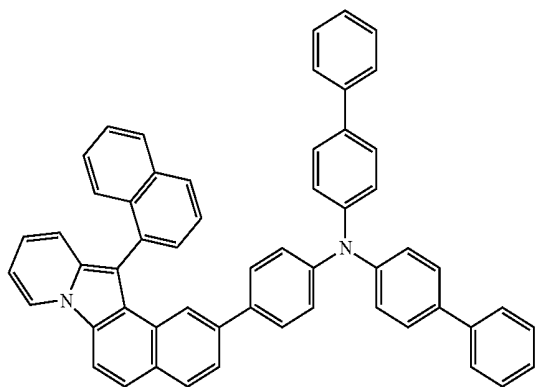
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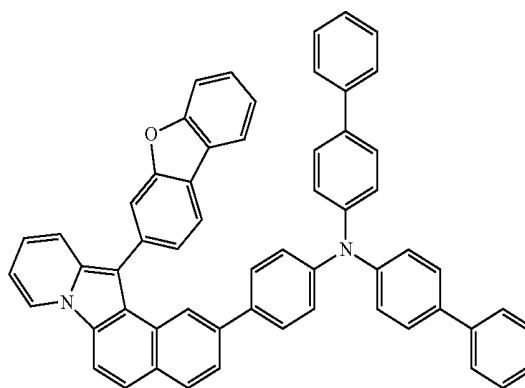
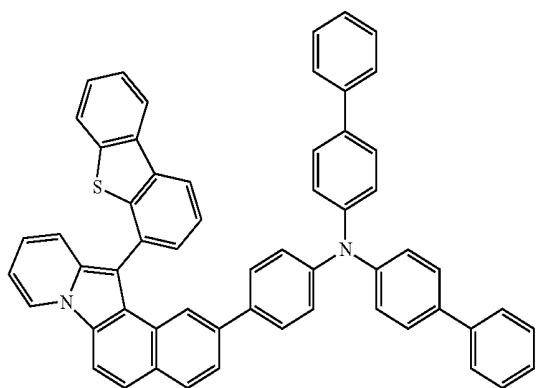
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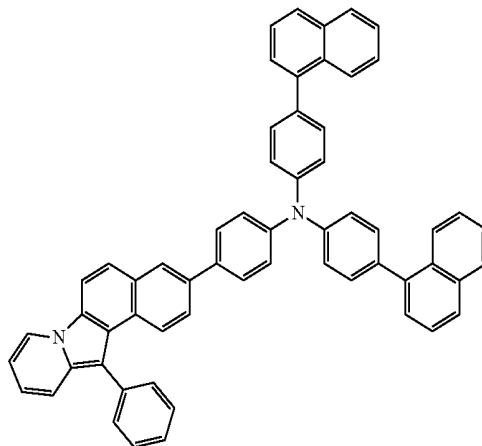
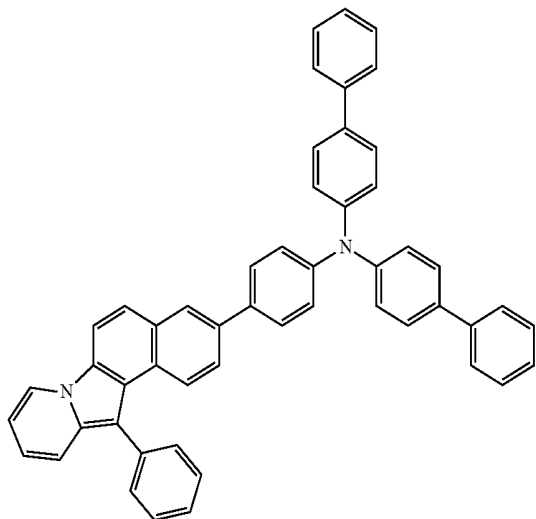
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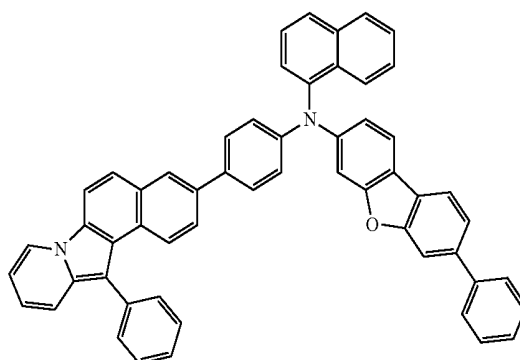
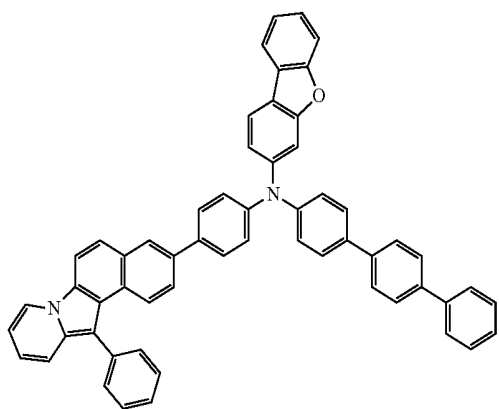
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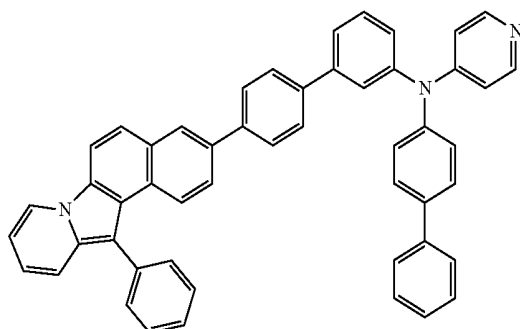
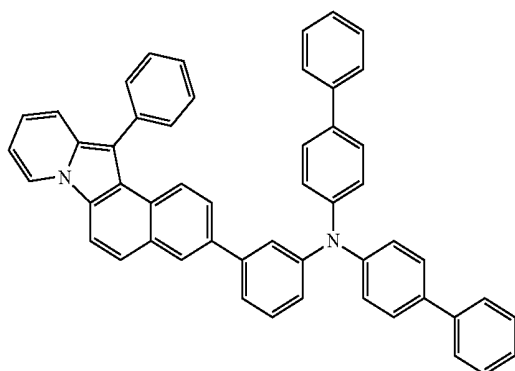
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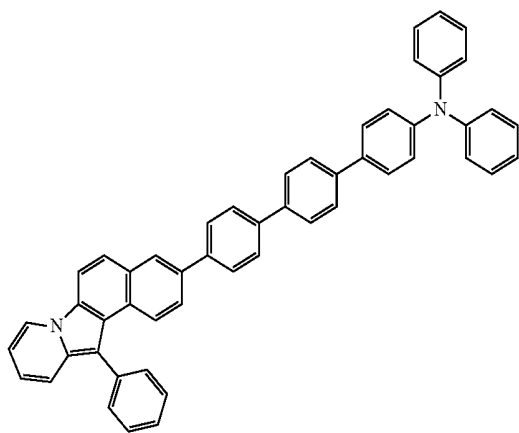


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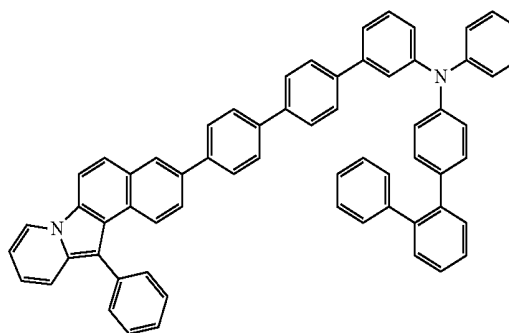
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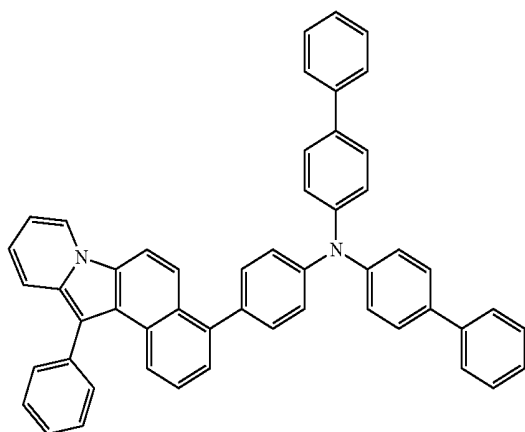
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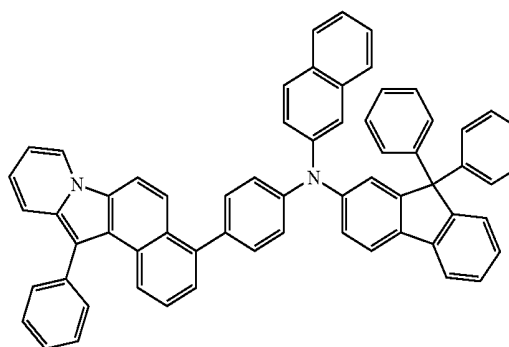
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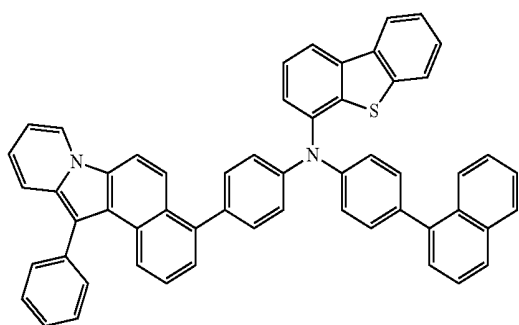
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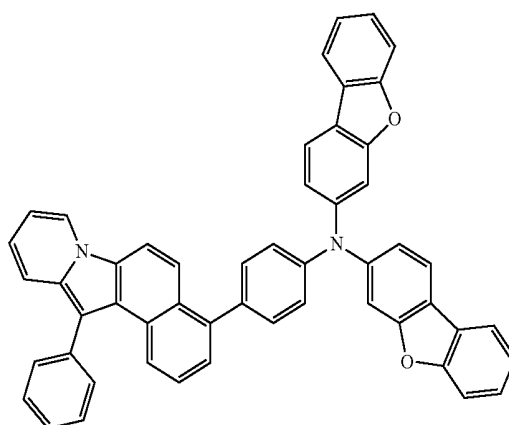
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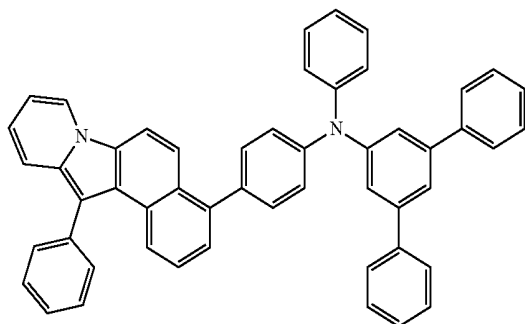
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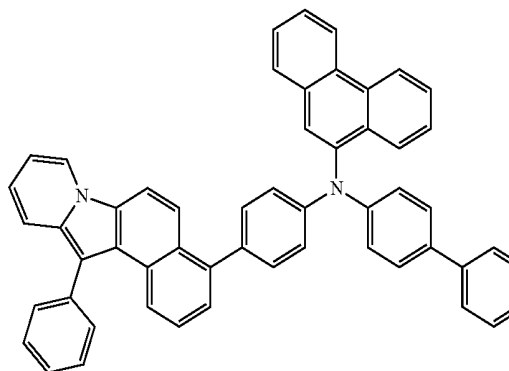
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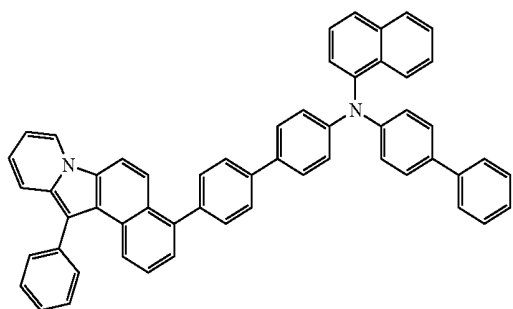


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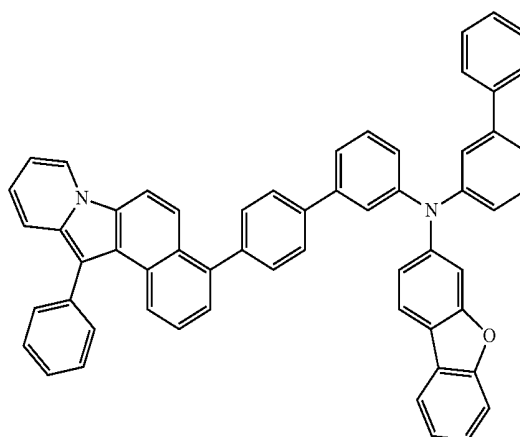


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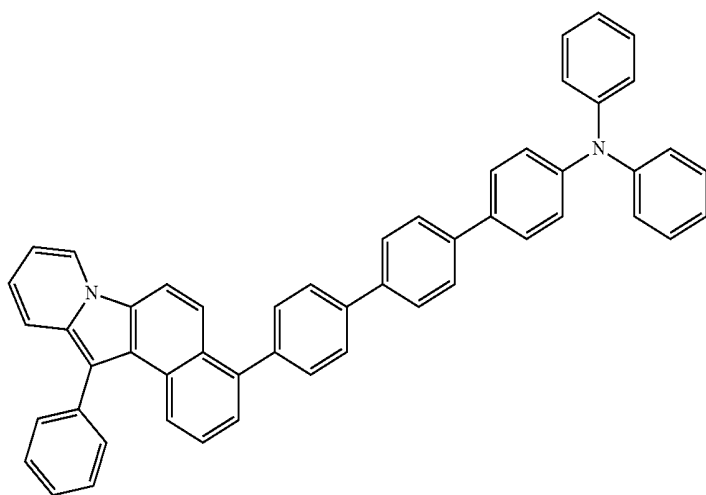
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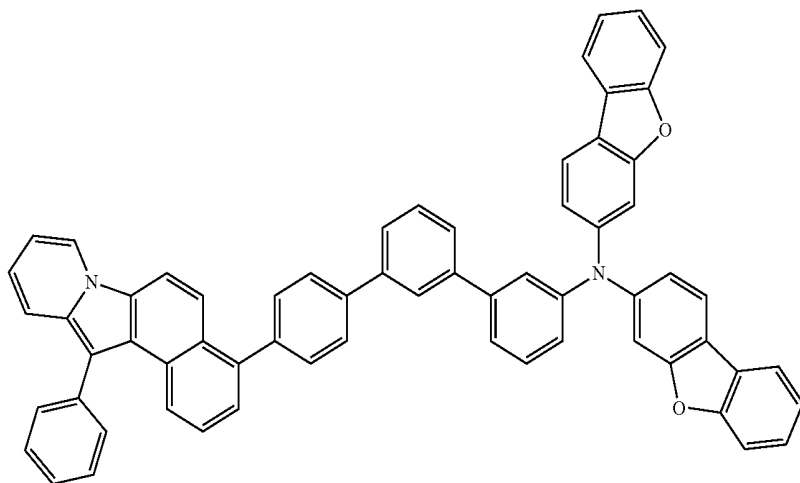
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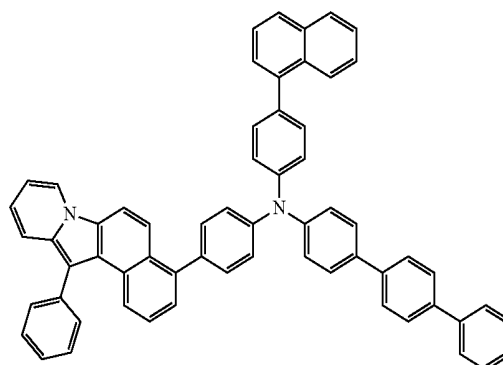
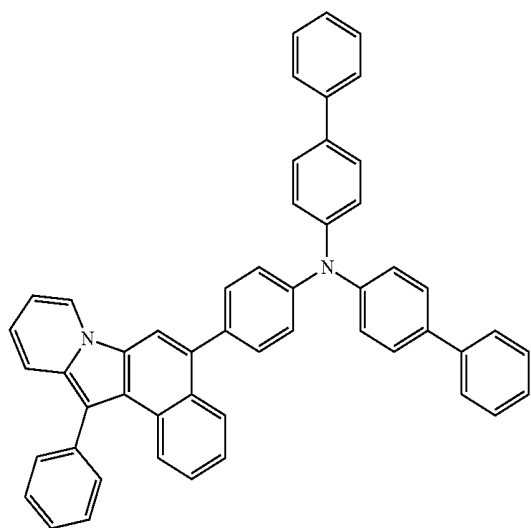
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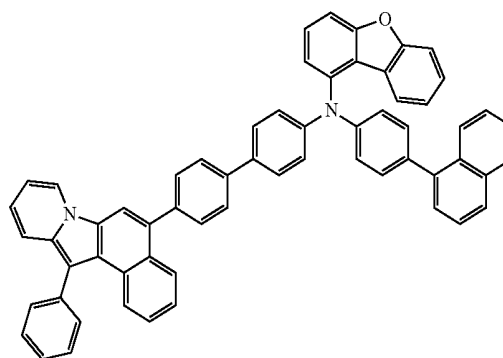
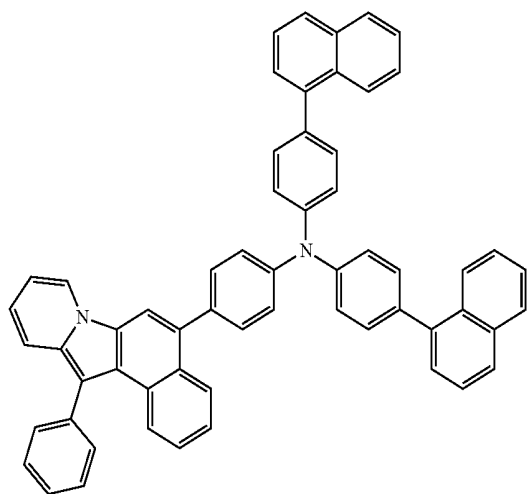


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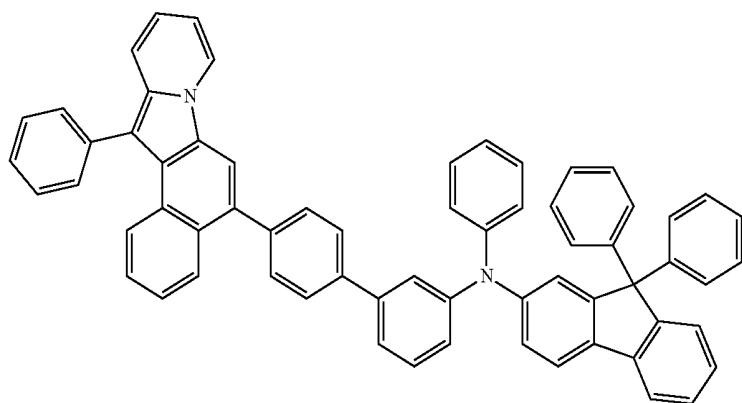
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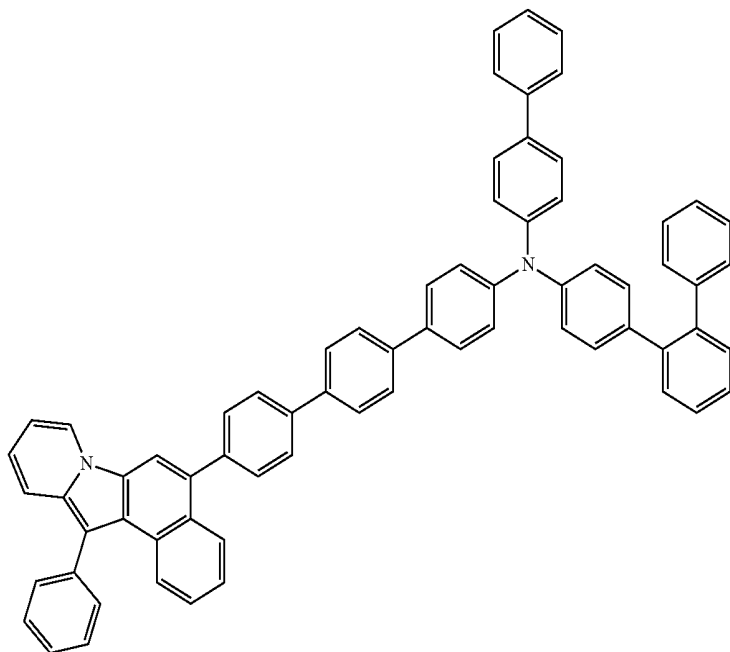
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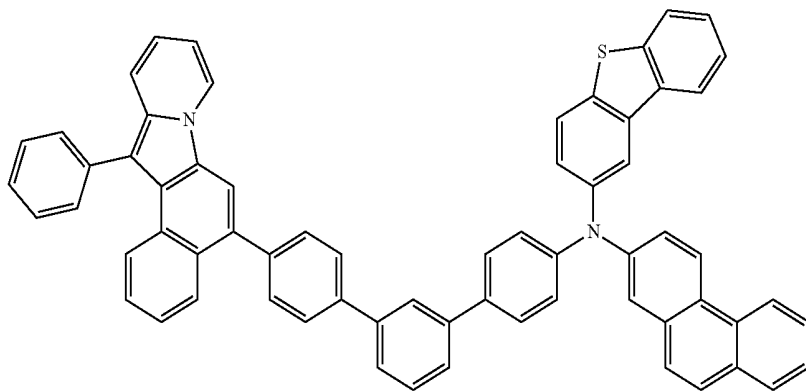


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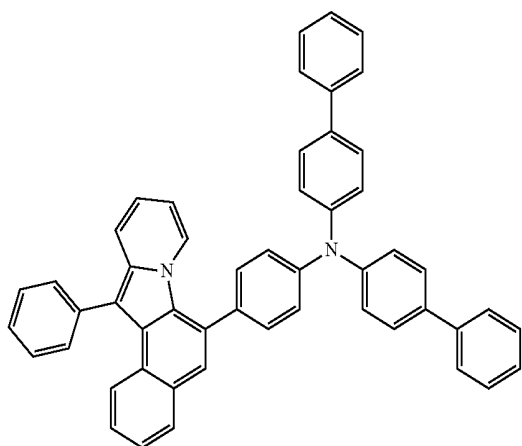
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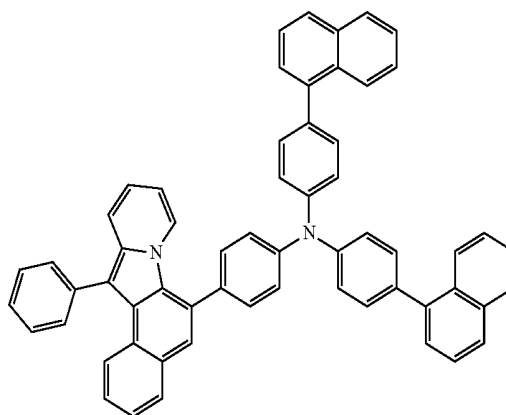
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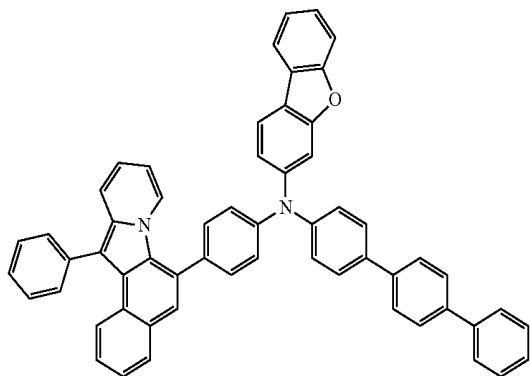


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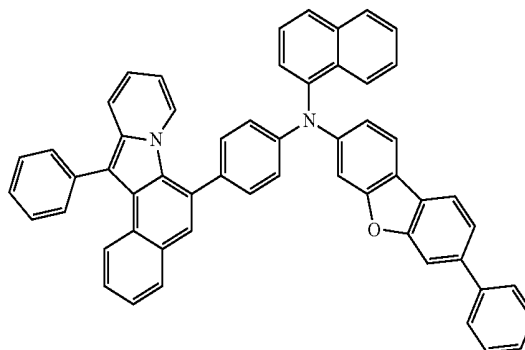


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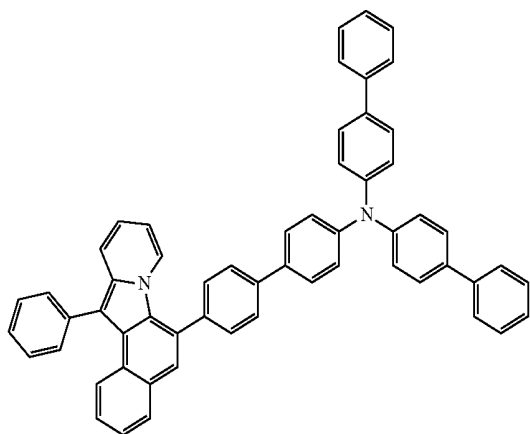
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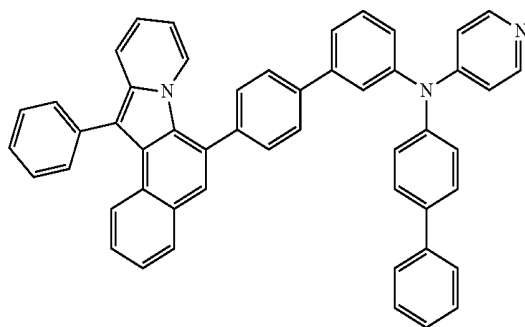
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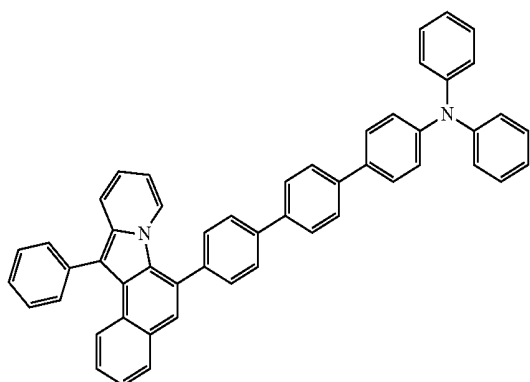
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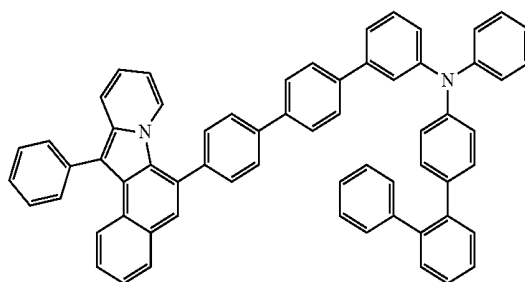
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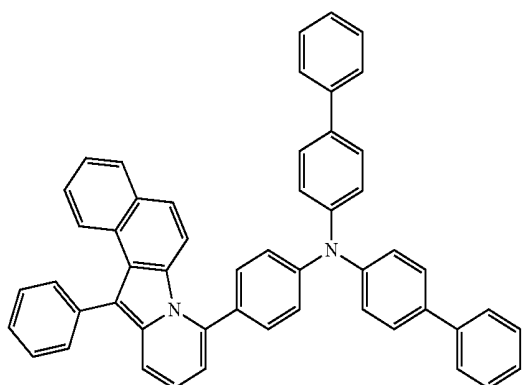
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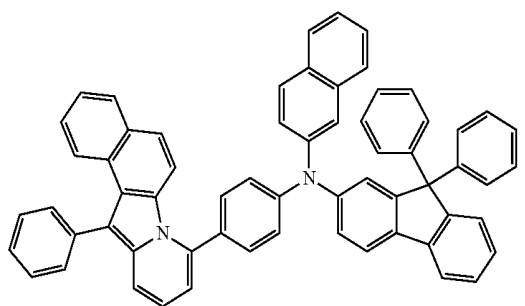
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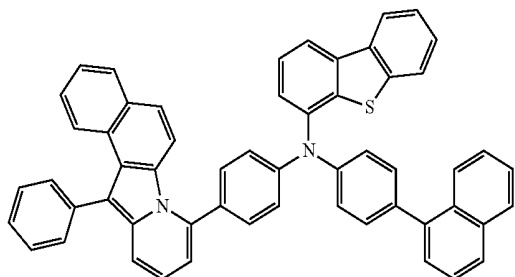


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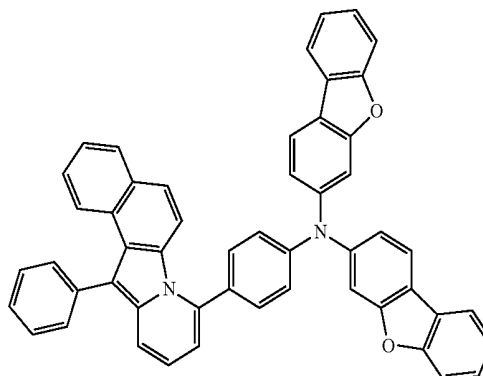


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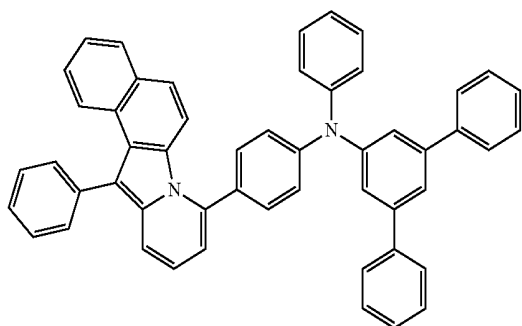
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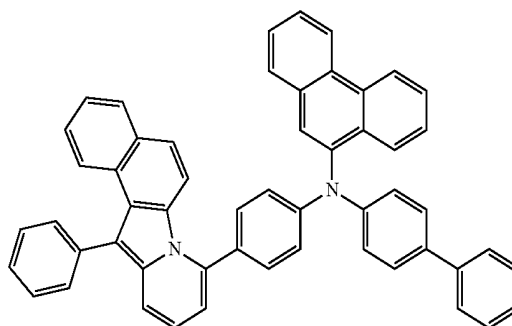
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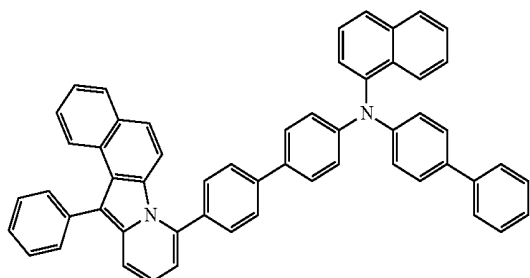
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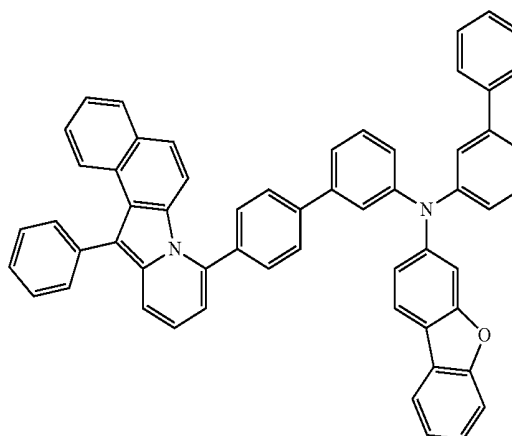
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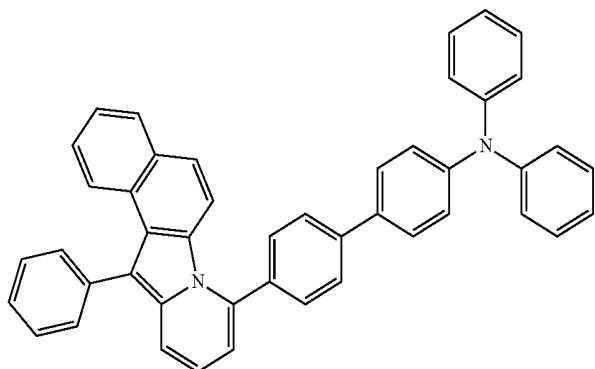
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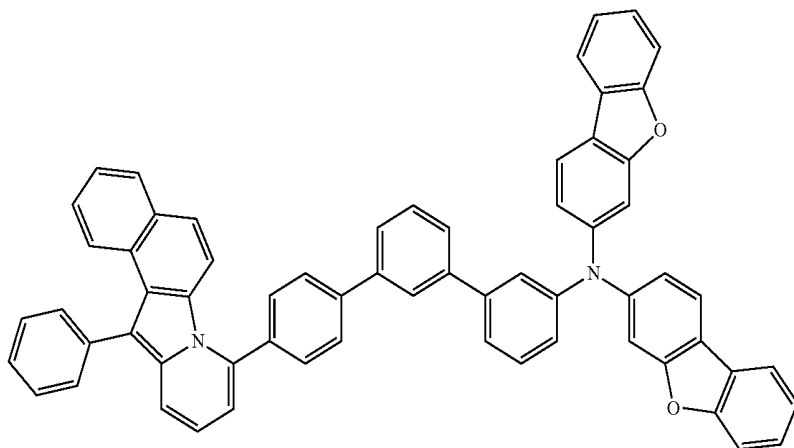


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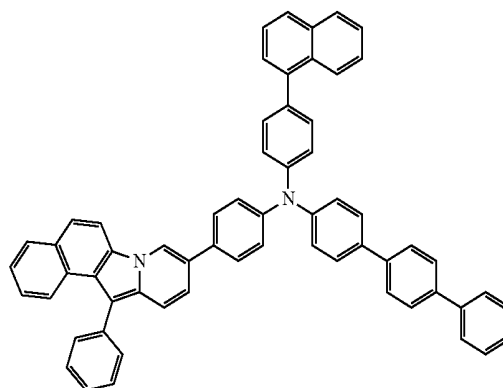
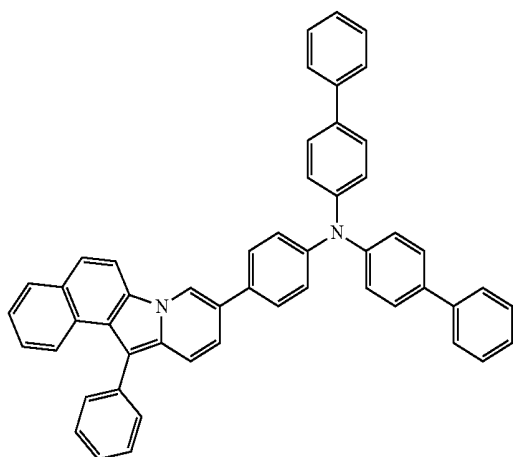
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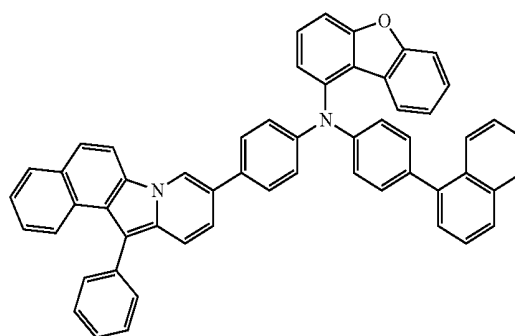
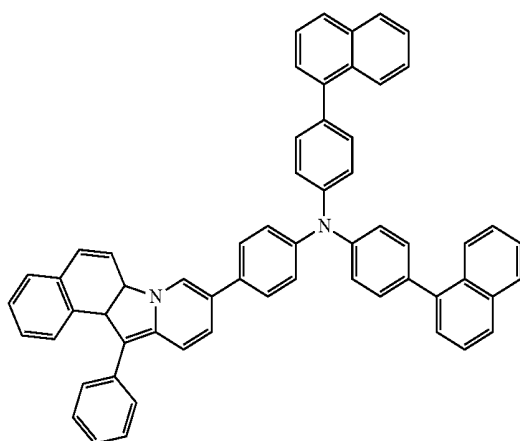
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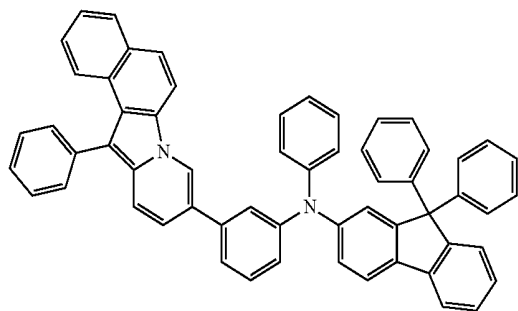


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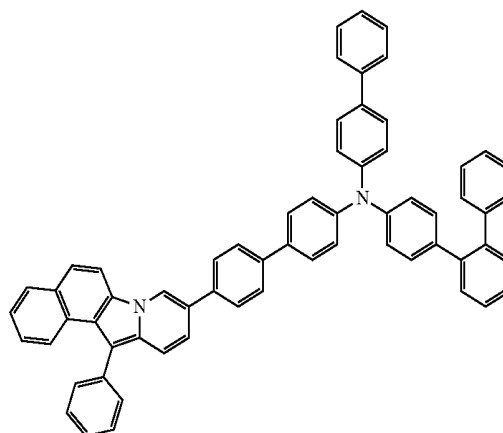
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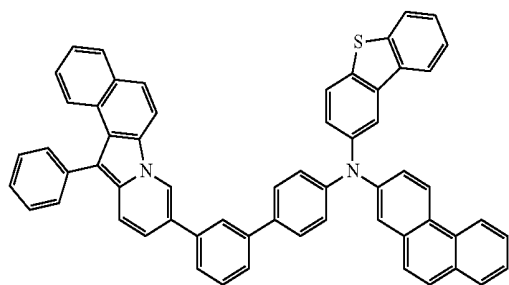
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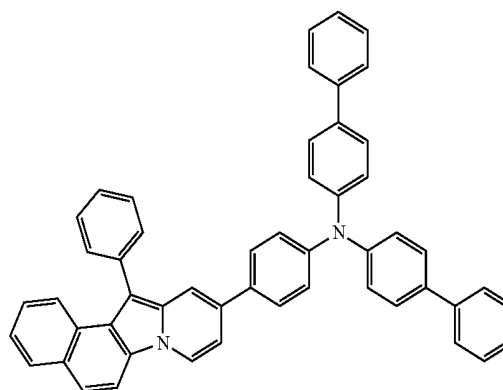
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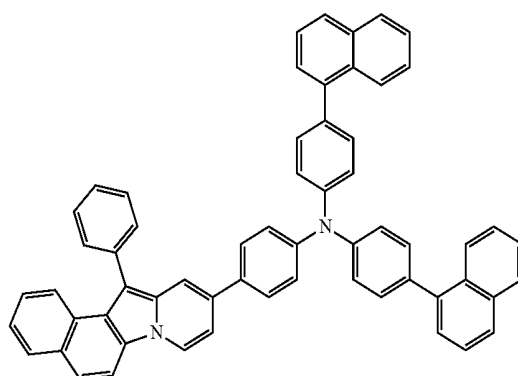
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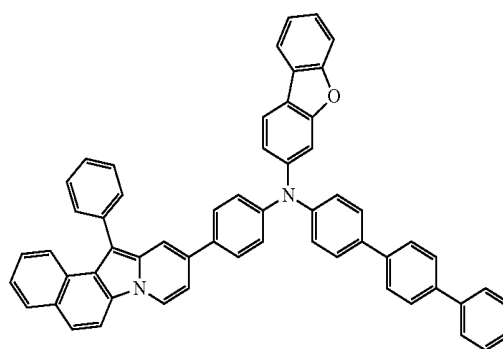
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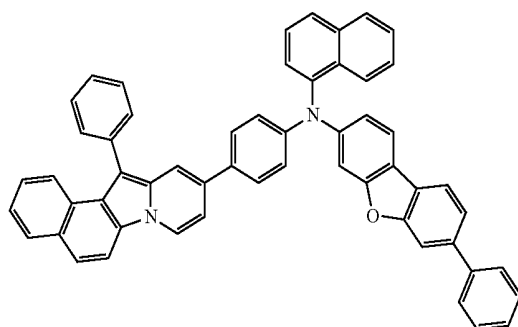
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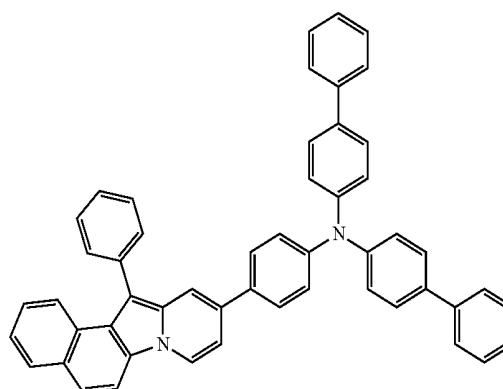
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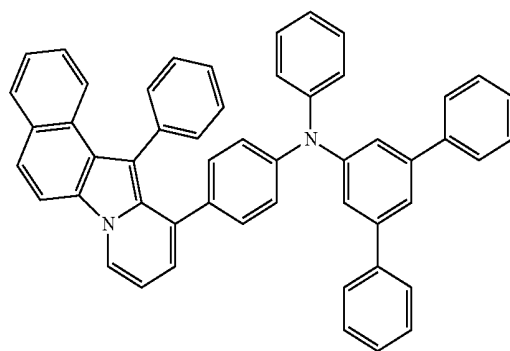
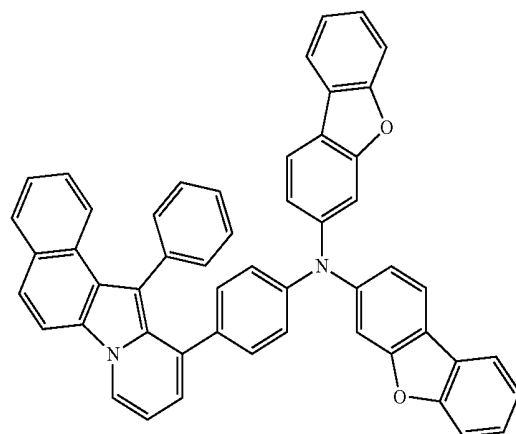
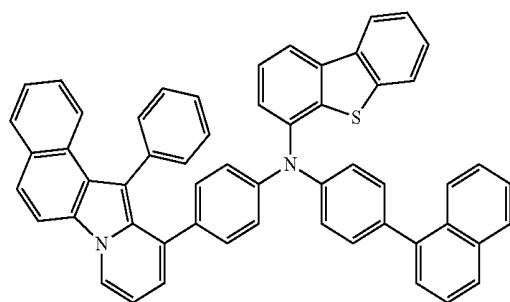
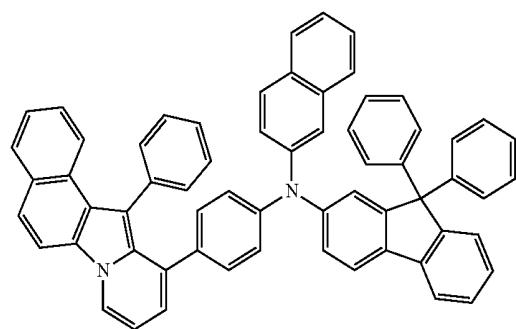
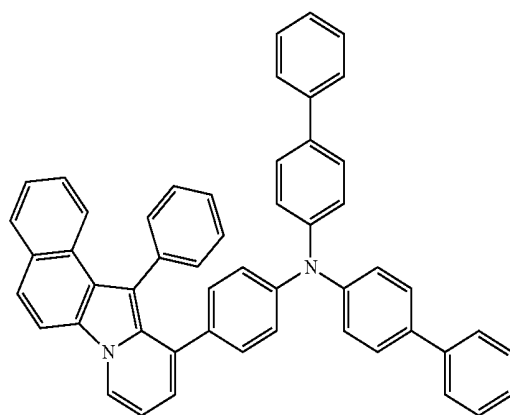
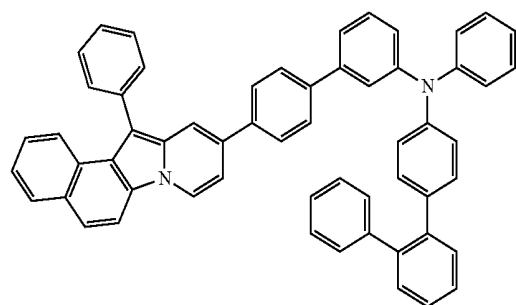
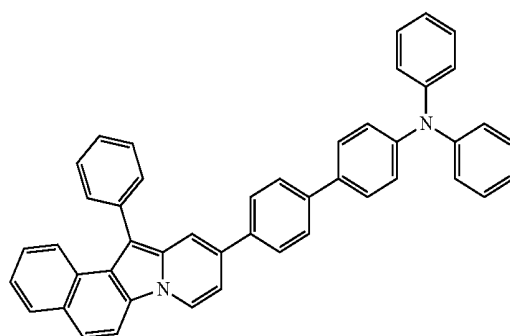
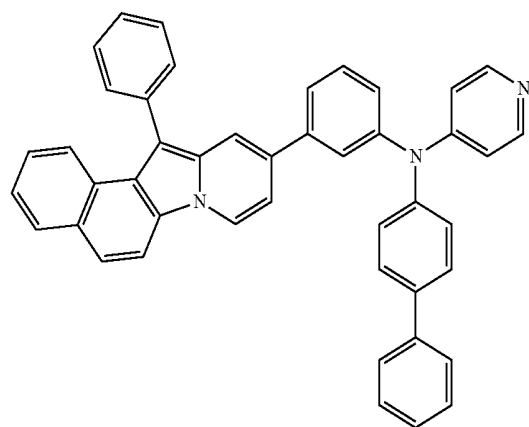


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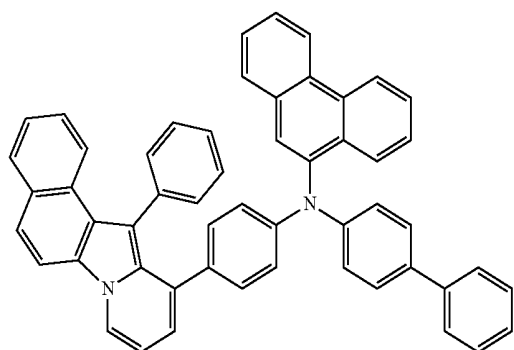


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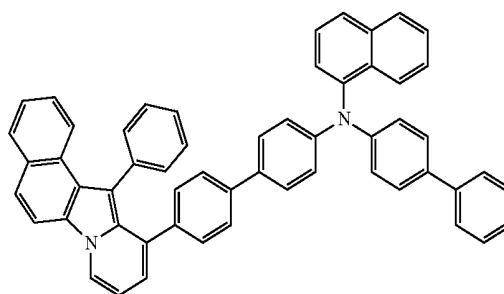
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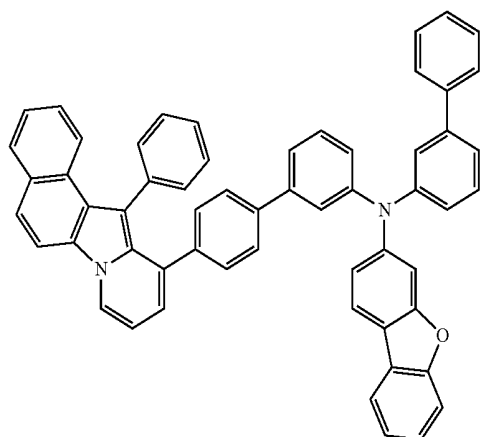
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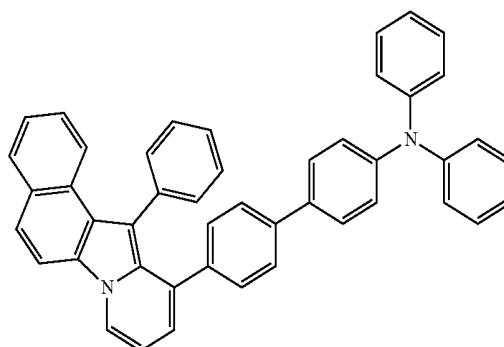
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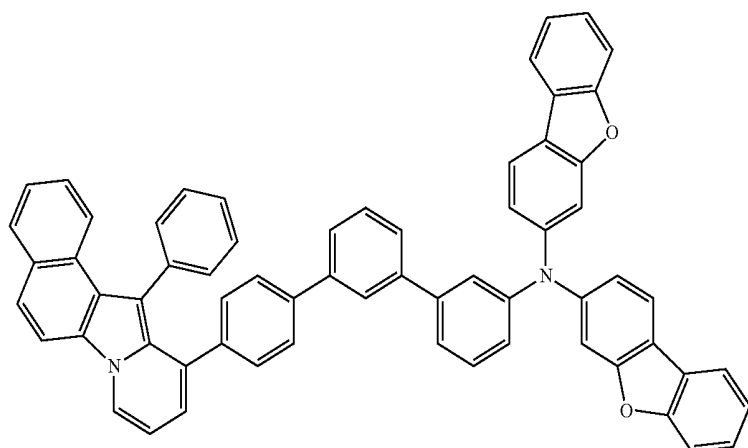
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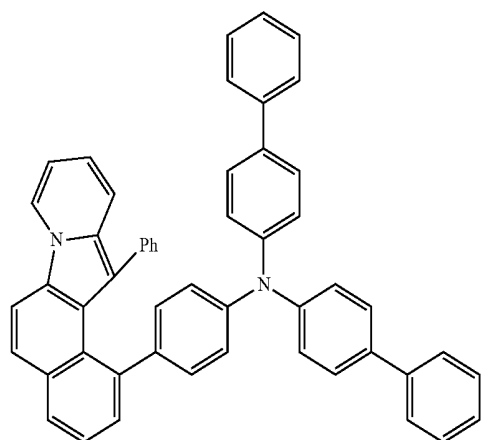


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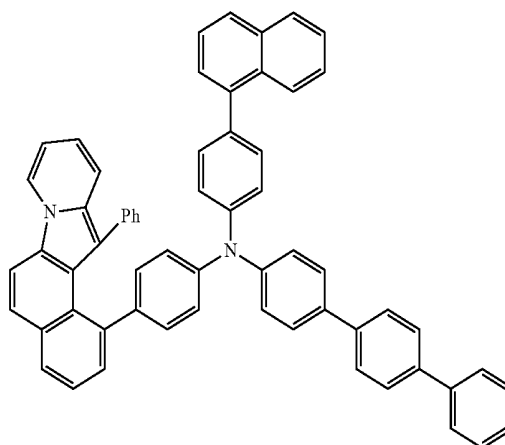


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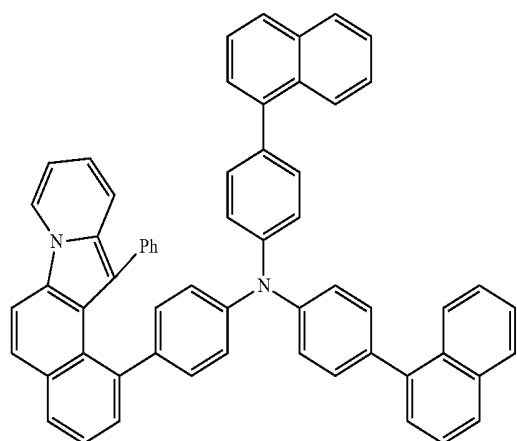
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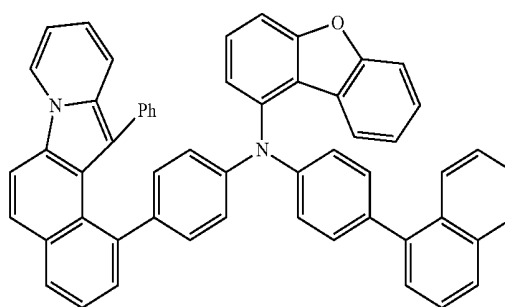
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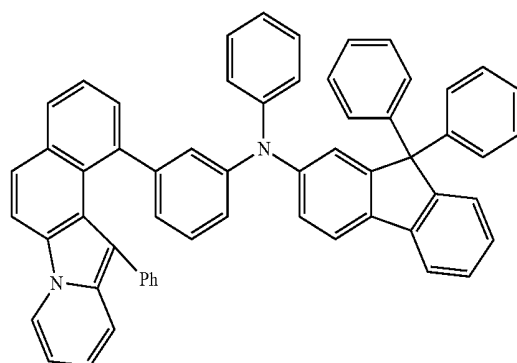
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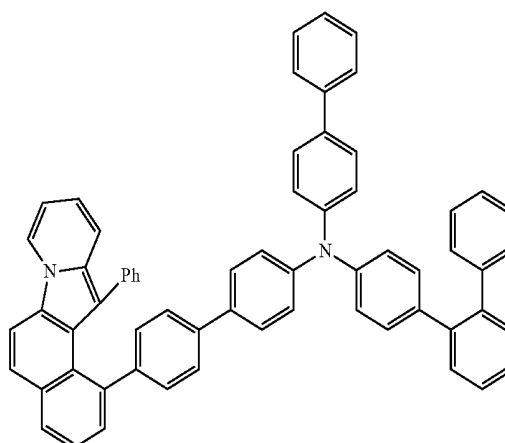
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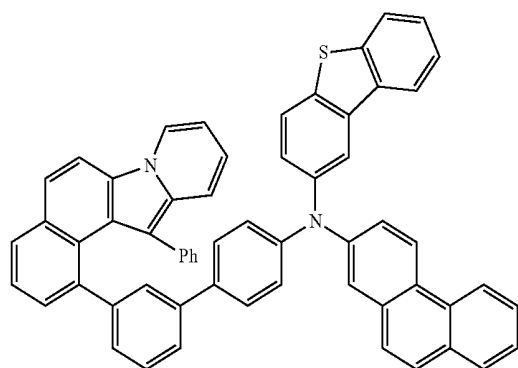


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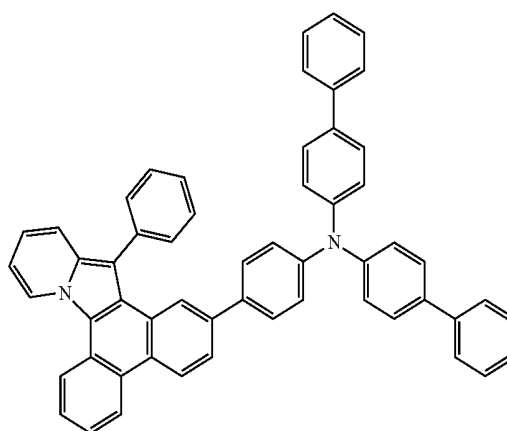


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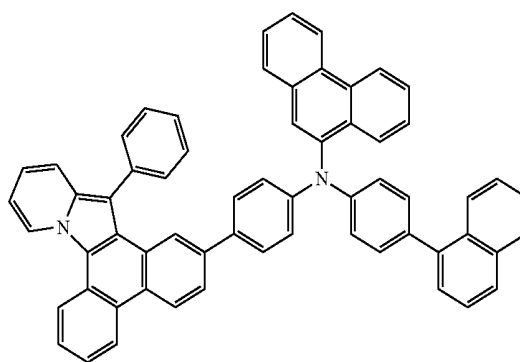
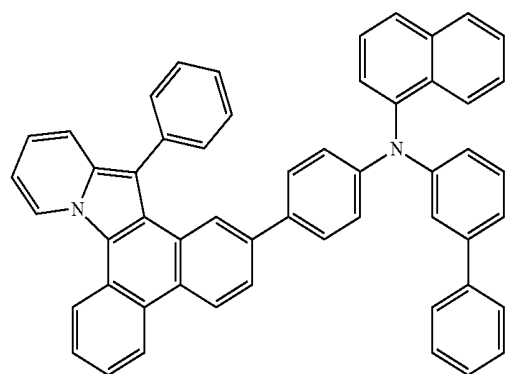


F1



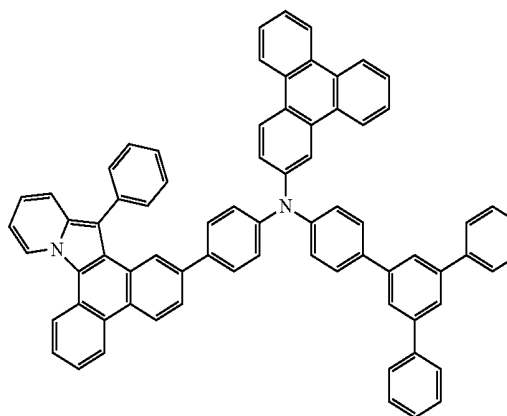
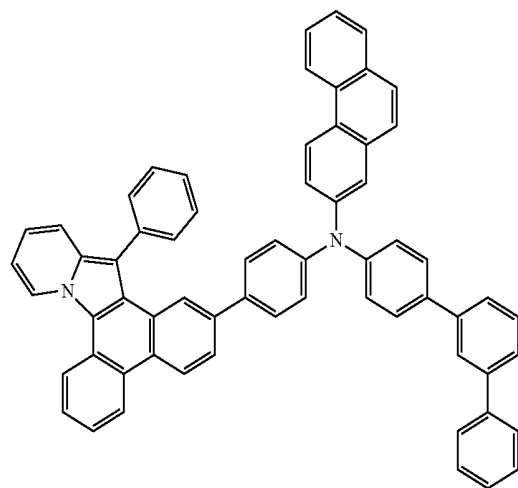
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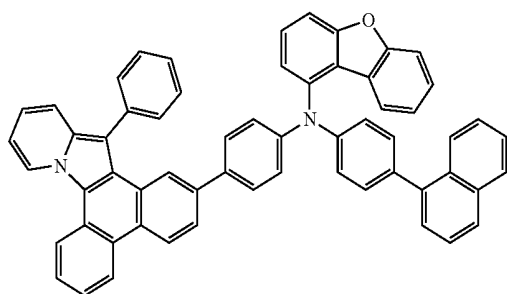
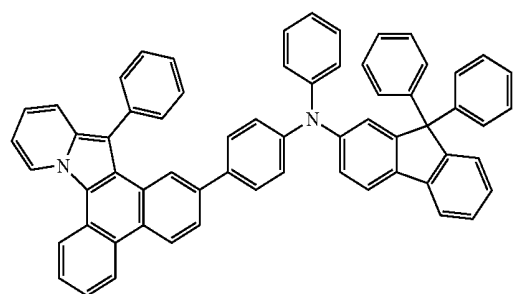
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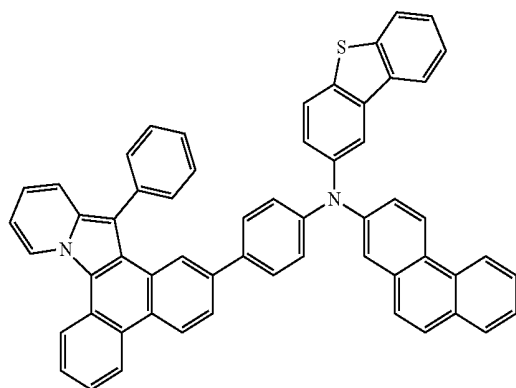
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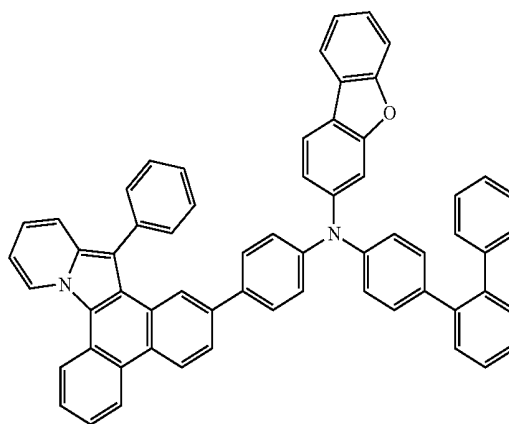


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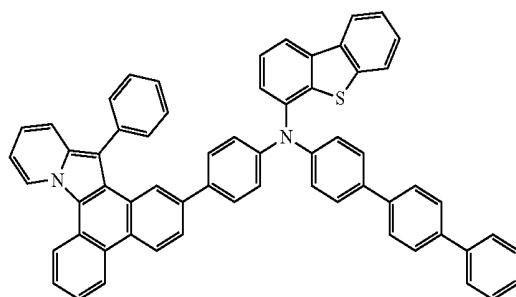
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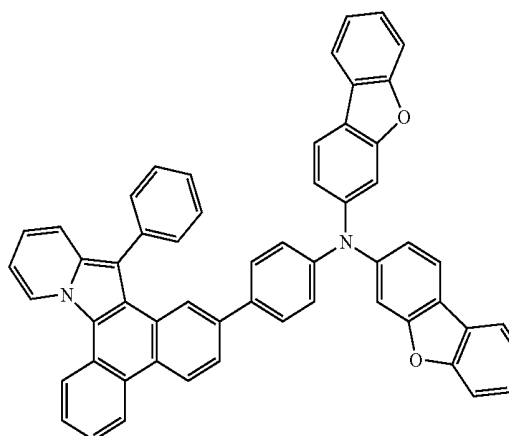
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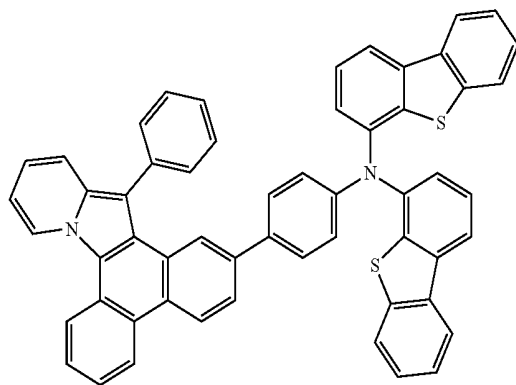
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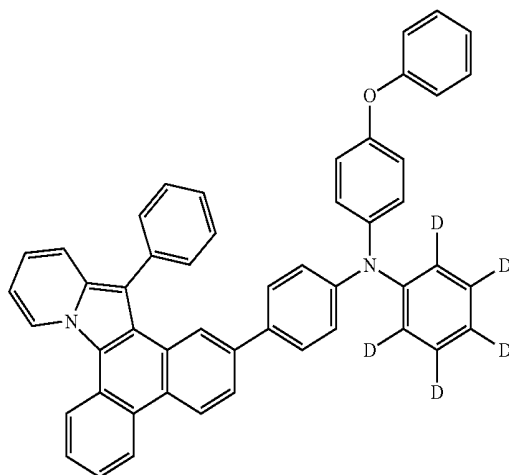
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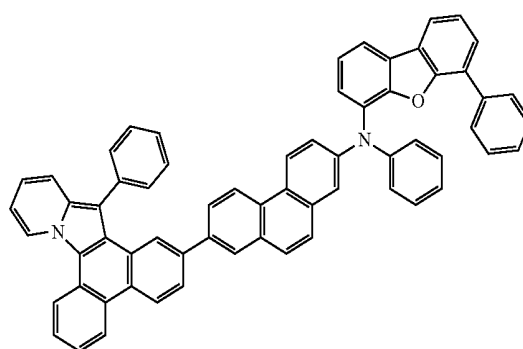
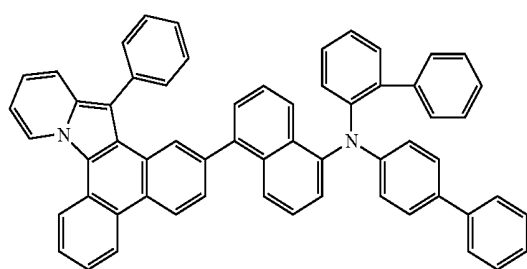
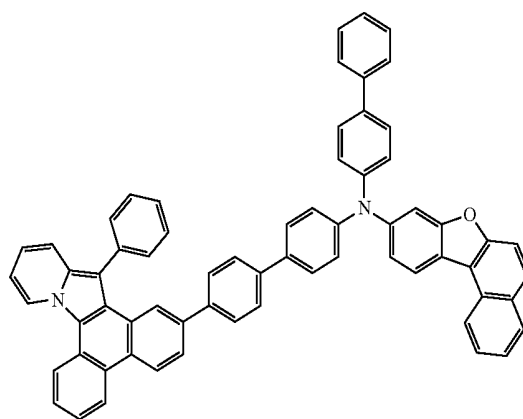
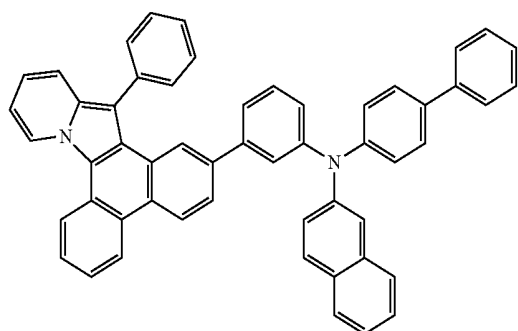
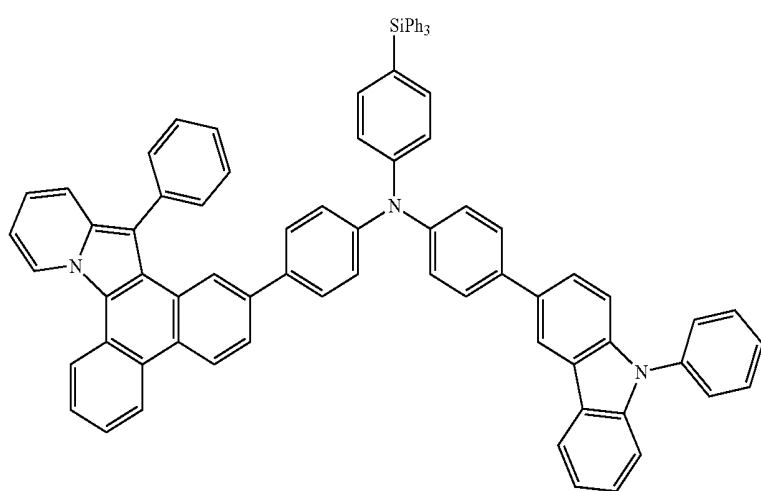
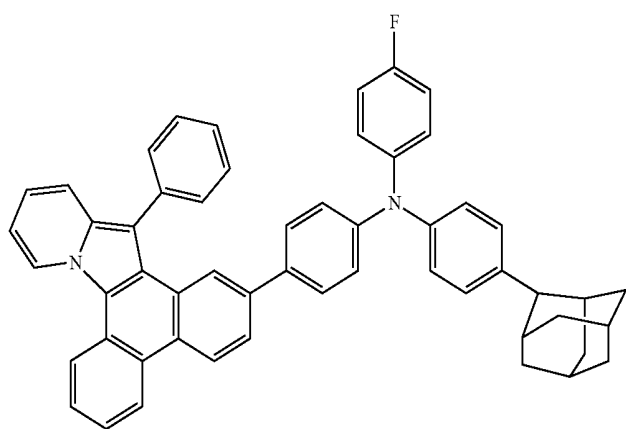
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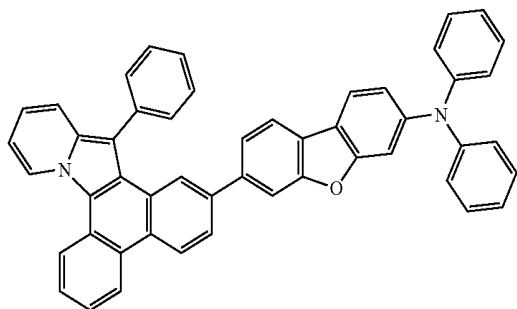


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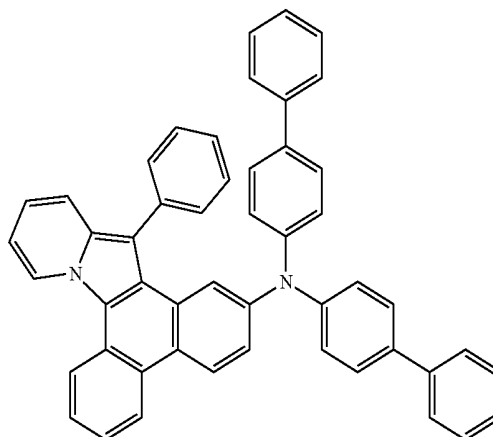


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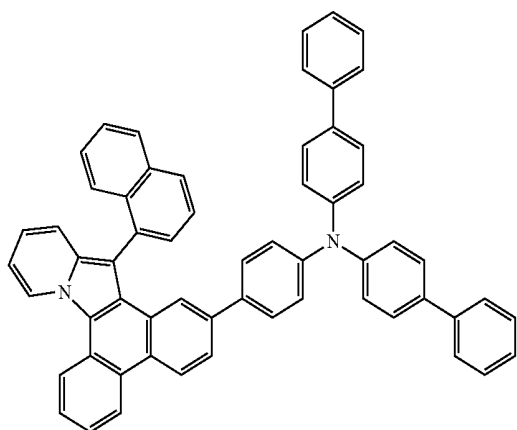
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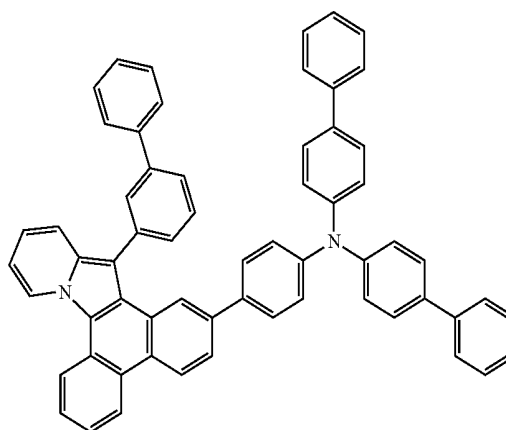
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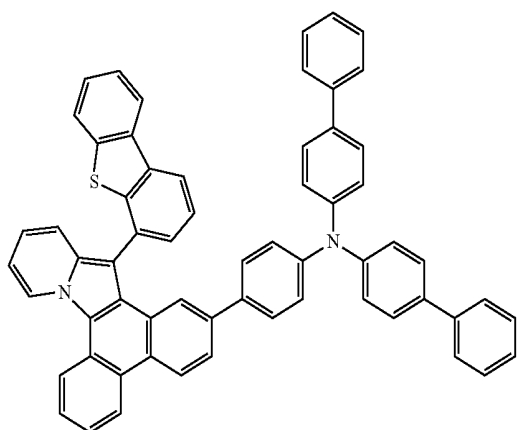
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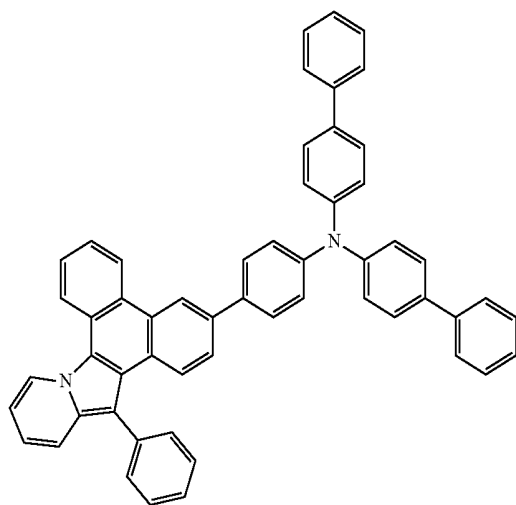
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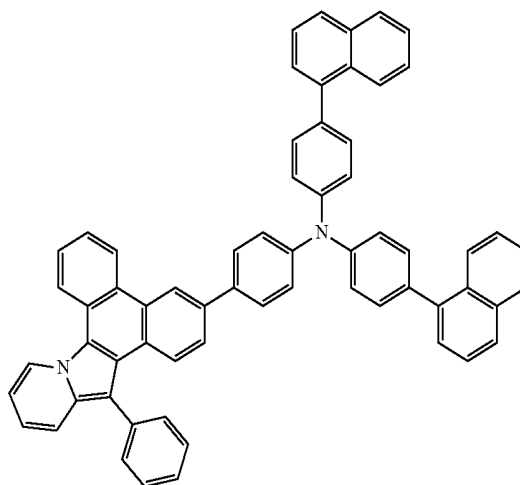
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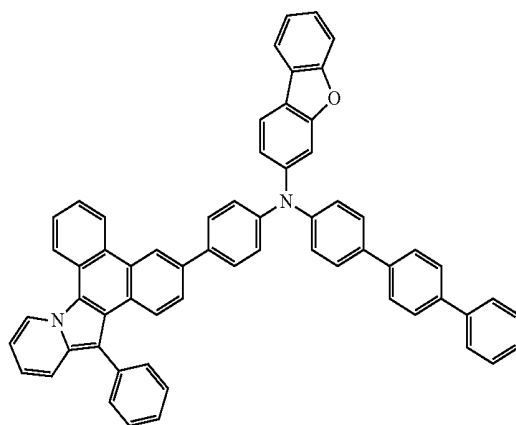
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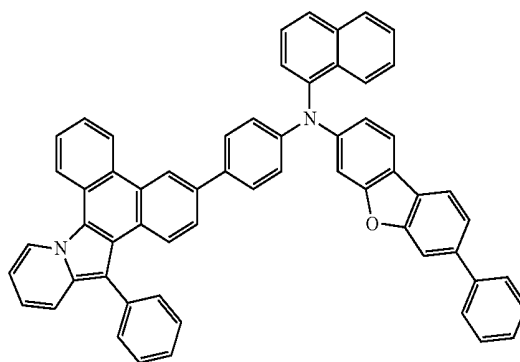
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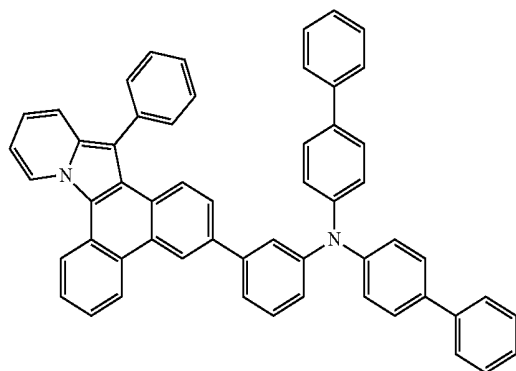
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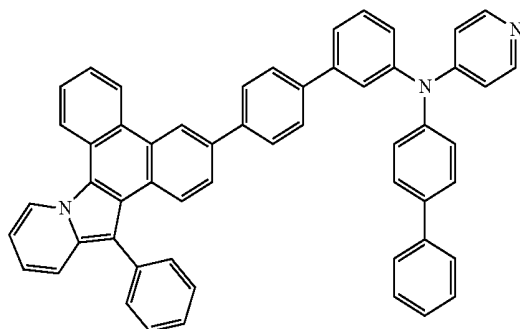
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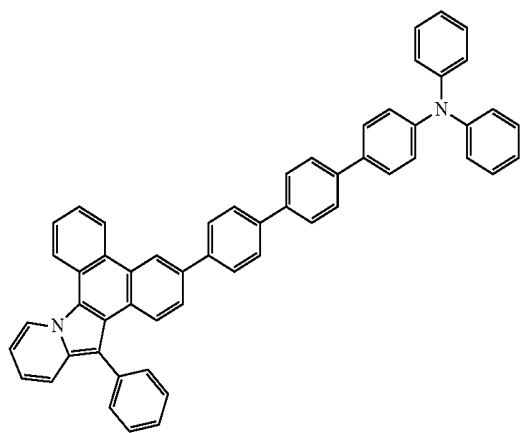
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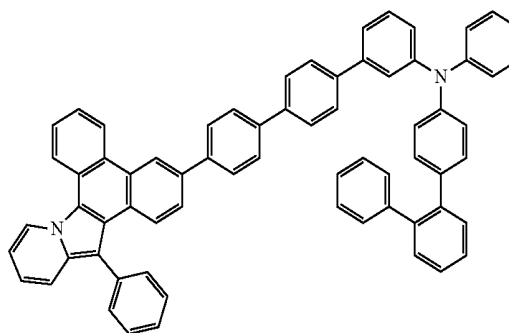
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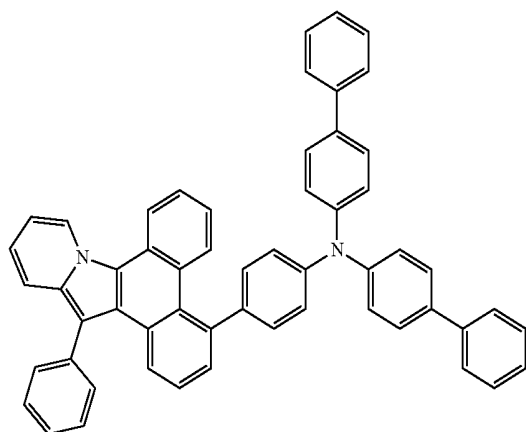
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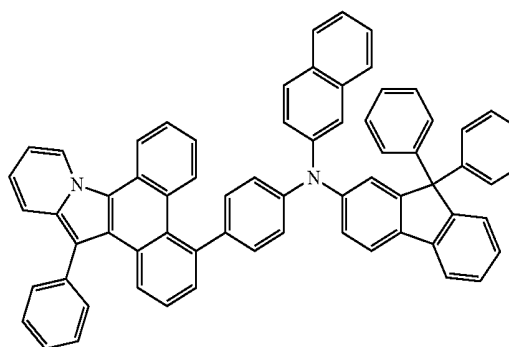
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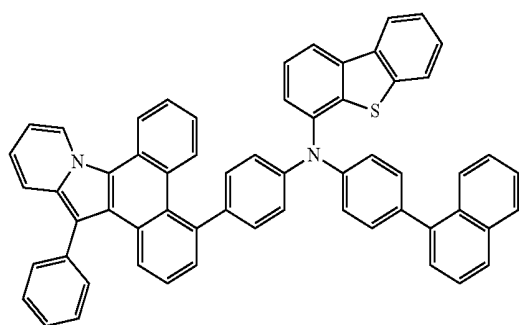
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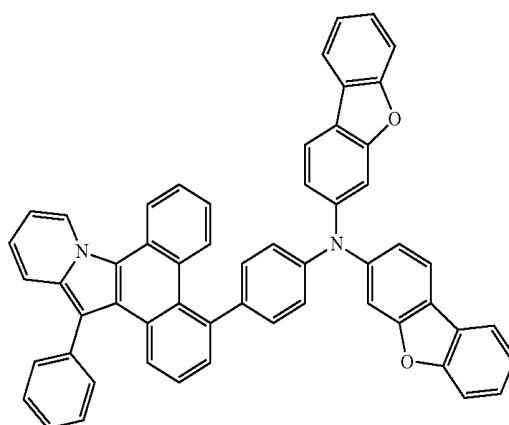
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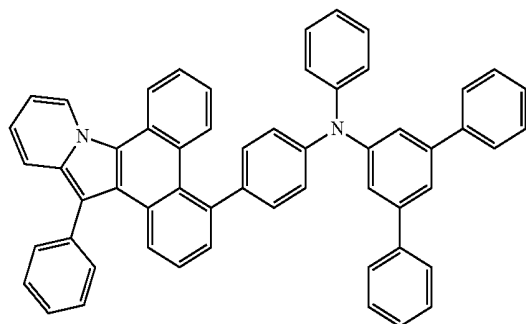
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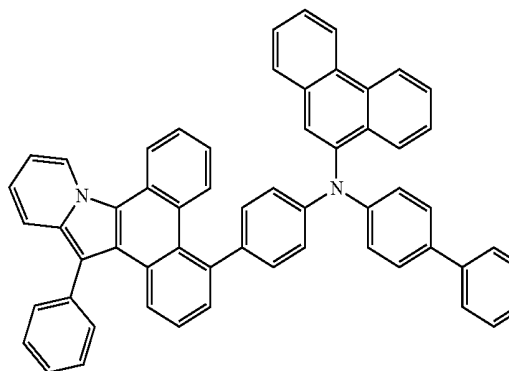
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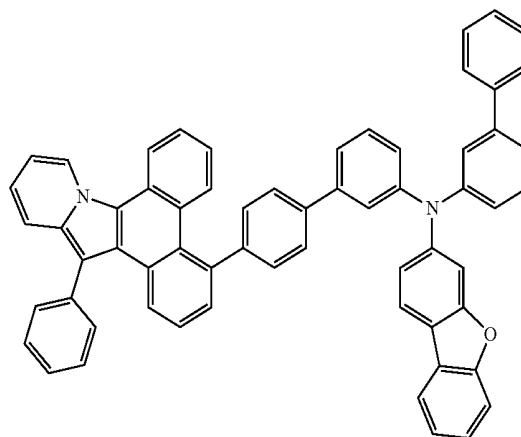
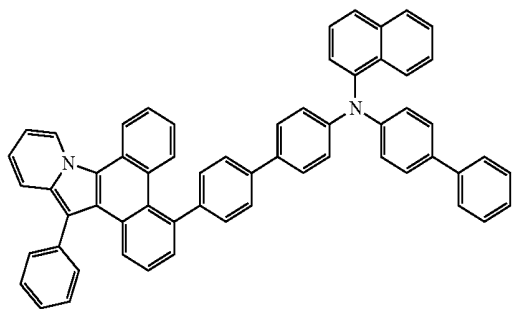


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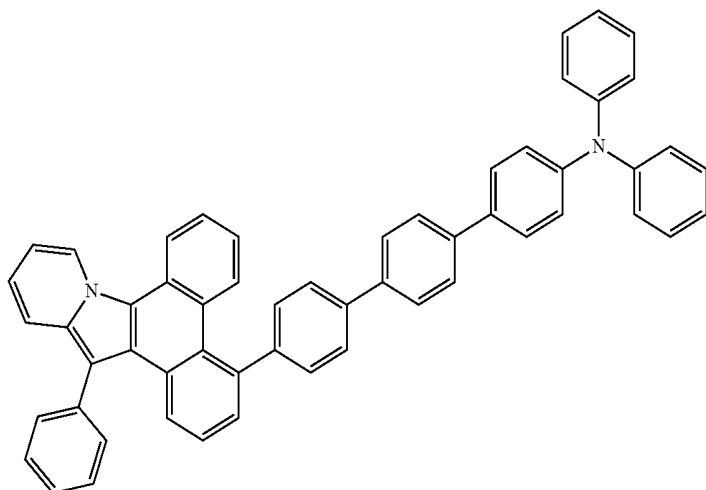


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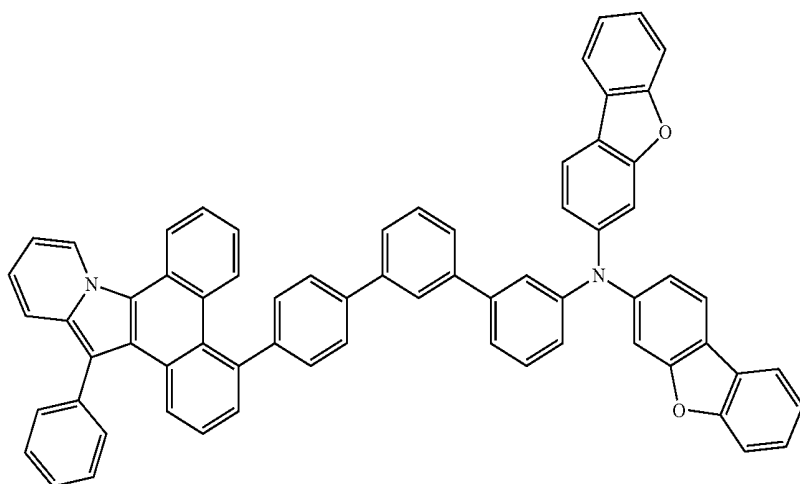
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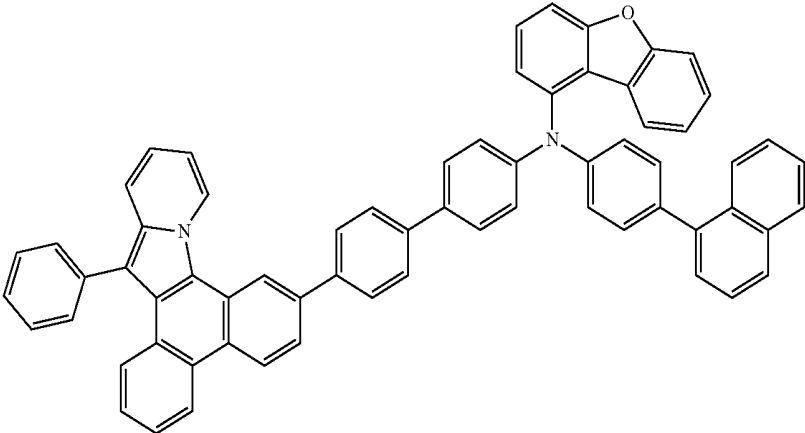
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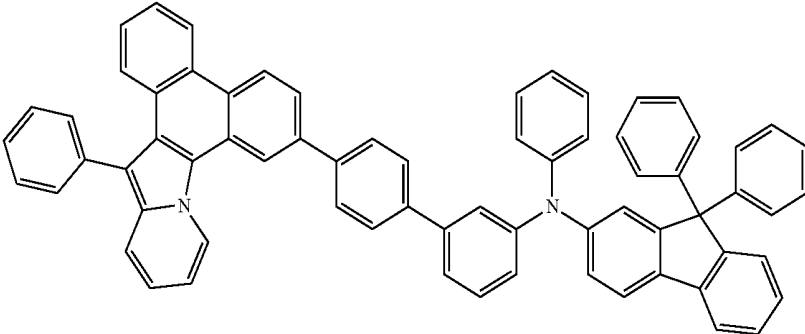
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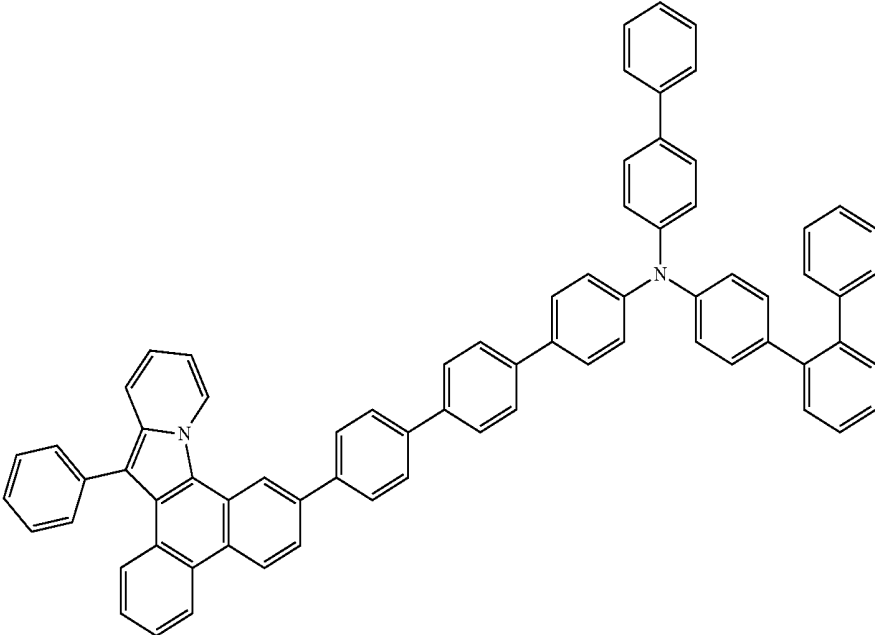
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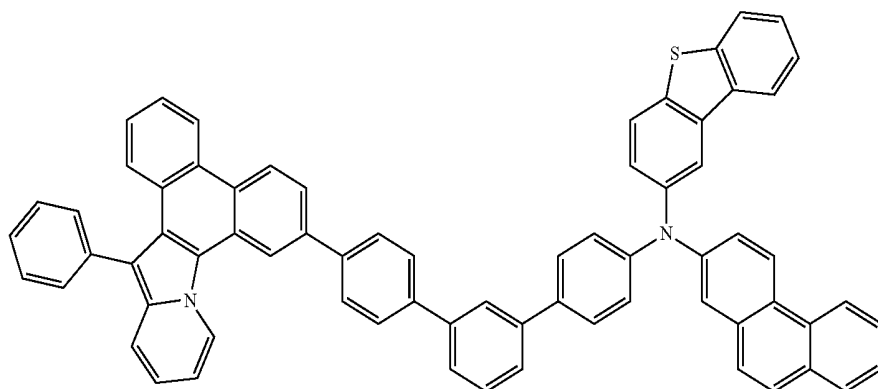


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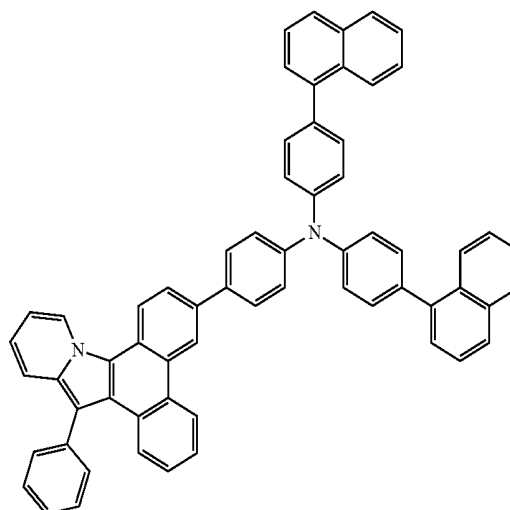
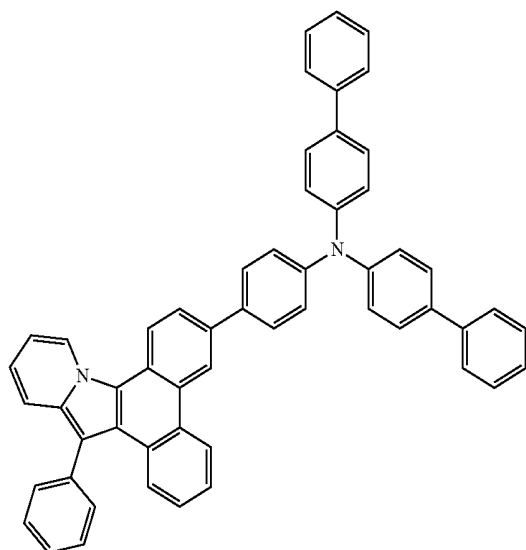
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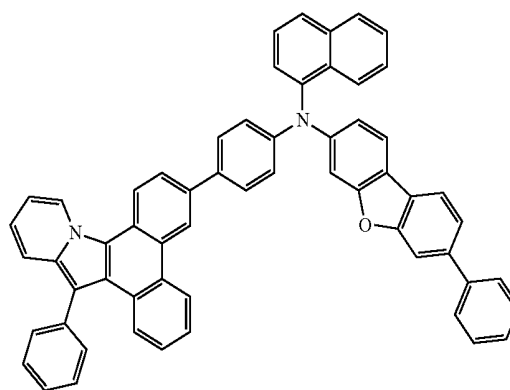
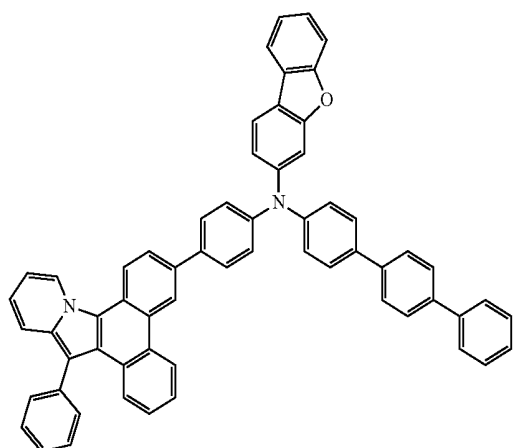
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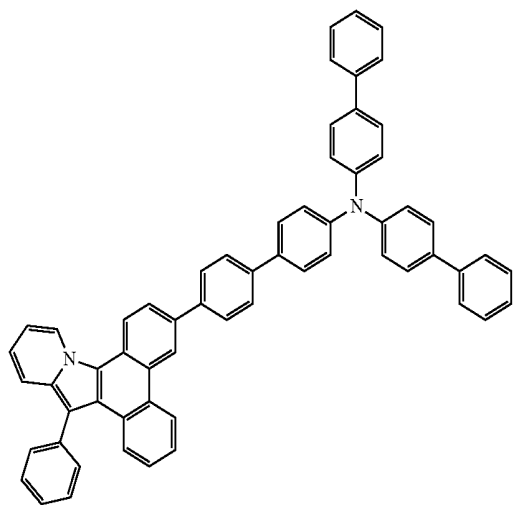


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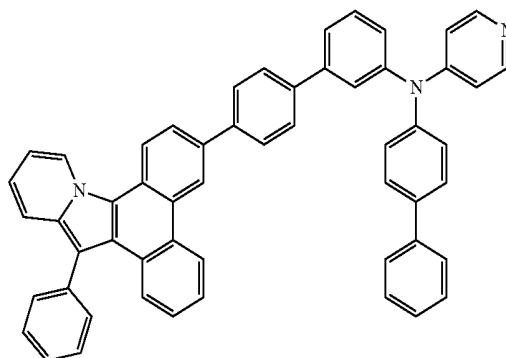
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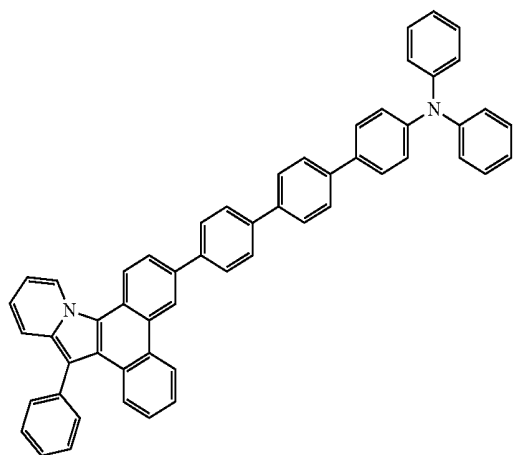
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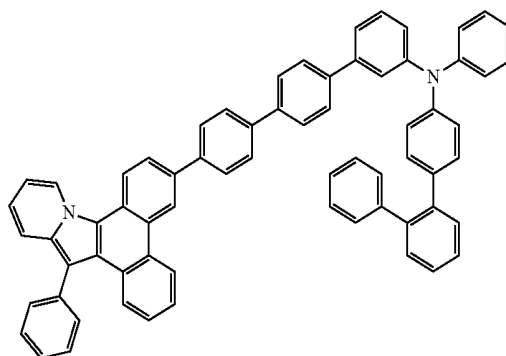
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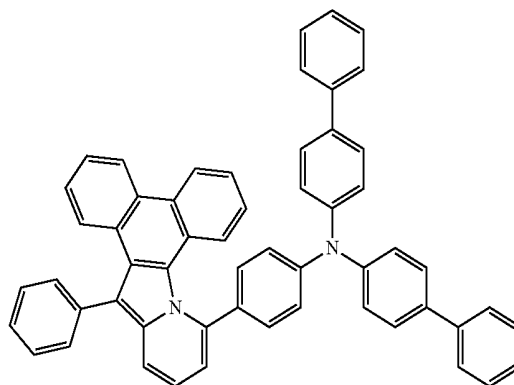
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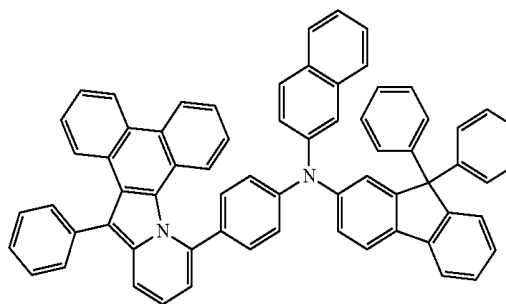
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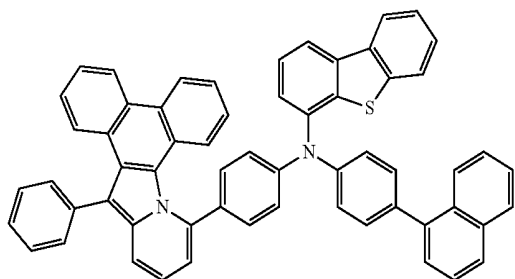


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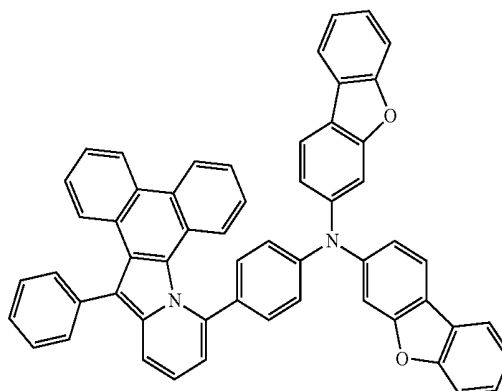


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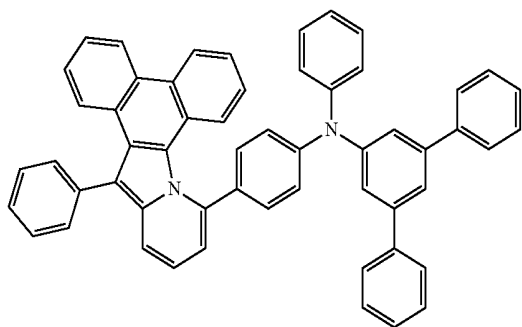
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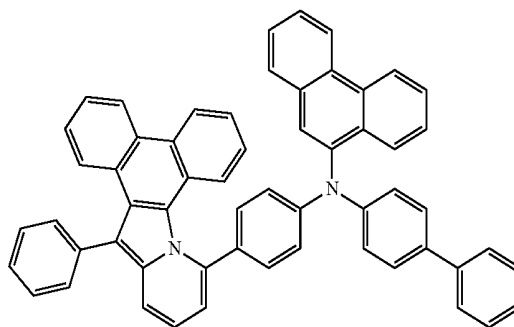
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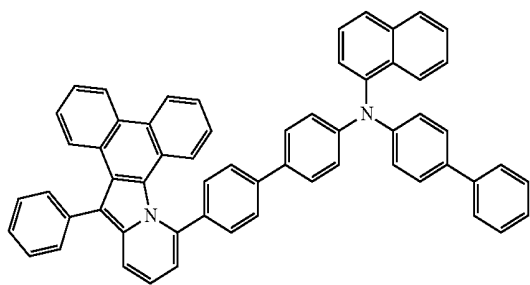
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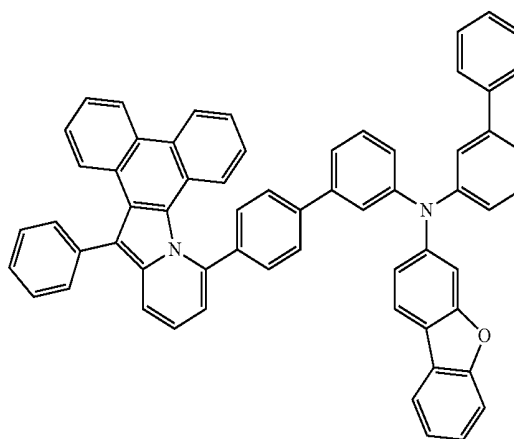
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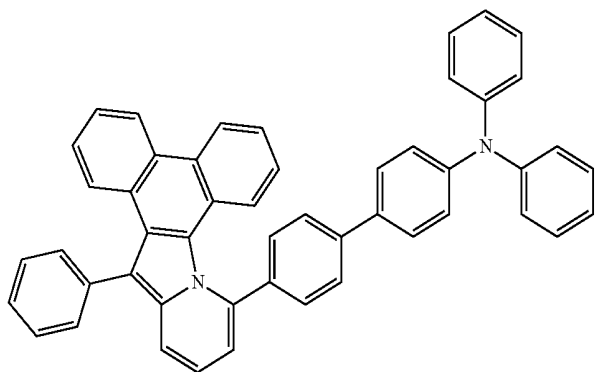
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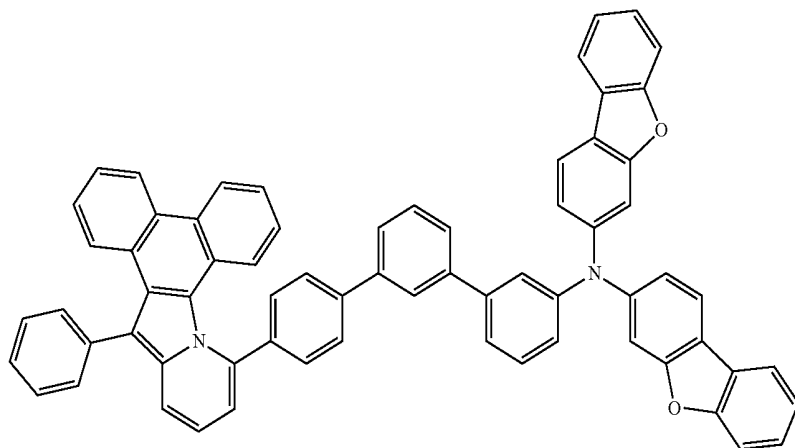


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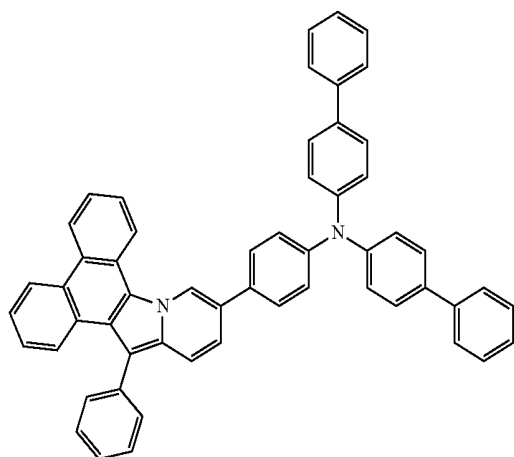


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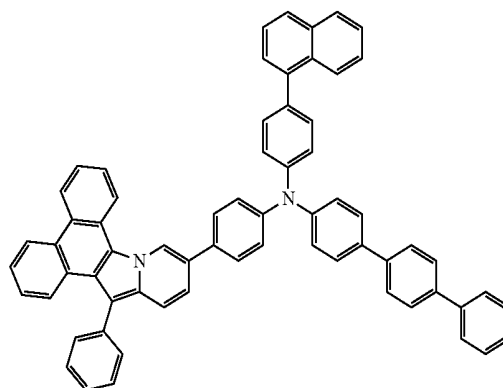
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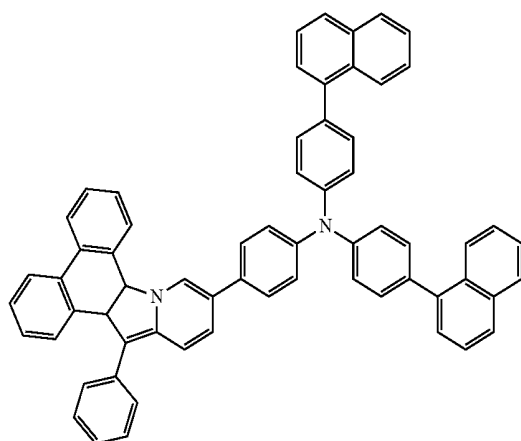
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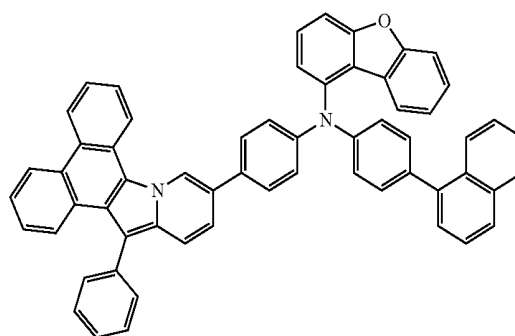
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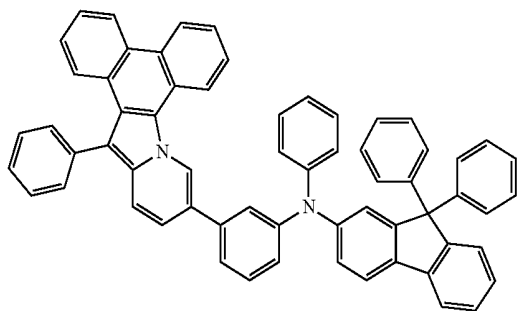


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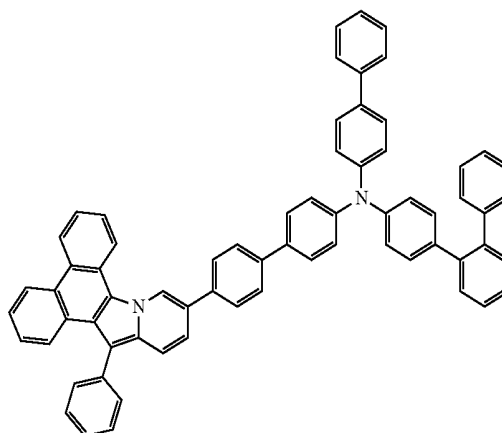


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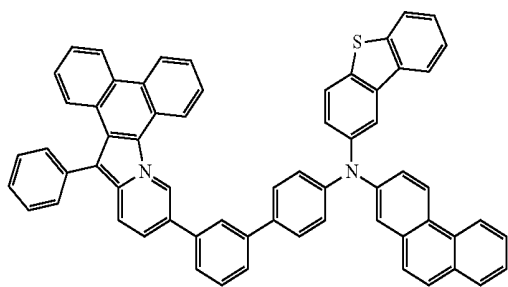
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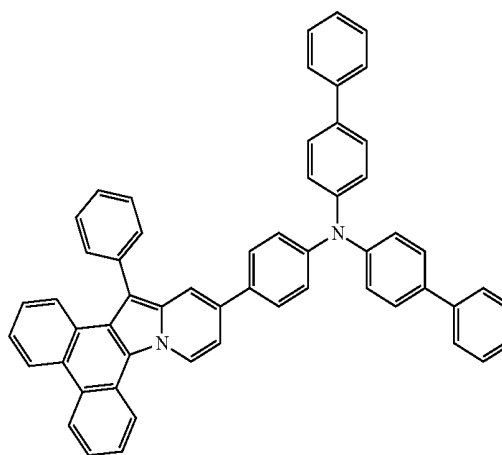
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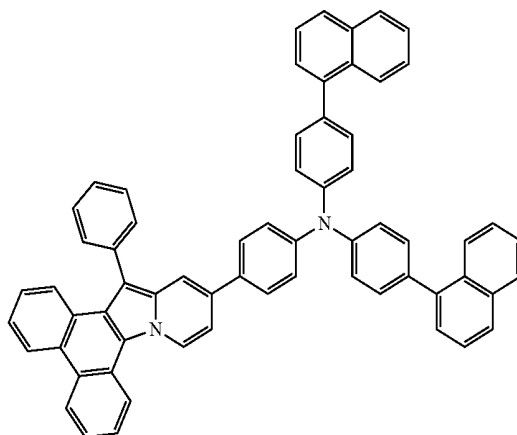
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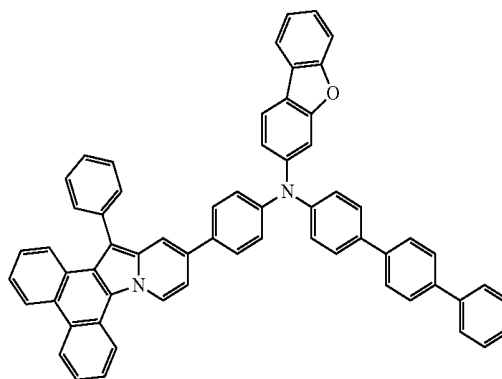
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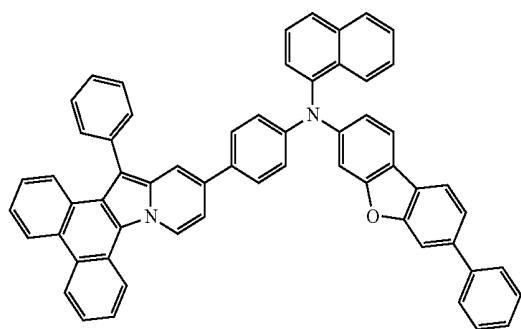
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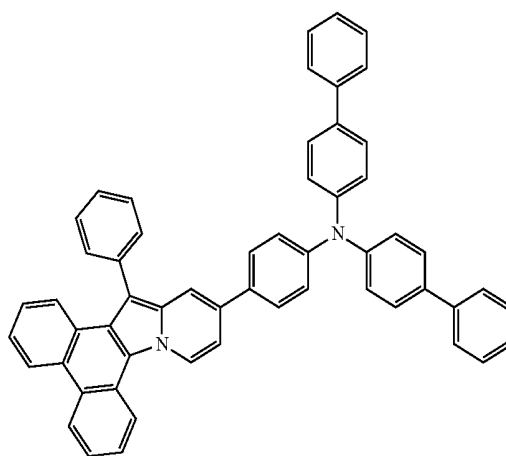
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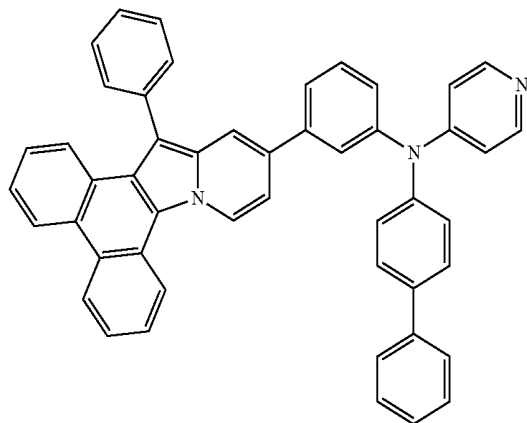
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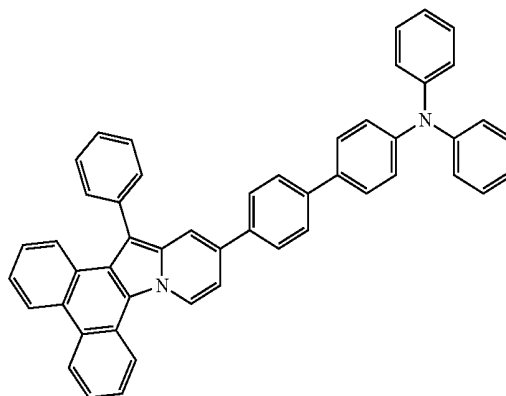
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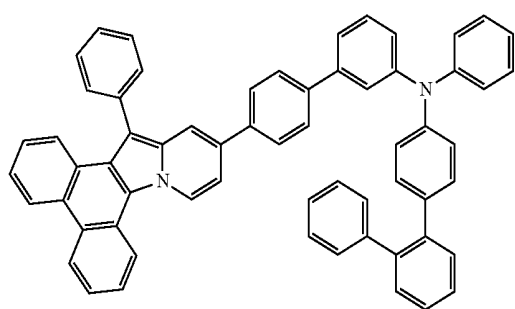
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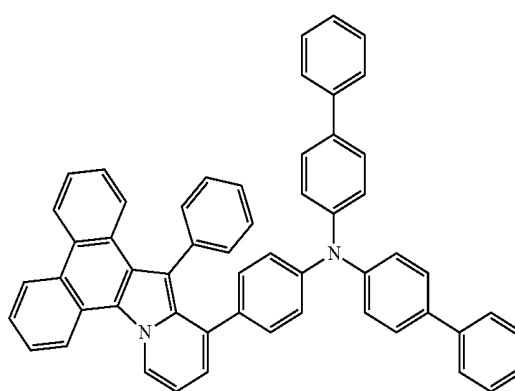
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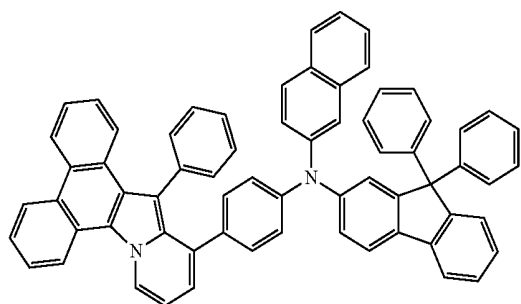
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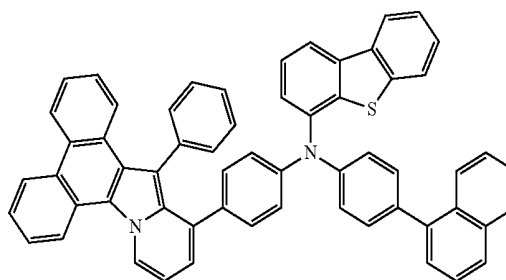
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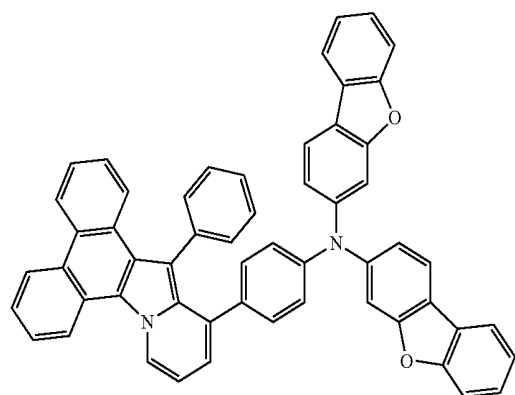


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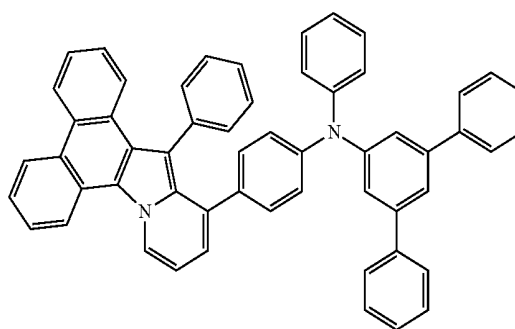
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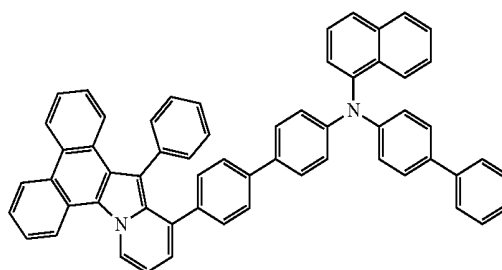
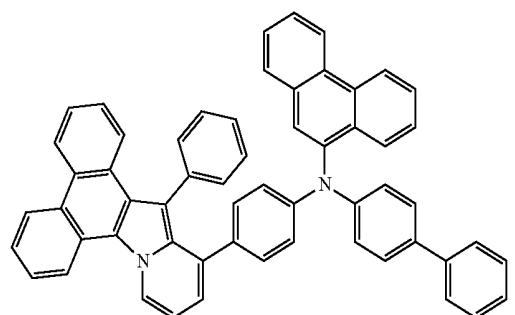
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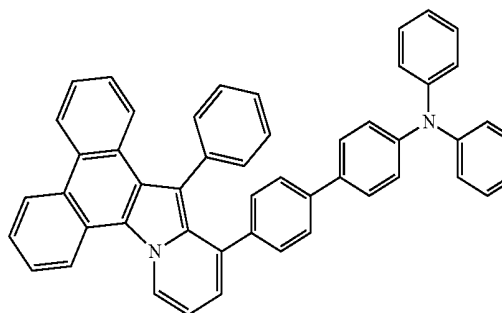
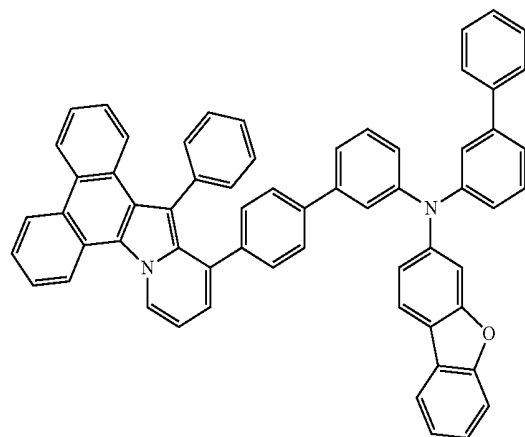
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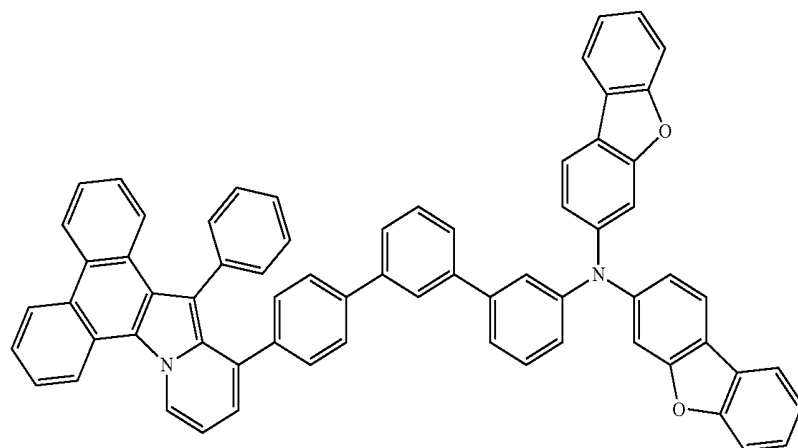


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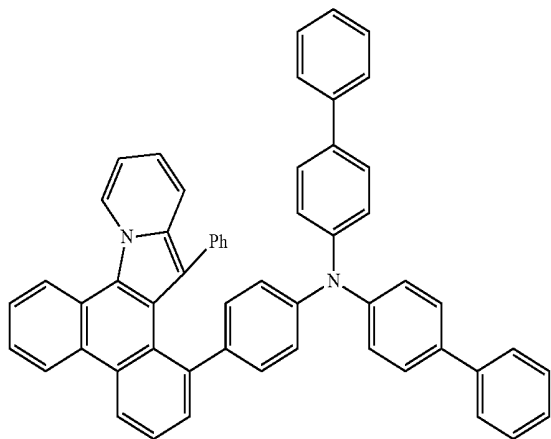


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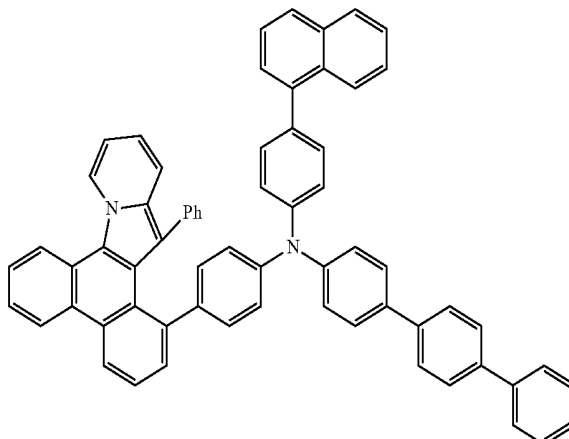


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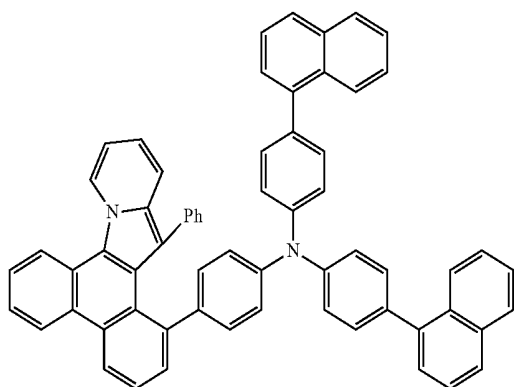
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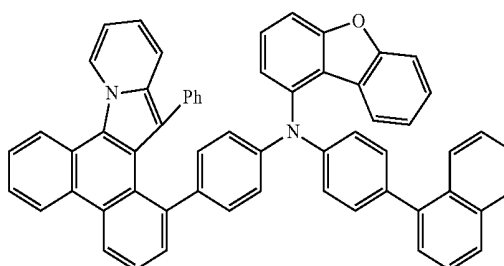
F95



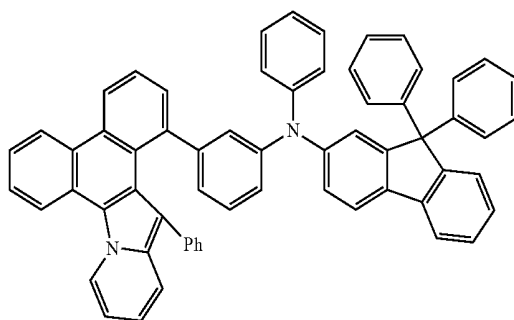
F96



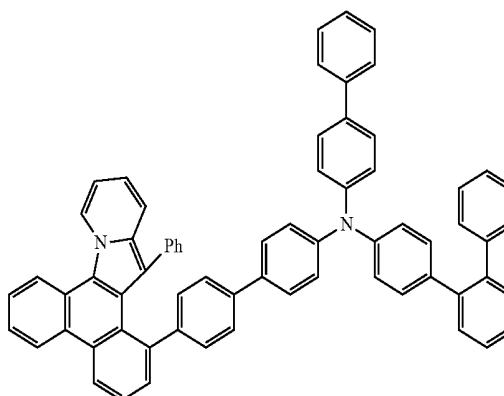
F97



F98

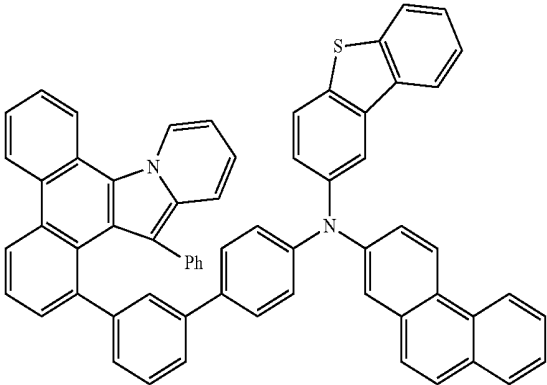


F99



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F100



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专利名称(译)	有机电致发光器件和用于有机电致发光器件的胺化合物		
公开(公告)号	US20200106022A1	公开(公告)日	2020-04-02
申请号	US16/455353	申请日	2019-06-27
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO., LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO., LTD.		
[标]发明人	UNO TAKUYA		
发明人	UNO, TAKUYA		
IPC分类号	H01L51/00 C07D471/04 C09K11/06		
CPC分类号	H01L51/0073 H01L51/0058 C09K11/06 H01L51/006 H01L51/5012 H01L51/0074 C07D471/04 H01L51/5056 H01L51/0052 H01L51/0061 H01L51/0072 C09K2211/1018 H01L51/5088 C07D471/02 H01L51/0059		
优先权	1020180115457 2018-09-28 KR		
外部链接	Espacenet USPTO		

摘要(译)

根据本公开的实施方式的有机电致发光器件包括第一电极，与第一电极相对的第二电极以及在第一电极和第二电极之间的至少一个有机层，其中该至少一个有机层包括胺化合物。式1中的HT 1，式1中的HT包括式2所表示的吡啶并吡啶部分。当将式1所表示的胺化合物包含在有机电致发光器件中时，可以实现改善的器件效率和寿命特性。

