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Ohrui et al.

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(54) **FUSED HETEROCYCLIC COMPOUND AND ORGANIC LIGHT EMITTING DEVICE**

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C07D 221/18 (2006.01)

(52) **U.S. Cl.** **313/504**; 546/42; 546/26; 428/690

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See application file for complete search history.

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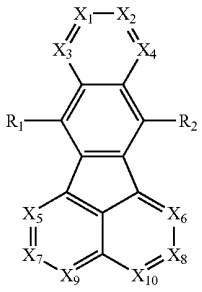
(57) **ABSTRACT**

To provide a material for an organic light emitting device showing a light emission hue with an extremely good purity and outputting light having high luminance and a long lifetime with high efficiency, the present invention relates to a fused heterocyclic compound having at least one partial structure represented by the following general formula [1].

[1]



14 Claims, 14 Drawing Sheets

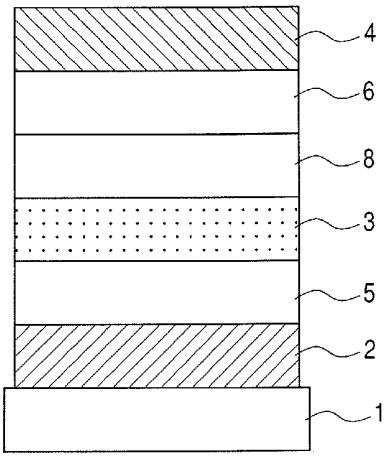


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FIG. 1

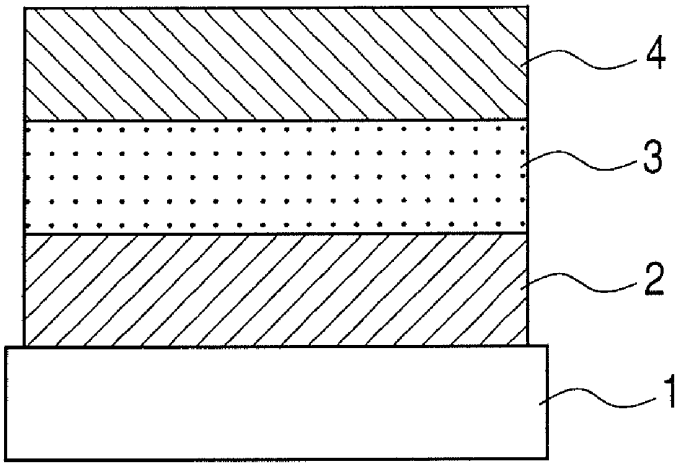


FIG. 2

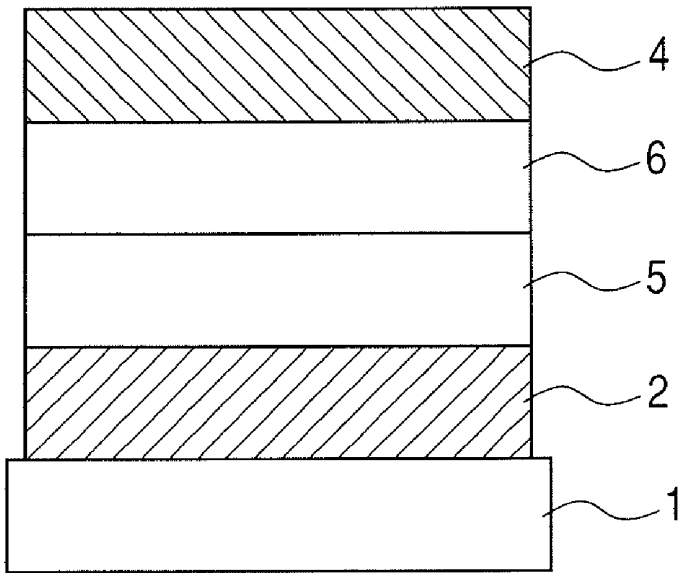


FIG. 3

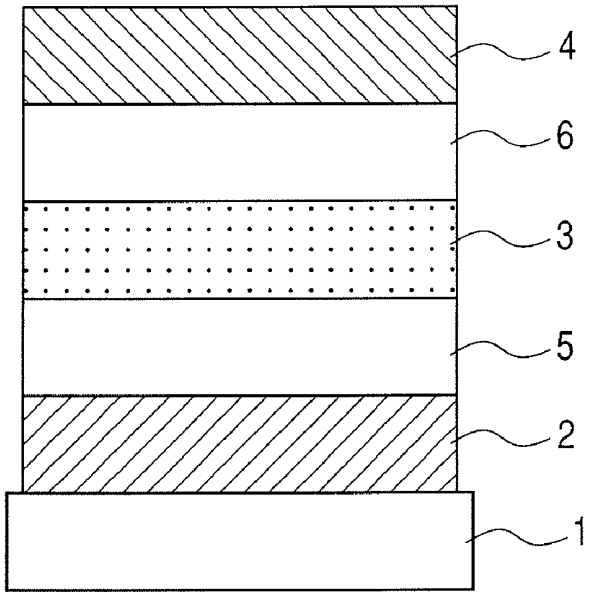


FIG. 4

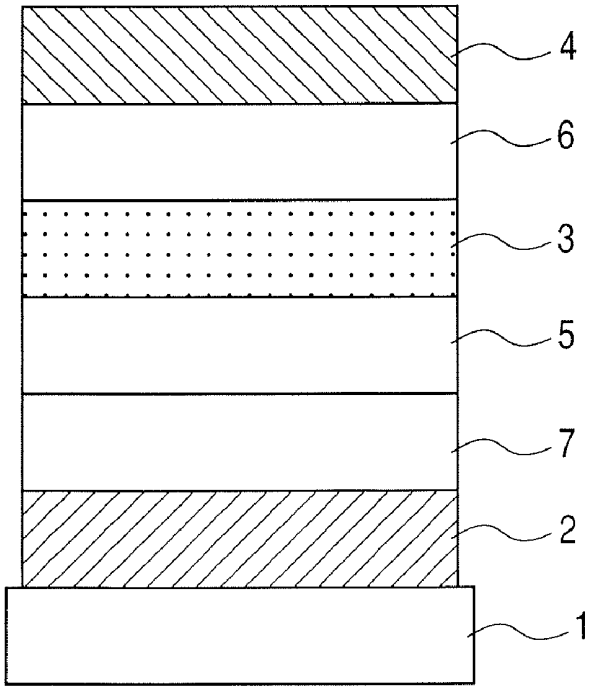


FIG. 5

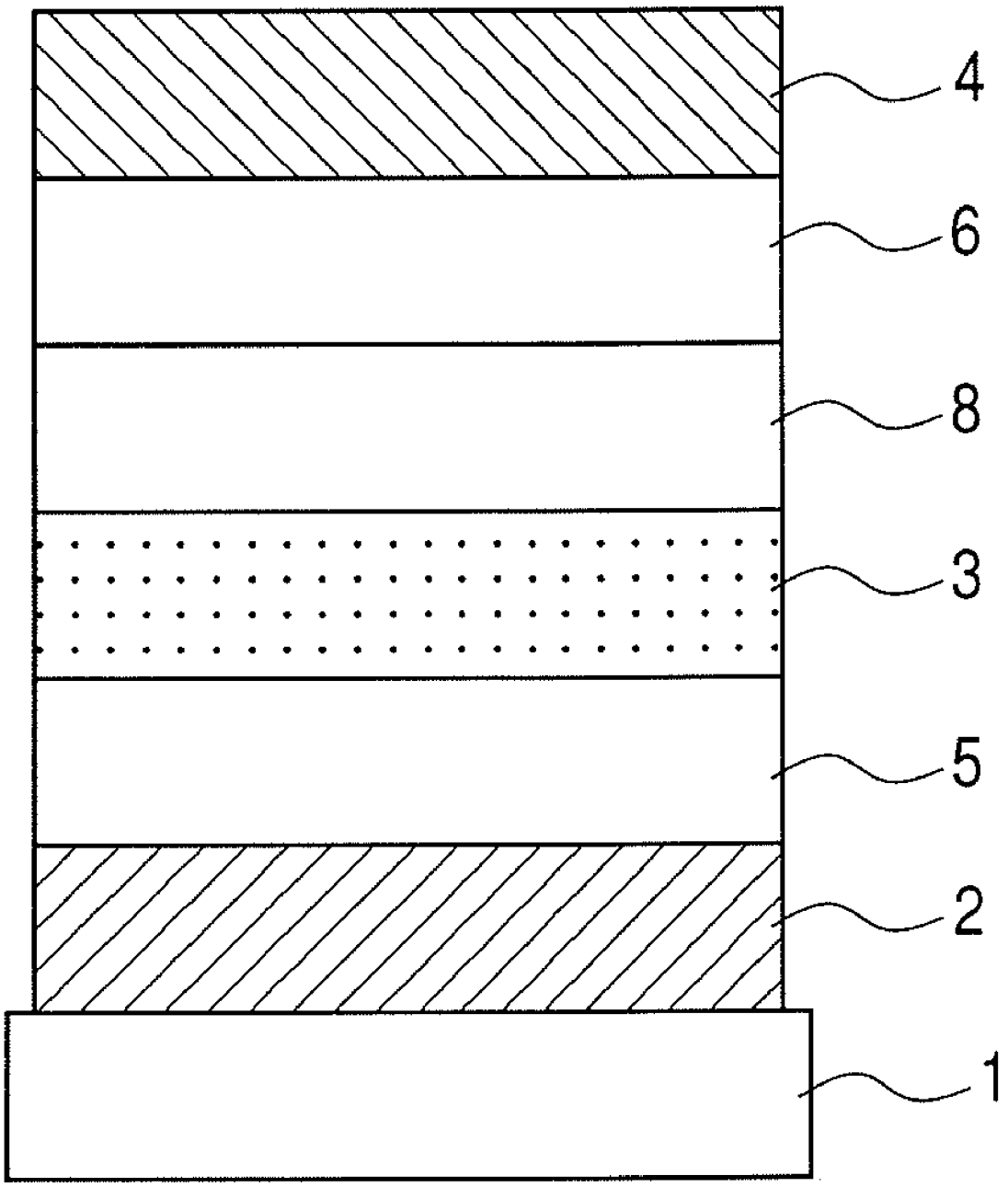


FIG. 6

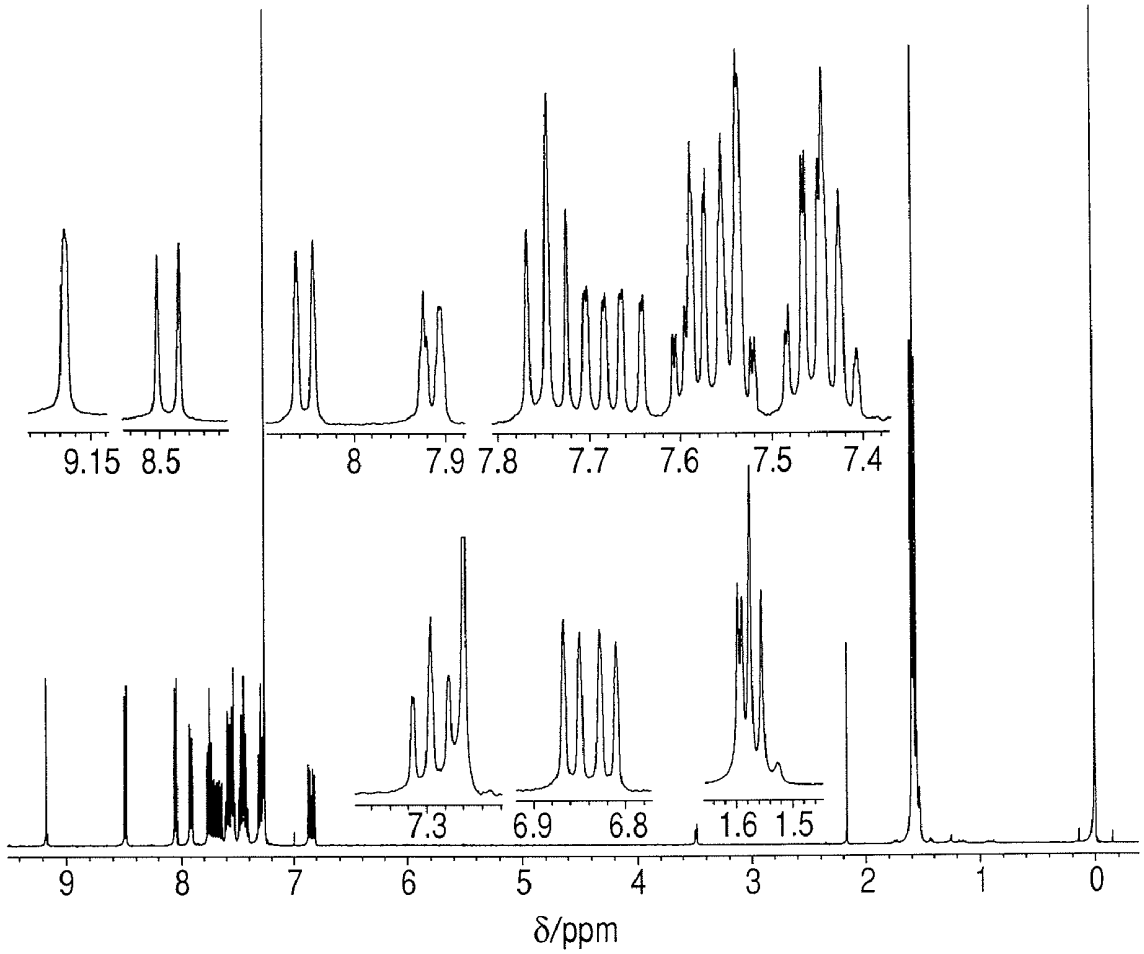


FIG. 7

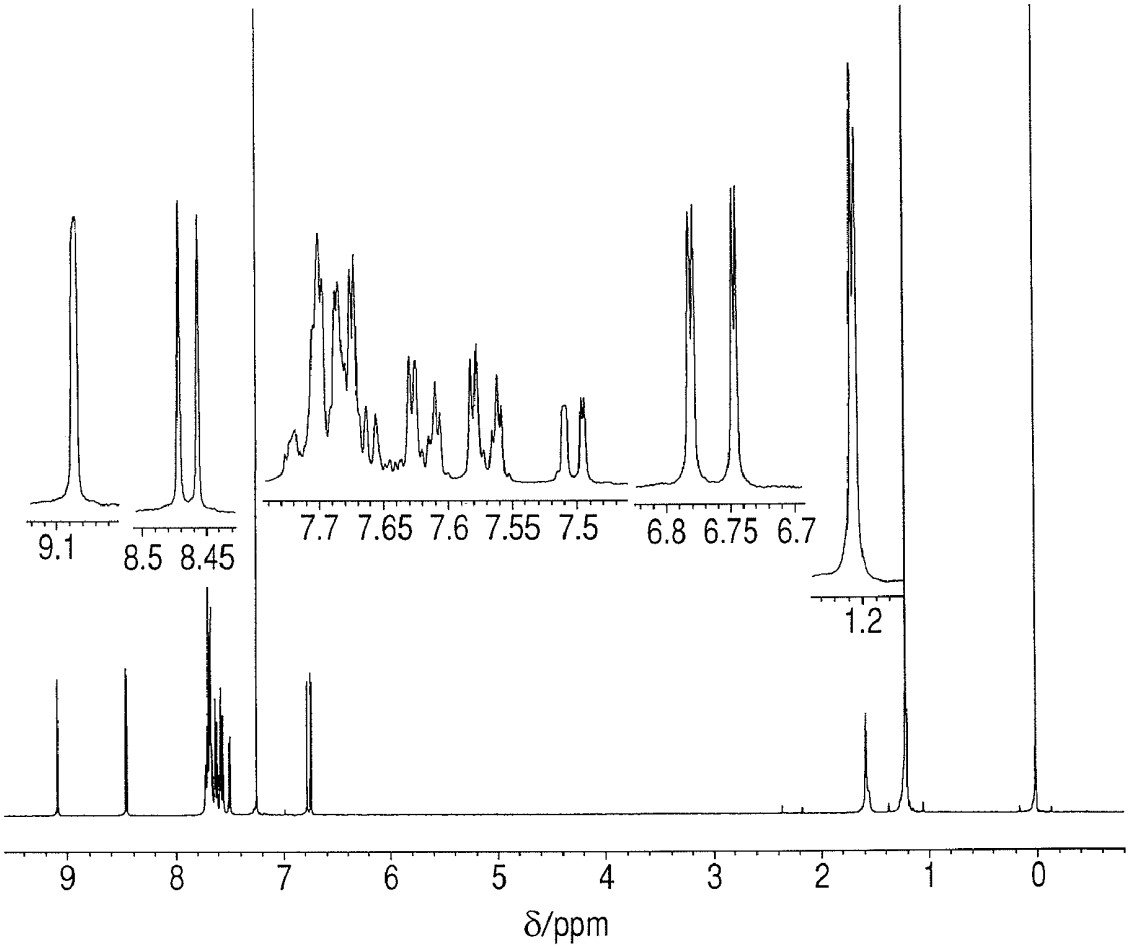


FIG. 8

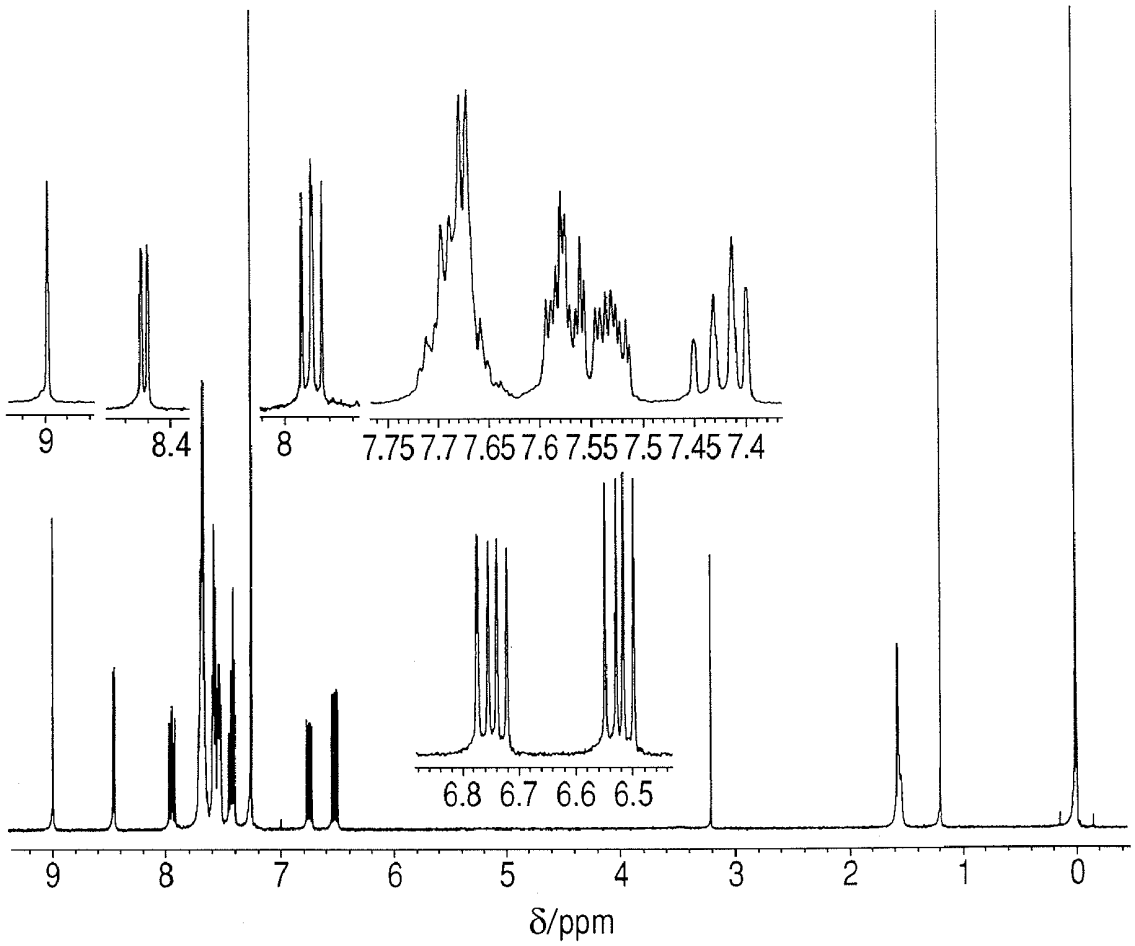


FIG. 9

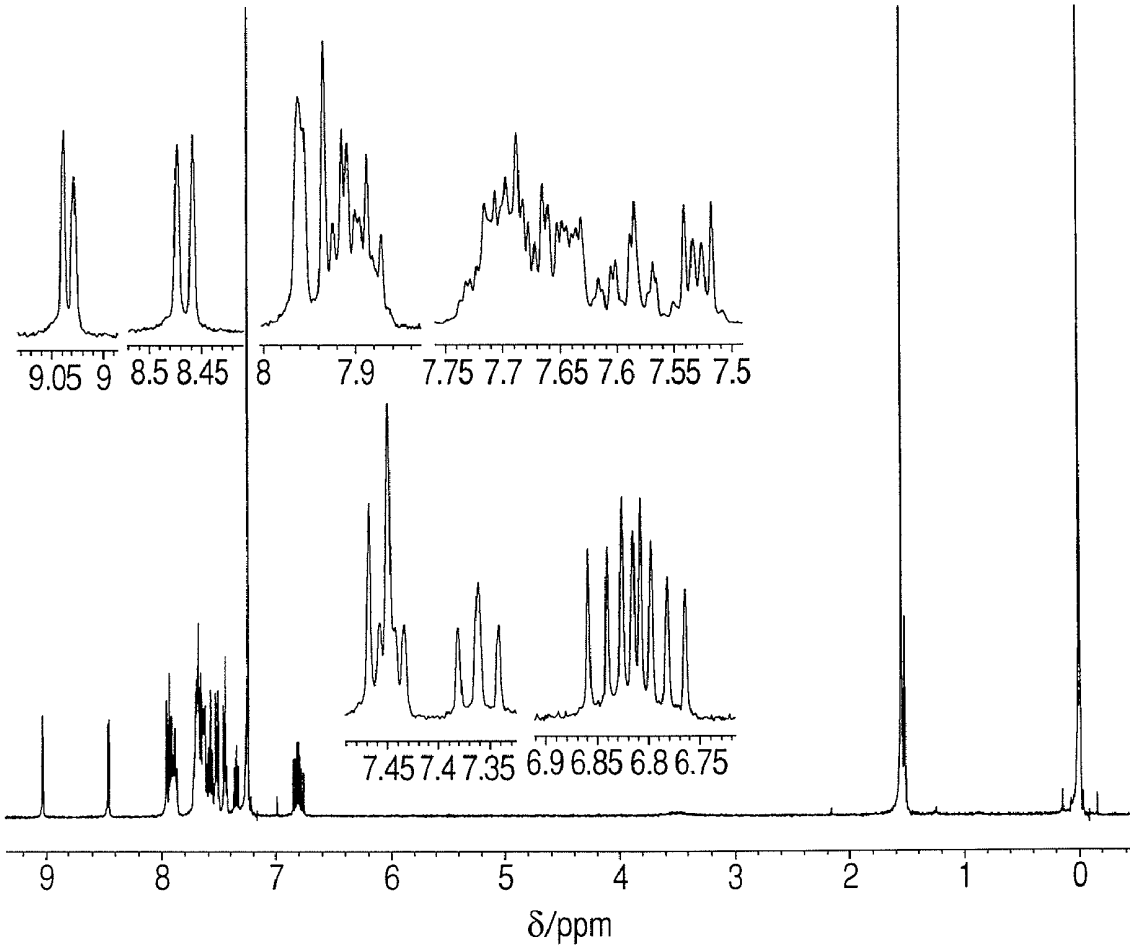

9.05 9
8.5 8.45
8
7.9
7.75 7.7 7.65 7.6 7.55 7.5
7.45 7.4 7.35
6.9 6.85 6.8 6.75
9
8
7
6
5
4
3
2
1
0
δ/ppm

FIG. 10

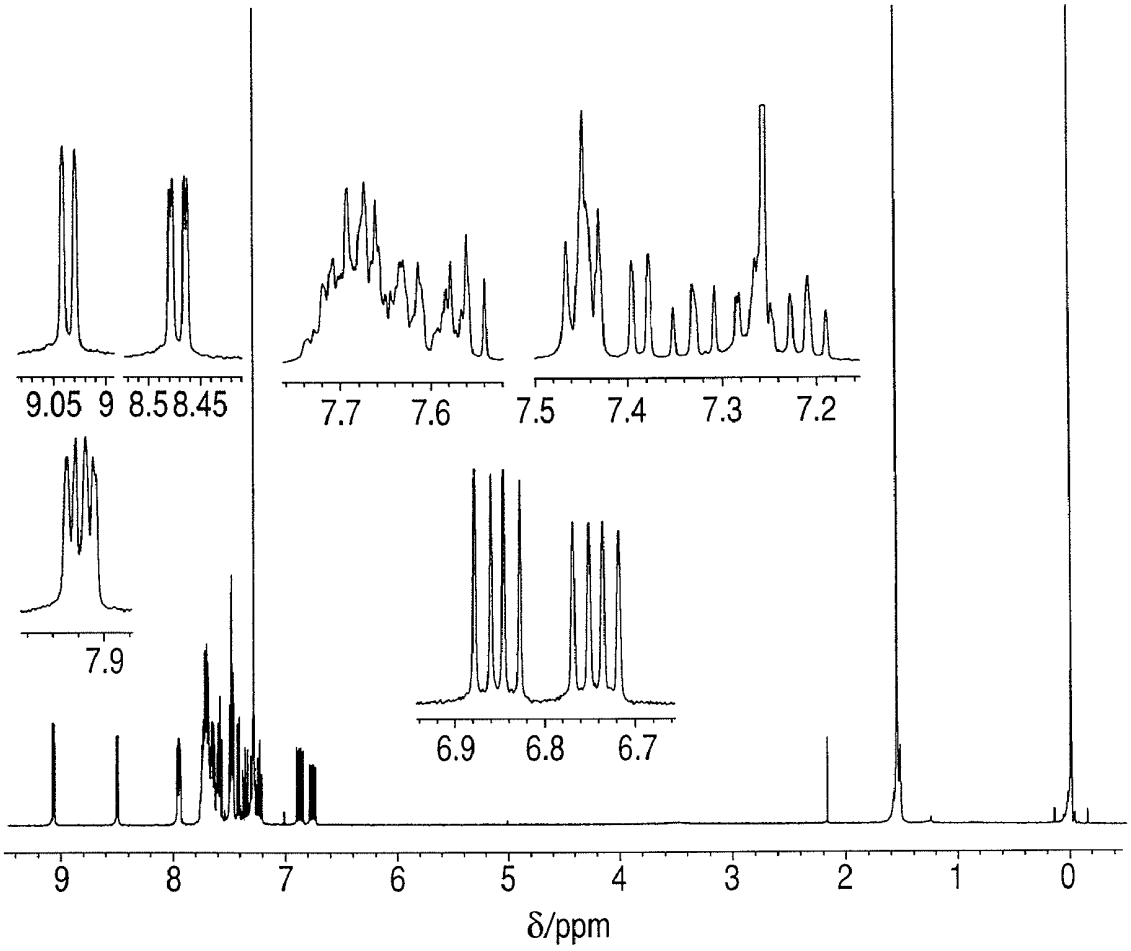


FIG. 11

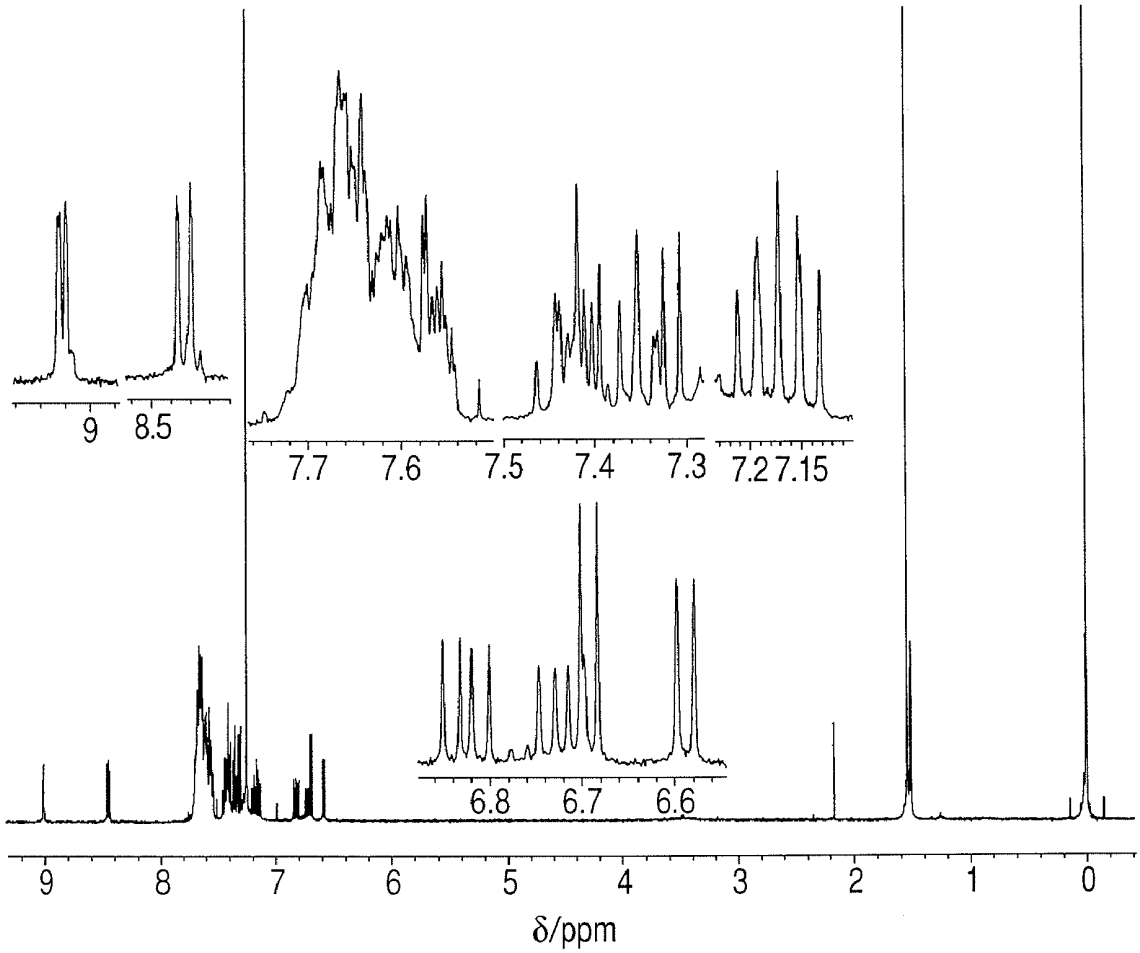
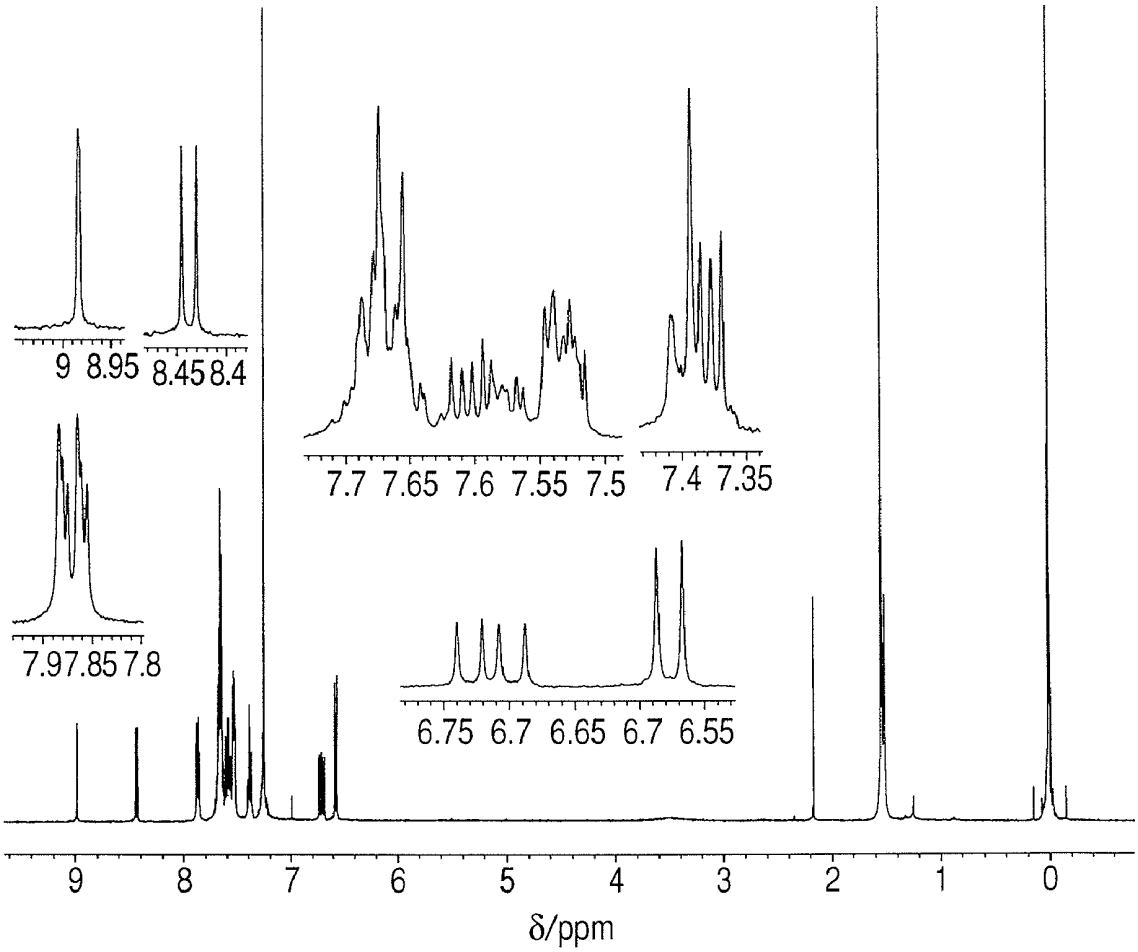


FIG. 12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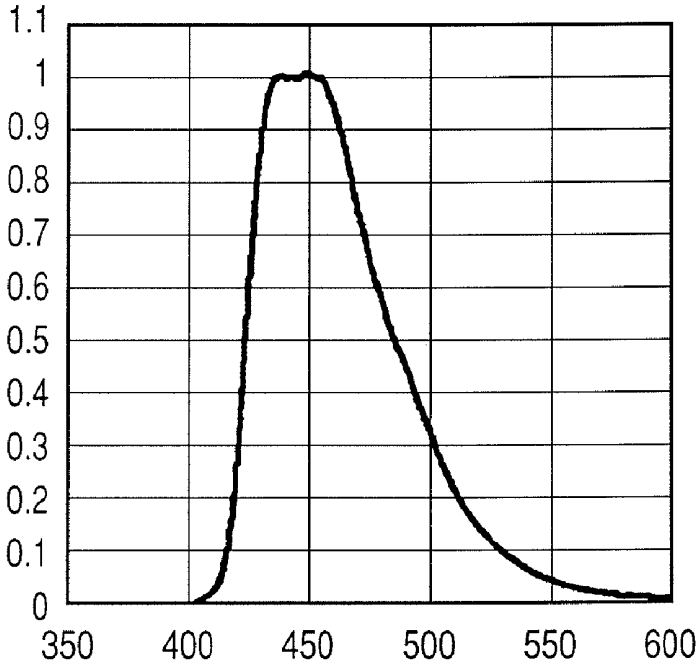
8.45 8.4
7.7 7.65 7.6 7.55 7.5
7.4 7.35
7.9 7.85 7.8
6.75 6.7 6.65 6.7 6.55
9 8 7 6 5 4 3 2 1 0
δ/ppm

FIG. 13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1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
350
400
450
500
550
600

FIG. 14

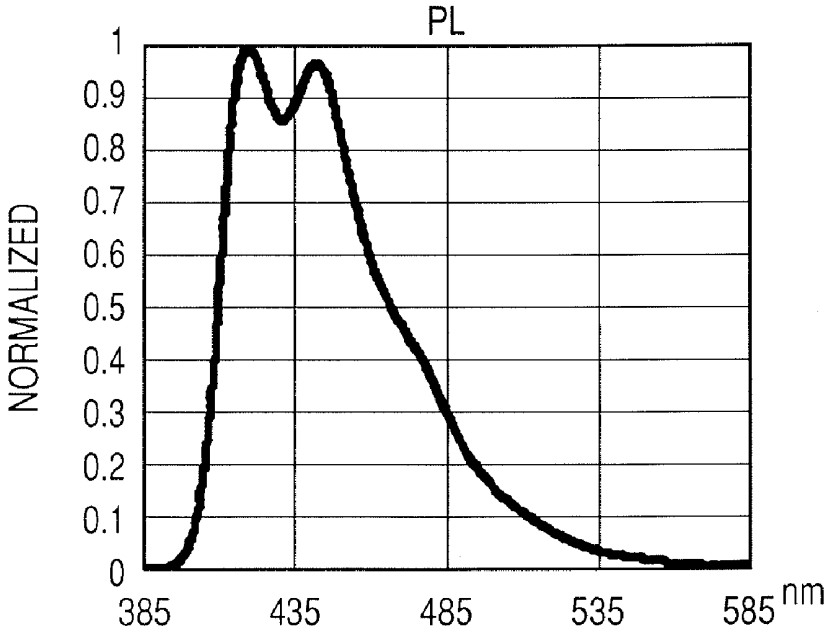
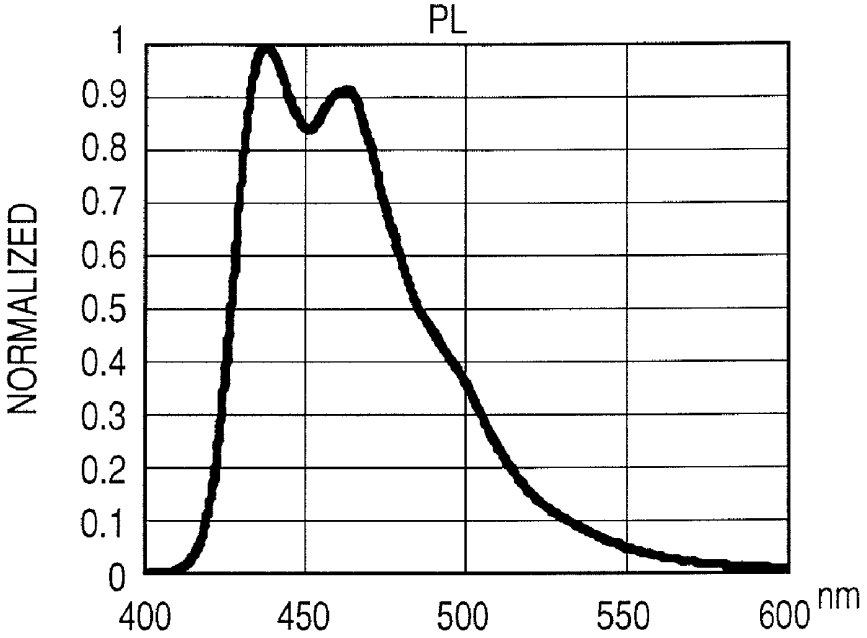

PL
NORMALIZED
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
385
435
485
535
585
nm

FIG. 15


PL
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0.9
0.8
0.7
0.6
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0.4
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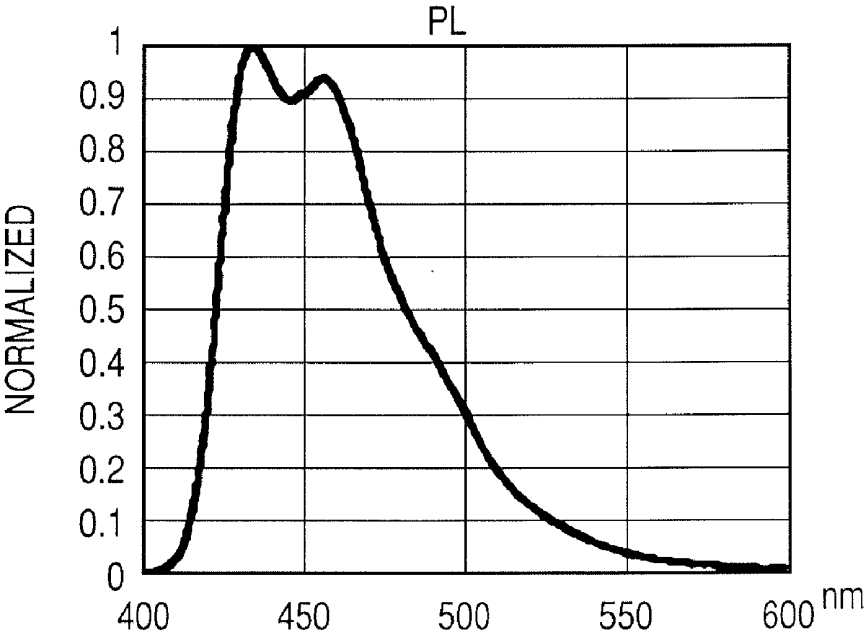
0.2
0.1
0
400
450
500
550
600
nm

FIG. 16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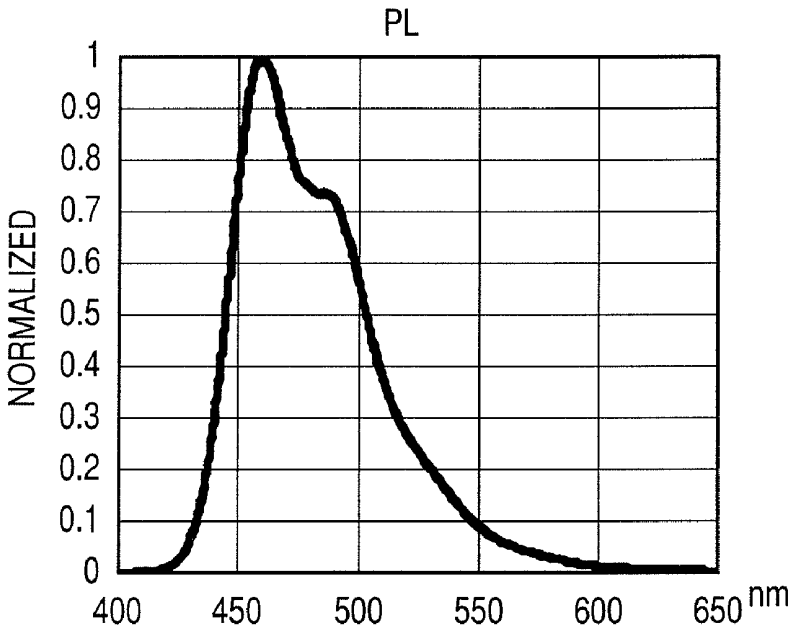
0.5
0.4
0.3
0.2
0.1
0
400
450
500
550
600
nm

FIG. 17


PL
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0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
400
450
500
550
600
650
nm

FIG. 18

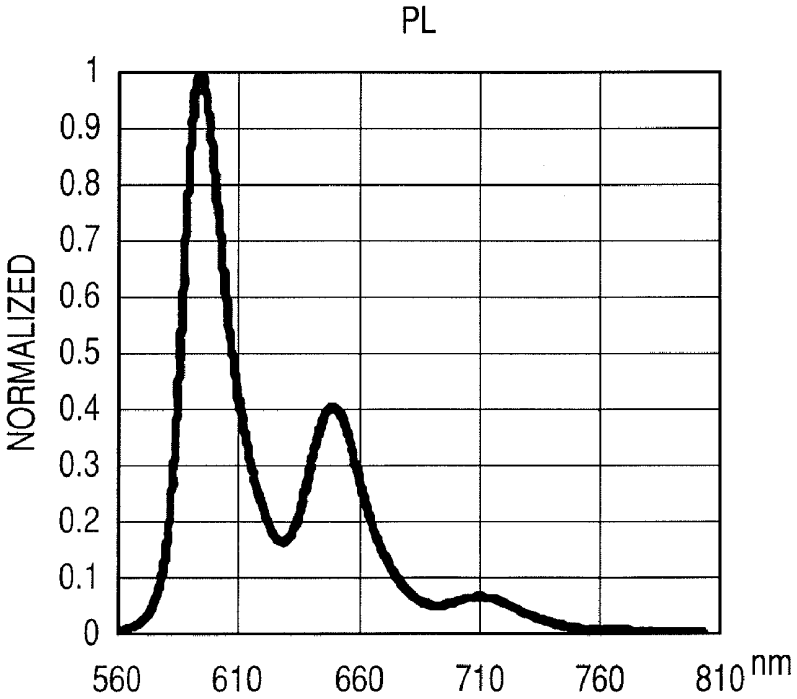
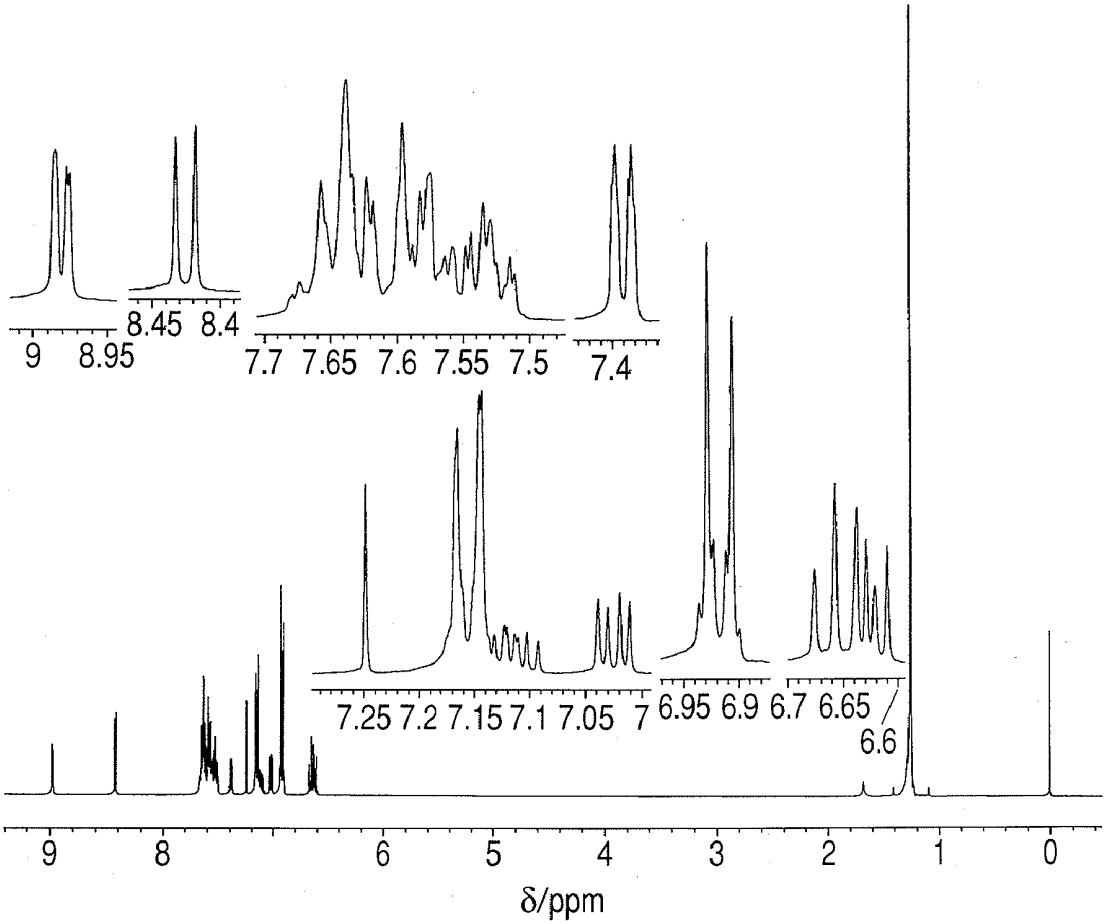

PL
NORMALIZED
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
560
610
660
710
760
810
nm

FIG. 19


9
8.95
8.45
8.4
7.7
7.65
7.6
7.55
7.5
7.4
7.25
7.2
7.15
7.1
7.05
7
6.95
6.9
6.7
6.65
6.6
9
8
6
5
4
3
2
1
0
δ/ppm

FUSED HETEROCYCLIC COMPOUND AND ORGANIC LIGHT EMITTING DEVICE

TECHNICAL FIELD

The present invention relates to a material for an organic light emitting device having a fused, heterocyclic skeleton and an organic light emitting device using the material.

BACKGROUND ART

An organic light emitting device is a device which includes a thin film which contains a fluorescent or phosphorescent organic compound and is interposed between electrodes, in which an exciton of the fluorescent or phosphorescent compound is generated when a hole and an electron are injected from the respective electrodes and which makes use of light radiated upon return of the exciton to its ground state. The recent progress of an organic light emitting device is significant, and the device suggests its potential to use in a wide variety of applications because of the following reasons. The device shows a high luminance at a low applied voltage. In addition, the device has a variety of emission wavelengths. Furthermore, the device can be a thin, light-weight light emitting device with high-speed responsiveness.

However, at present, an optical output with additionally higher luminance, or additionally higher conversion efficiency has been needed. In addition, the organic light emitting device still has many problems in terms of durability. For example, the device changes over time owing to long-term use, and deteriorates owing to an atmospheric gas containing oxygen, or to humidity or the like. Further, assuming that the device is applied to a full-color display or the like, the device must emit blue light, green light, and red light each having good color purity, but the problems concerning the color purity have not been sufficiently solved yet.

In the meantime, compounds related to the compound of the present invention are disclosed in J. Chem. Soc. 3920 (1964), Compt. Rend. 258 (12), 3387 (1964), Tetrahedron 30, 813 (1974), and Monatsh. fur Chem. 129, 1035 (1998). However, in each of J. Chem. Soc. 3920 (1964) and Compt. Rend. 258 (12), 3387 (1964), research has been conducted mainly on the carcinogenicity of a compound having an azabenzofluoranthene skeleton. In addition, Tetrahedron 30, 813 (1974) describes the emission spectrum of an unsubstituted azabenzofluoranthene compound having a nitrogen atom at a specific position. However, the spectrum has a light emission peak in an ultraviolet region, so the compound may be lowly useful as a light emitting substance.

In addition, organic light emitting devices utilizing a compound having a diazabenzofluoranthene skeleton obtained by introducing two or more nitrogen atoms into a benzofluoranthene skeleton are disclosed in Japanese Patent Application Laid-Open No. 2001-160489, Japanese Patent Application Laid-Open No. 2003-212875, and Japanese Patent Application Laid-Open No. 2006-16363. However, Japanese Patent Application Laid-Open No. 2001-160489 and Japanese Patent Application Laid-Open No. 2003-212875 each describe a compound having a fused diazabenzofluoranthene skeleton, so a light emitting material the luminescent color of which is limited to a luminescent color having a wavelength longer than that of a blue color, in particular, to a red color is provided. In addition, Japanese Patent Application Laid-Open No. 2006-16363 describes that the compound described in the document is used mainly as an electron transporting material, and partly describes that the compound is used as a blue light emitting material. However, the luminous efficiency of the device disclosed in the document is remarkably low.

In addition, Japanese Patent Application Laid-Open No. 2000-311786 describes an organic light emitting device using a compound having an azanaphthoanthracene skeleton obtained by: causing a benzene ring to fuse with a benzofluoranthene skeleton; and introducing one nitrogen atom into the resultant. However, the application of the compound is limited to a green light emitting material owing to the skeleton of the compound.

The present invention has been made with a view to solving such problems of the prior art as described above, and an object of the present invention is to provide a material for an organic light emitting device showing a light emission hue with an extremely good purity and outputting light having high luminance and a long lifetime with high efficiency.

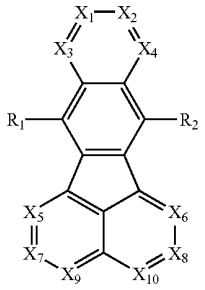
Another object of the present invention is to provide an organic light emitting device that can be easily produced at a relatively low cost.

DISCLOSURE OF THE INVENTION

The inventors of the present invention have made extensive studies with a view to solving the above-mentioned problems. As a result, the inventors have completed the present invention.

Therefore, according to the present invention, there is provided a fused heterocyclic compound having at least one partial structure represented by the following general formula [1]:

[1]



wherein:

X_1 to X_{10} each represent a carbon atom having a substituent R or a nitrogen atom, the carbon atom or the nitrogen atom forming a ring, R represents a hydrogen atom, a halogen atom, a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group and a cyano group, or a single bond provided that at least one of X_1 to X_{10} represents a nitrogen atom, and when a plurality of carbon atoms each having the substituent R are present, R's may be independently identical to or different from each other, and adjacent substituents may form a ring structure; and

R_1 and R_2 each represent a halogen atom, a group selected from a substituted or unsubstituted alkyl group, a substituted

or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group and a cyano group, or a single bond, and R_1 and R_2 may be identical to or different from each other.

The fused heterocyclic compound provided by the present invention has a nitrogen-containing aromatic heterocyclic ring obtained by introducing a nitrogen atom into a specific position of a benzofluoranthene skeleton, so the compound can provide a stable amorphous film property and shows excellent electron transporting property. Further, an emission spectrum showing a wide range of luminescent colors and having a controlled molecular vibration can be monodispersed, and its half width can be reduced depending on the position where the nitrogen atom is introduced, and various combinations of the kind of a substituent and the position where the substituent is introduced, so a light emitting material having a good color purity can be provided.

In addition, an organic light emitting device containing the fused heterocyclic compound provided by the present invention can emit light having high luminance at a low applied voltage, and is excellent in durability. In particular, an organic light emitting device using the fused heterocyclic compound as a guest for its light emitting layer exerts the following excellent effect. That is, the device has such extensibility that the device shows a wide range of light emission hues ranging from a blue light emission hue having a light emission peak at 430 nm or more to 460 nm or less and an extremely good purity to a red light emission hue having a light emission peak at 590 nm or more to 630 nm or less as a result of proper molecular modification of the compound. In addition, the device can emit light having high luminance at a low applied voltage, and is excellent in durability.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view showing an example of an organic light emitting device of the present invention.

FIG. **2** is a sectional view showing another example of the organic light emitting device of the present invention.

FIG. **3** is a sectional view showing another example of the organic light emitting device of the present invention.

FIG. **4** is a sectional view showing another example of the organic light emitting device of the present invention.

FIG. **5** is a sectional view showing another example of the organic light emitting device of the present invention.

FIG. **6** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1308.

FIG. **7** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1303.

FIG. **8** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of a mixture of Intermediate Compounds 4 and 5.

FIG. **9** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1536.

FIG. **10** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1540.

FIG. **11** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1515.

FIG. **12** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1901.

FIG. **13** is a diagram showing the PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1308 in toluene.

FIG. **14** is a diagram showing the PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1303 in toluene.

FIG. **15** is a diagram showing the PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1536 in toluene.

FIG. **16** is a diagram showing the PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1540 in toluene.

FIG. **17** is a diagram showing the PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1515 in toluene.

FIG. **18** is a diagram showing the PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1901 in toluene.

FIG. **19** is a diagram showing the ^{1}H-NMR ($CDCl_3$) spectrum of Exemplified Compound 1653.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the present invention will be described in detail.

First, a fused heterocyclic compound of the present invention will be described.

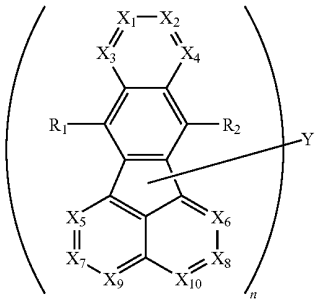
The fused heterocyclic compound of the present invention has at least one partial structure represented by the above general formula [1]. R in the general formula [1] preferably represents any one of the following: a hydrogen atom, a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group and a substituted or unsubstituted fused polycyclic heterocyclic group, and a single bond.

In addition, R_1 and R_2 each preferably represent any one of the following: a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group and a substituted or unsubstituted fused polycyclic heterocyclic group, and a single bond.

An example of the fused heterocyclic compound of the present invention is a compound in which none of R, R_1, and R_2 in the general formula [1] represents a single bond.

Another example of the fused heterocyclic compound is a compound represented by the following general formula [2]:

[2]



wherein:

X_1 to X_{10} each represent a carbon atom having a substituent R or a nitrogen atom, the carbon atom or the nitrogen atom forming a ring, at least one of X_1 to X_{10} represents a nitrogen atom, and when a plurality of carbon atoms each having the substituent R are present, R's may be independently identical to or different from each other;

Y represents a single bond, or an n-valent linking group derived from a substituted or unsubstituted alkane, a substituted or unsubstituted alkene, a substituted or unsubstituted alkyne, a substituted or unsubstituted amine, a substituted or unsubstituted aromatic ring, a substituted or unsubstituted

heterocyclic ring, a substituted or unsubstituted fused polycyclic aromatic ring, or a substituted or unsubstituted fused polycyclic heterocyclic ring;

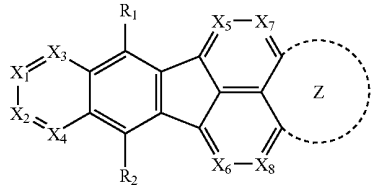
R_1 and R_2 each represent a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, and a substituted or unsubstituted fused polycyclic heterocyclic group, and R_1 and R_2 may be identical to or different from each other;

Y is bonded to any one of a carbon atom represented by any one of X_1 to X_{10}, R_1, and R_2; and

n represents an integer of 2 or more to 10 or less.

In addition, another example of the fused heterocyclic compound is a compound represented by the following general formula [3], more specifically, a compound represented by the following general formula [4] or [5]:

[3]



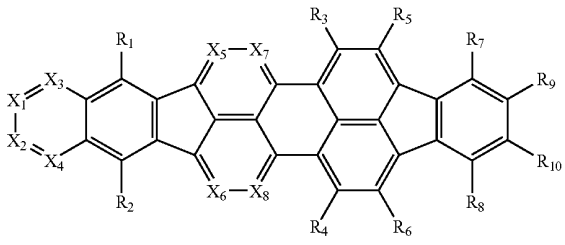
wherein:

Z represents a ring structure;

X_1 to X_8 each represent a carbon atom having a substituent R or a nitrogen atom, the carbon atom or the nitrogen atom forming a ring, at least one of X_1 to X_8 represents a nitrogen atom, R represents a hydrogen atom, a halogen atom, or a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group, and a cyano group, and when a plurality of carbon atoms each having the substituent R are present, R's may be independently identical to or different from each other; and

R_1 and R_2 each represent a halogen atom, or a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group and a cyano group, and R_1 and R_2 may be identical to or different from each other,

[4]

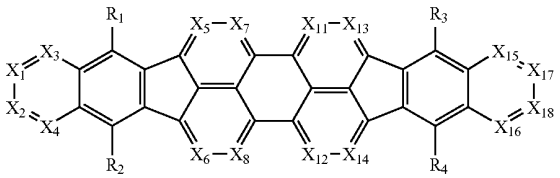


wherein:

X_1 to X_8 each represent a carbon atom having a substituent R or a nitrogen atom, the carbon atom or the nitrogen atom forming a ring, at least one of X_1 to X_8 represents a nitrogen atom, R represents a hydrogen atom, a halogen atom, or a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group and a cyano group; and

R_1 to R_{10} each represent a halogen atom, or a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group and a cyano group, and R_1 to R_{10} may be identical to or different from one another, and

[5]



wherein:

X_1 to X_{18} each represent a carbon atom having a substituent R or a nitrogen atom, the carbon atom or the nitrogen atom forming a ring, at least one of X_1 to X_{18} represents a nitrogen atom, R represents a hydrogen atom, a halogen atom, or a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group, and a cyano group, and when a plurality of carbon atoms each having the substituent R are present, R's may be independently identical to or different from each other; and

R_1 to R_4 each represent a halogen atom, or a group selected from a substituted or unsubstituted alkyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted fused polycyclic aromatic group, a substituted or unsubstituted fused polycyclic heterocyclic group and a cyano group, and R_1 to R_4 may be identical to or different from one another.

A compound having an azabenzofluoranthene structure is an additionally preferable example of the fused heterocyclic compound. More preferable examples of the fused heterocyclic compound include a compound represented by any one of the general formulae [1] to [4] in which X_1 or X_2 represents a nitrogen atom, and a compound represented by the general formula [5] in which at least one of X_1, X_2, X_{17}, and X_{18} represents a nitrogen atom.

The fused heterocyclic compound of the present invention can be used as a material for an organic light emitting device. When the compound is used for a light emitting layer in the device, the compound can be used alone in the light emitting

layer, or can be used in the layer for the purpose of serving as a dopant (guest) material or a host material, whereby a device emitting light with high efficiency, maintaining high luminance for a long time period, and showing small deterioration due to energization can be obtained.

When a light emission layer is composed of a host material and a guest each having carrier transport property, light emission mainly involves some of the following processes:

1. the transport of an electron or a hole in the light emission layer;

2. the generation of an exciton of the host;

3. the transfer of excitation energy between host molecules; and

4. the transfer of excitation energy from the host to the guest.

Desired energy transfer or light emission in each process occurs in competition with various deactivation processes.

It is needless to say that an improvement in luminous efficiency of an EL device requires a material itself that is mainly responsible for light emission to have a large light emission quantum yield. However, how efficiently energy can be transferred between hosts or between a host and a guest is also of great concern. In addition, no cause for the degradation of light emission due to energization has been revealed at present. However, the degradation is assumed to be related to at least the material itself that is mainly responsible for light emission or a change in environment surrounding the luminescent material due to a molecule around the material.

In view of the foregoing, the inventors of the present invention have made various studies, and have found that, when a fused ring compound represented by the general formula [1] is especially used as a host or guest. for the light emission layer of a device, the device emits light with high efficiency, maintains high luminance for a long time period, and shows small degradation of light emission due to energization.

One possible cause for the deterioration of light emission due to energization is the deterioration of the thin film shape of the light emitting layer. The deterioration of the thin film shape is considered to result from the crystallization of an organic thin film due to, for example, the temperature of an environment in which the device is driven, and heat generation at the time of the driving of the device. This is considered to originate from the low glass transition temperature of a material for the device, so an organic EL material is required to have a high glass transition temperature. The fused heterocyclic compound of the present invention has a high glass transition temperature, so an achievement in high durability of an organic EL device can be expected.

In addition, the fused heterocyclic compound of the present invention is a material having a high reduction potential and large electron accepting property because an atom having high electronegativity is inserted into the fused aromatic ring structure of the compound. In addition, electron mobility can be adjusted by controlling the reduction potential through the selection of R and Y in the compound represented by any one of the general formulae [1]. to [5]. In view of the foregoing, the inventors have found that the voltage at which the device is driven can be reduced, high luminance can be maintained for a long time period, and the deterioration of the device due to energization can be reduced by properly selecting R and Y in the compound represented by any one of the general formulae [1] to [5] through a combination with any one of various host materials.

Further, the inventors have found that a wide range of luminescent colors ranging from a pure blue color to a red color can be shown by properly modifying the molecular structure represented by the general formula [1] as represented by any one of the general formulae [2] to [5], so a material having the molecular structure represented by the general formula [1] is a light emitting material having extensibility.

In addition, an improvement in quantum yield of a light emitting material to be used in an organic electroluminescence device is indispensable for providing an organic electroluminescence device having an optical output with high efficiency. When a nitrogen atom is introduced mainly into a fused polycyclic aromatic group, the n-Π* orbital of a triplet becomes an orbital at a Tn level (n represents 1 or more) depending on the position where the atom is introduced. Then, when the n-Π* orbital (triplet) is energetically close to an S1 orbital, energy deactivation from the S1 orbital to the n-Π* orbital is apt to occur, so the quantum yield of the light emitting material is apt to reduce. However, the proper selection of the position where the nitrogen atom is introduced and the kind of a substituent to be introduced into the molecular skeleton of the light emitting material can increase a difference in energy between the n-Π* orbital (triplet) and the S1 orbital, and can alleviate the reduction in quantum yield. The position where the nitrogen atom is introduced is preferably simulated on the basis of molecular orbital calculation. That is, nitrogen atoms are more preferably introduced into the positions of X_1 and X_2 represented in the general formula [1] on the basis of the design of a molecular skeleton capable of maintaining high quantum yield.

Further, an emission spectrum having a controlled molecular vibration can be monodispersed, and its half width can be reduced by properly designing not only the position where a nitrogen atom is introduced but also the position and kind of a substituent to be introduced into the molecular skeleton of a light emitting material, so a light emitting material having a good color purity can be provided.

Further, the introduction of substituents into R_1 and R_2 represented in the general formula [1] prevents molecules of the compound of the present invention from associating with each other. As a result, upon use of the compound of the present invention as a light emitting material for an organic electroluminescence device, an increase in wavelength of light to be emitted from the device due to the molecular association of the light emitting material itself can be prevented, whereby an organic electroluminescence device having a good color purity can be provided.

Further, the positions of X_9 and X_{10} represented in the general formula [1] have high reactivity, so the introduction of a ring structure such as Z represented in the general formula [3] as a structure having a substituent introduced into each of the positions can improve the chemical stability of the compound of the present invention.

The present invention has been made as a result of molecular design based on the foregoing discussion.

Examples of the substituted or unsubstituted alkyl group in any one of the above general formulae. [1] to [**5**] include, but of course are not limited to, the following.

A methyl group, an ethyl group, an n-propyl group, an n-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, an n-decyl group, an iso-propyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, an iso-pentyl group, a neopentyl group, a tert-octyl group, a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a 2-fluoroethyl group, a 2,2,2-trifluoroethyl group, a perfluoroethyl group, a 3-fluoropropyl group, a perfluoropropyl group, a 4-fluorobutyl group, a perfluorobutyl group, a 5-fluoropentyl group, a 6-fluorohexyl group, a chloromethyl group, a trichloromethyl group, 2-chloroethyl group, a 2,2,2-trichloroethyl group, a 4-chlorobutyl group, a

5-chloropentyl group, a 6 chlorohexyl group, a bromomethyl group, a 2-bromoethyl group, an iodomethyl group, a 2-iodoethyl group, a hydroxymethyl group, a hydroxyethyl group, a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, a cyclopentylmethyl group, a cyclohexylmethyl group, a cyclohexylethyl group, a 4-fluorocyclohexyl group, a norbornyl group, and an adamantyl group.

Examples of the substituted amino group include a dimethylamino group, a diethylamino group, a dibenzylamino group, a diphenylamino group, a ditolylamino group, a dianisolylamino group, and a carbazoyl group. From the viewpoints of conductive property and glass transition temperature, a dimethylamino group, a diphenylamino group, a ditolylamino group, and a carbazoyl group are preferable.

Examples of the substituted or unsubstituted aralkyl group include, but of course are not limited to, the following.

A benzyl group, a 2-phenylethyl group, a 2-phenylisopropyl group, a 1-naphthylmethyl group, a 2-naphthylmethyl group, a 2-(1-naphthyl)ethyl group, a 2-(2-naphthyl)ethyl group, a 9-anthrylmethyl group, a 2-(9-anthryl)ethyl group, a 2-fluorobenzyl group, a 3-fluorobenzyl group, a 4-fluorobenzyl group, a 2-chlorobenzyl group, a 3-chlorobenzyl group, a 4-chlorobenzyl group, a 2-bromobenzyl group, a 3-bromobenzyl group, and a 4-bromobenzyl group.

Examples of the substituted or unsubstituted aryl group include, but of course are not limited to, the following.

A phenyl group, a 4-methylphenyl group, a 4-ethylphenyl group, a 4-fluorophenyl group, a 4-trifluorophenyl group, a 3,5-dimethylphenyl group, a 2,6-diethylphenyl group, a mesityl group, a 4-tert-butylphenyl group, a ditolylaminophenyl group, and a biphenyl group.

Examples of the substituted or unsubstituted fused polycyclic aromatic group include, but of course are not limited to, the following.

A naphthyl group, an acenaphthylenyl group, an anthryl group, a phenanthryl group, a pyrenyl group, an acephenanthrylenyl group, an aceanthrylenyl group, a chrysenyl group, a dibenzochrysenyl group, a benzoanthryl group, a dibenzoanthryl group, a naphthacenyl group, a picenyl group, a pentacenyl group, a fluorenyl group, a 9,9-dihydroanthryl group, a triphenylenyl group, a perylenyl group, and a fluoranthenyl group.

Examples of the substituted or unsubstituted heterocyclic group include, but of course are not limited to, the following.

A pyridyl group, a pyrrolyl group, a bipyridyl group, a methylpyridyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a terpyrrolyl group, a thienyl group, a terthienyl group, a propylthienyl group, a furyl group, an oxazolyl group, an oxadiazolyl group, a thiazolyl group, and a thiadiazolyl group.

Examples of the substituted or unsubstituted fused polycyclic heterocyclic group include, but of course are not limited to, the following.

A quinolyl group, an isoquinolyl group, a benzothienyl group, a dibenzothienyl group, a benzofuryl group, an isobenzofuryl group, a dibenzofuryl group, a quinoxalinyl group, a naphthylidinyl group, a quinazolinyl group, a phenanthridinyl group, an indolidinyl group, a phenadinyl group, a carbazolyl group, an acridinyl group, a phenadinyl group, and a diazafluorenyl group.

Examples of the halogen atom include fluorine, chlorine, bromine, and iodine.

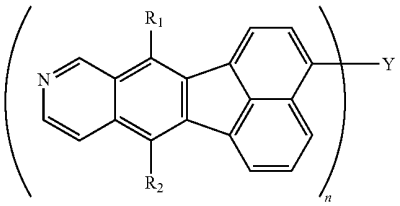
Examples of a substituent which the above substituents may additionally have include, but of course are not limited to, the following.

Alkyl groups such as a methyl group, an ethyl group, a propyl group, a tert-butyl group, and a trifluoromethyl group; aryl groups such as a phenyl group and a biphenyl group; heterocyclic groups such as a thienyl group and a pyrrolyl group; amino groups such as a dimethylamino group, a diethylamino group, dibenzylamino group, a diphenylamino group, ditolylamino group, and a dianisolylamino group; alkoxy groups such as a methoxy group, and an ethoxy group; halogen atoms such as fluorine, chlorine, bromine, and iodine; hydroxyl group; cyano group; and nitro group.

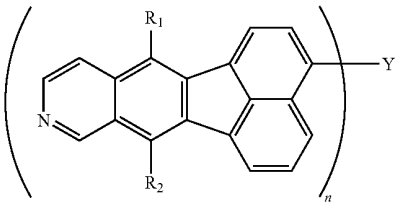
Hereinafter, specific structural formulae of the fused heterocyclic compound of the present invention are shown below. However, these formulae are merely representative examples, and the present invention is not limited to them.

Compound Example 1

[6]



[7]



wherein:

Y represents a linking group which is divalent or more such as a phenylene group or a biphenylene group; and

R_1 and R_2 each represent an aryl group such as a phenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group or a butyl group.

When R_1 and R_2 are different from each other, R_1 and R_2 shown in the following tables may be replaced with each other.

In the tables, "Compd. No." is Compound No.

TABLE 1

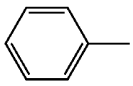
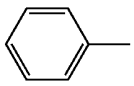
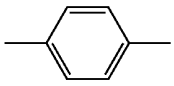
Compd. No.	n	R1	R2	Y
1001	2			

TABLE 1-continued

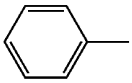
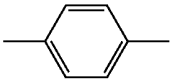
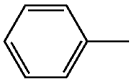
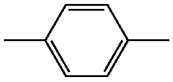
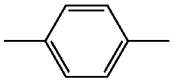
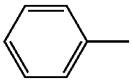
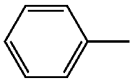
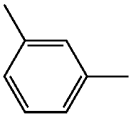
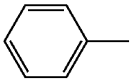
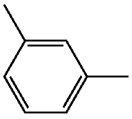
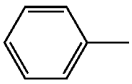
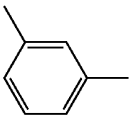
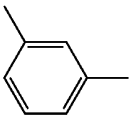
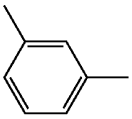
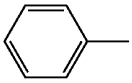
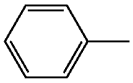
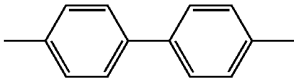
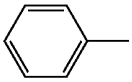
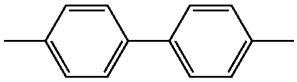
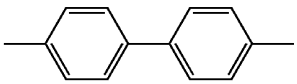
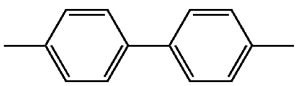
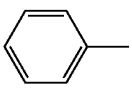
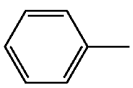
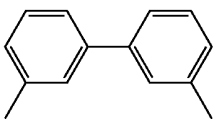
Compd. No.	n	R1	R2	Y
1002	2		CH_3—	
1003	2		C_4H_9—	
1004	2	CH_3—	CH_3—	
1005	2	C_4H_9—	C_4H_9—	
1006	2			
1007	2		CH_3—	
1008	2		C_4H_9—	
1009	2	CH_3—	CH_3—	
1010	2	C_4H_9—	C_4H_9—	
1011	2			
1012	2		C_4H_9—	
1013	2	CH_3—	CH_3—	
1014	2	C_4H_9—	C_4H_9—	
1015	2			

TABLE 1-continued

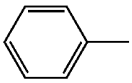
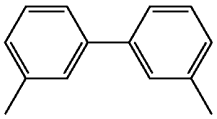
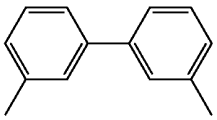
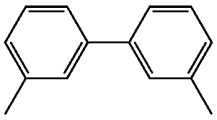
Compd. No.	n	R1	R2	Y
1016	2		C_4H_9—	
1017	2	CH_3—	CH_3—	
1018	2	C_4H_9—	C_4H_9—	

TABLE 2

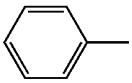
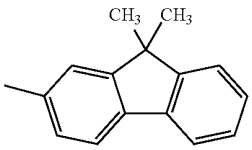
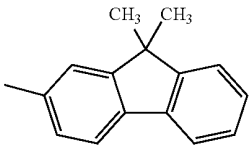
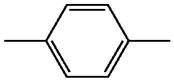
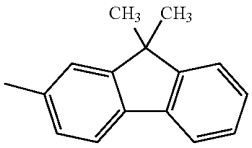
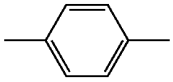
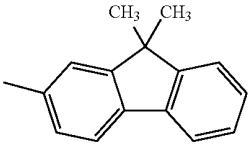
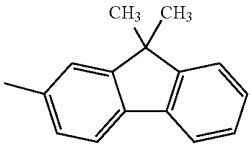
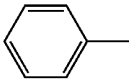
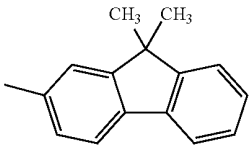
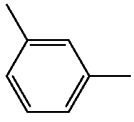
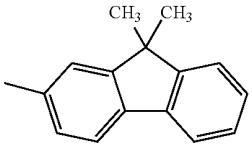
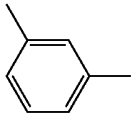
Compd. No.	n	R1	R2	Y
1019	2			
1020	2	CH_3—		
1021	2	C_4H_9—		
1022	2			
1023	2			
1024	2	CH_3—		

TABLE 2-continued

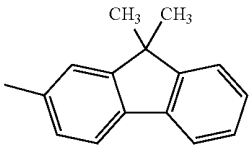
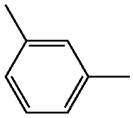
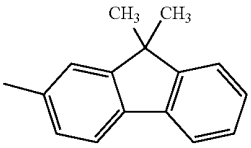
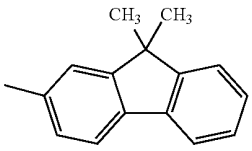
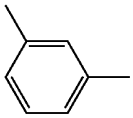
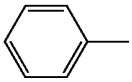
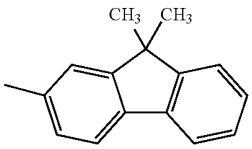
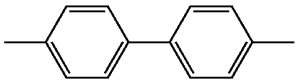
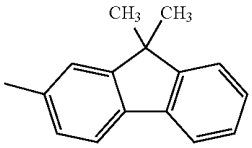
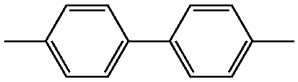
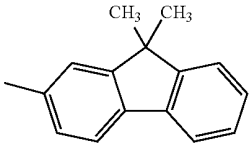
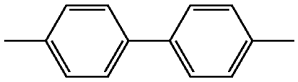
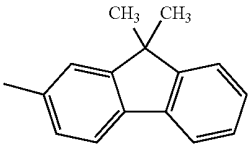
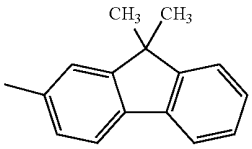
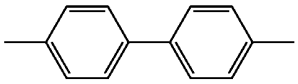
Compd. No.	n	R1	R2	Y
1025	2	C_4H_9—		
1026	2			
1027	2			
1028	2	CH_3—		
1029	2	C_4H_9—		
1030	2			

TABLE 3

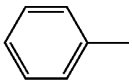
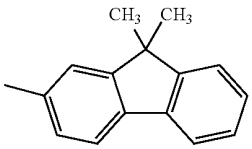
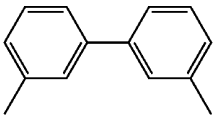
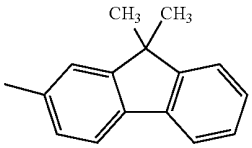
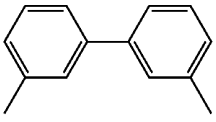
Compd. No.	n	R1	R2	Y
1031	2			
1032	2	CH_3—		

TABLE 3-continued

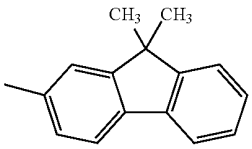
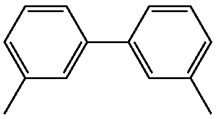
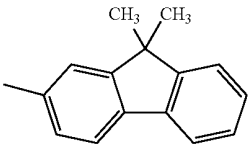
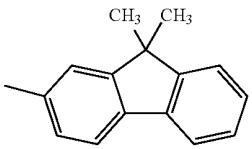
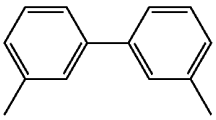
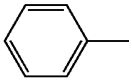
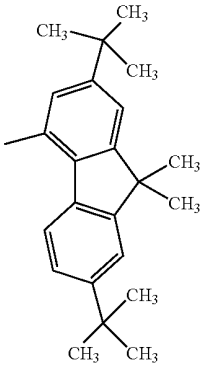
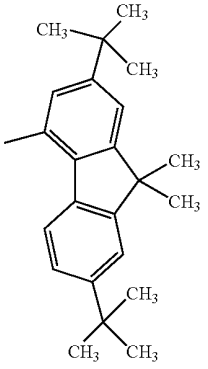
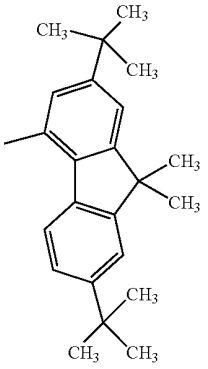
Compd. No.	n	R1	R2	Y
1033	2	C_4H_9—		
1034	2			
1035	2			
1036	2	CH_3—		
1037	2	C_4H_9—		

TABLE 4

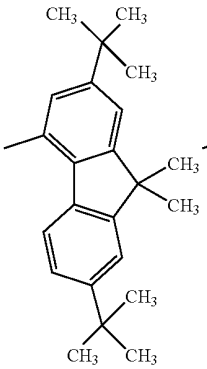
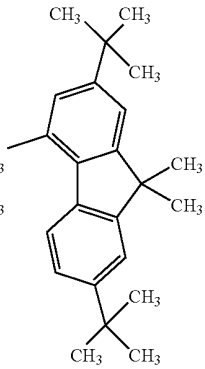
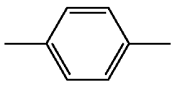
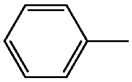
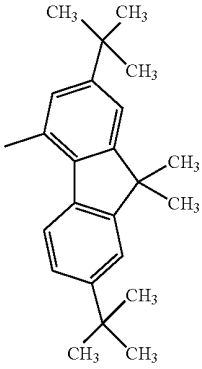
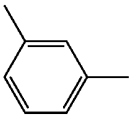
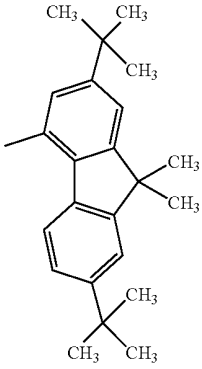
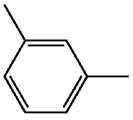
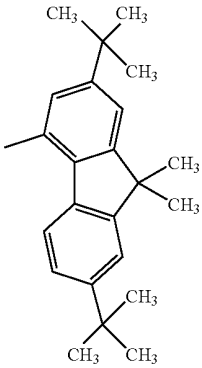
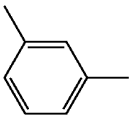
Compd. No	n	R1	R2	Y
1038	2			
1039	2			
1040	2	CH_3—		
1041	2	C_4H_9—		

TABLE 4-continued

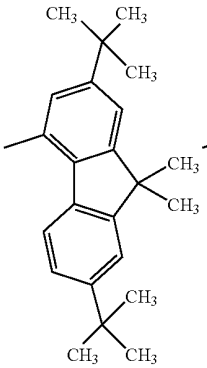
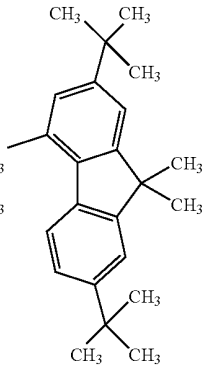
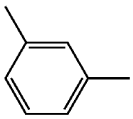
Compd. No	n	R1	R2	Y
1042	2			

TABLE 5

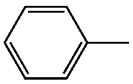
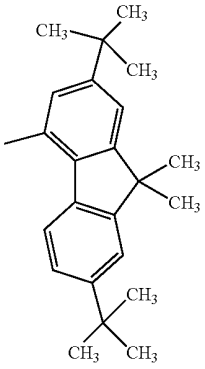
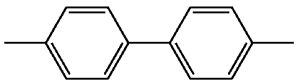
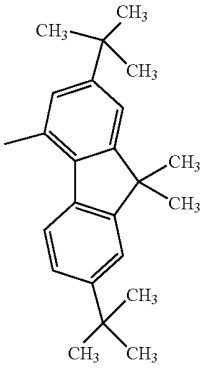
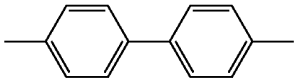
Compd. No.	n	R1	R2	Y
1043	2			
1044	2	CH_3—		

TABLE 5-continued

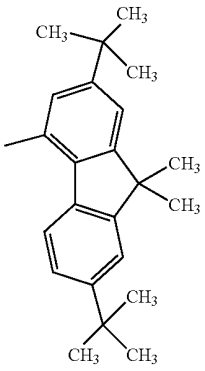
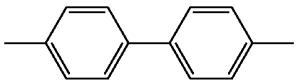
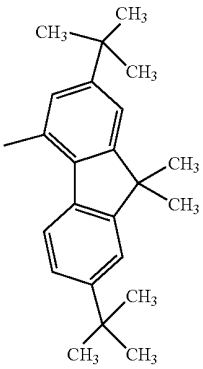
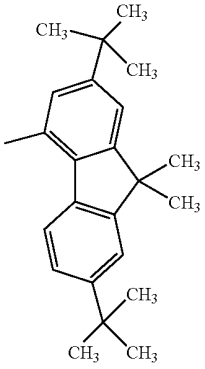
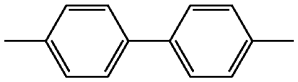
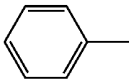
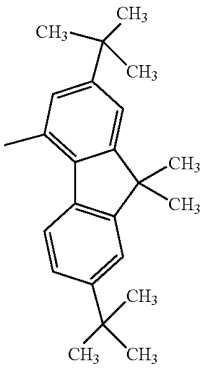
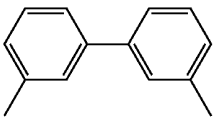
Compd. No.	n	R1	R2	Y
1045	2	C_4H_9—		
1046	2			
1047	2			

TABLE 6

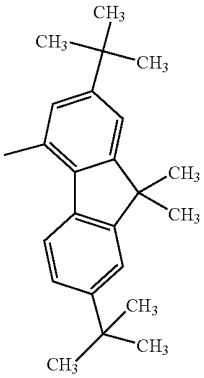
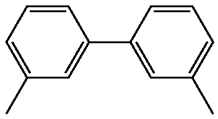
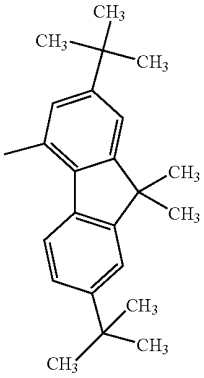
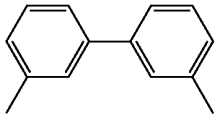
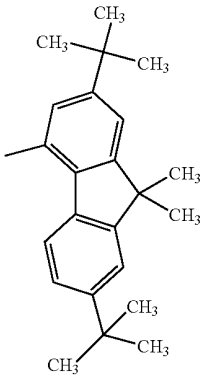
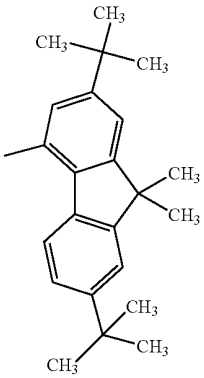
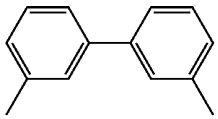
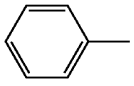
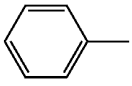
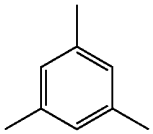
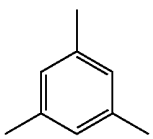
Compd. No.	n	R1	R2	Y
1048	2	CH_3—		
1049	2	C_4H_9—		
1050	2			
1051	3			
1052	3	CH_3—	CH_3—	

TABLE 6-continued

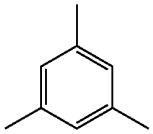
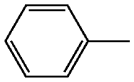
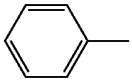
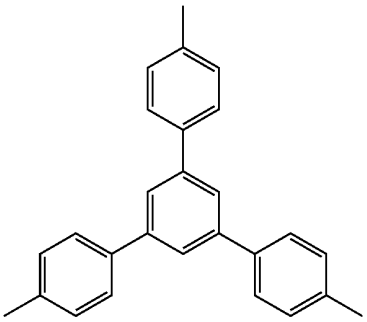
Compd. No.	n	R1	R2	Y
1053	3	C_4H_9—	C_4H_9—	
1054	3			

TABLE 7

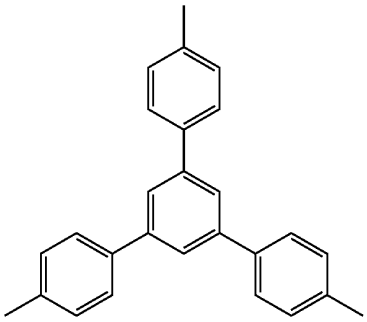
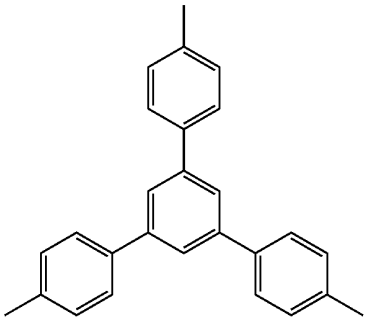
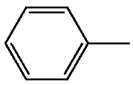
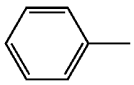
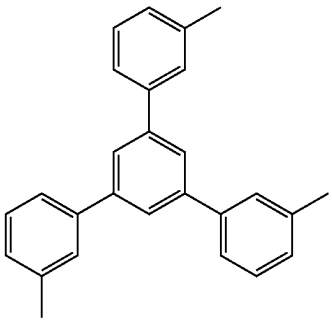
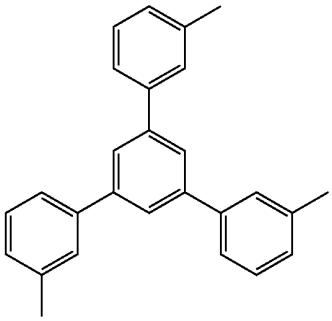
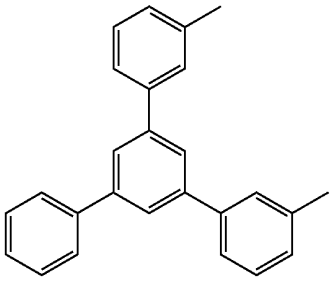
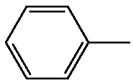
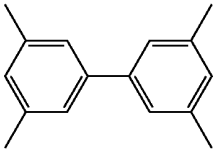
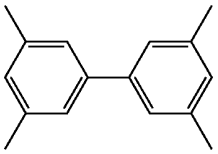
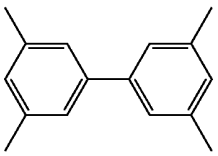
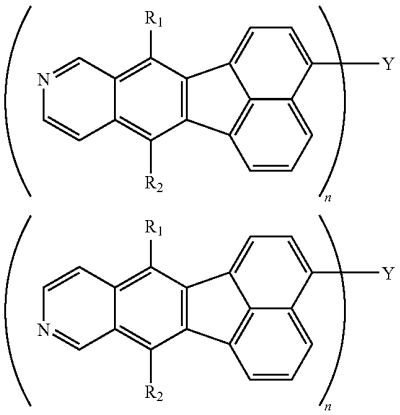
Compd. No.	n	R1	R2	Y
1055	3	CH_3—	CH_3—	
1056	3	C_4H_9—	C_4H_9—	

TABLE 7-continued

Compd. No.	n	R1	R2	Y
1057	3			
1058	3	CH_3—	CH_3—	
1059	3	C_4H_9—	C_4H_9—	
1060	4			
1061	4	CH_3—	CH_3—	
1062	4	C_4H_9—	C_4H_9—	

Compound Example 2



wherein:

[6] Y represents a linking group which is divalent or more such as a phenylene group or a biphenylene group; and

[7] At least one of R_1 and R_2 represents a heterocyclic group such as a pyridyl group, or a fused polycyclic heterocyclic group such as a quinolyl group.

When R_1 and R_2 are different from each other, R_1 and R_2 shown in the following tables may be replaced with each other.

TABLE 8

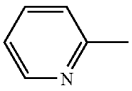
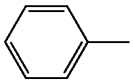
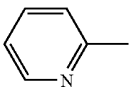
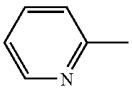
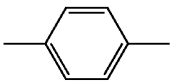
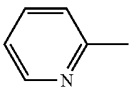
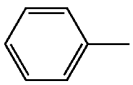
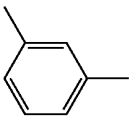
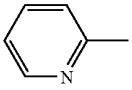
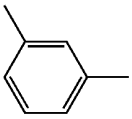
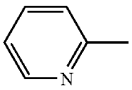
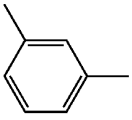
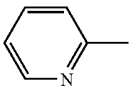
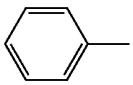
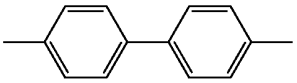
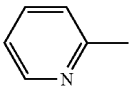
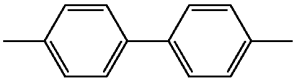
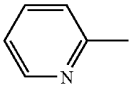
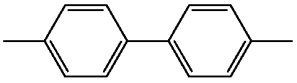
Compd. No.	n	R1	R2	Y
1101	2			
1102	2		CH_3—	
1103	2		C_4H_9—	
1104	2			
1105	2		CH_3—	
1106	2		C_4H_9—	
1107	2			
1108	2		CH_3—	
1109	2		C_4H_9—	

TABLE 8-continued

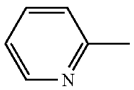
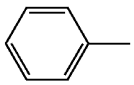
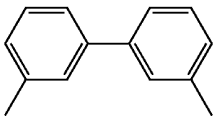
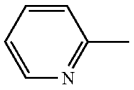
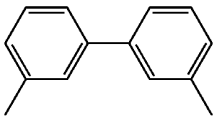
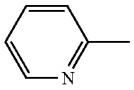
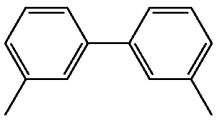
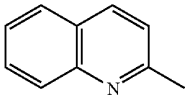
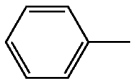
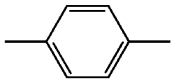
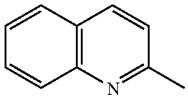
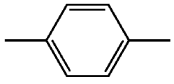
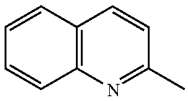
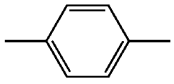
Compd. No.	n	R1	R2	Y
1110	2			
1111	2		CH_3—	
1112	2		C_4H_9—	
1113	2			
1114	2		CH_3—	
1115	2		C_4H_9—	

TABLE 9

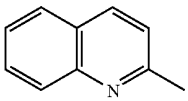
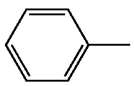
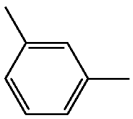
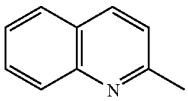
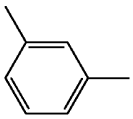
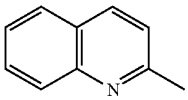
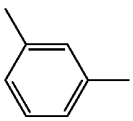
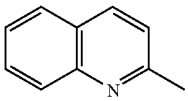
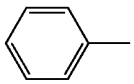
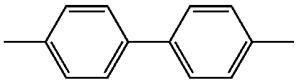
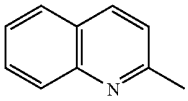
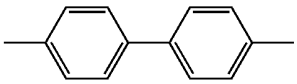
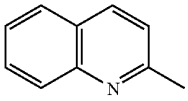
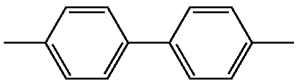
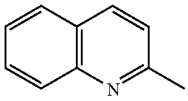
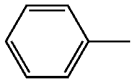
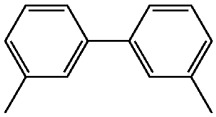
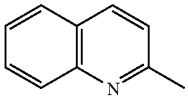
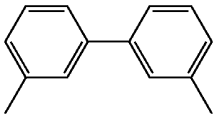
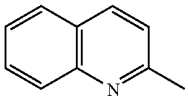
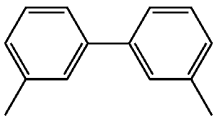
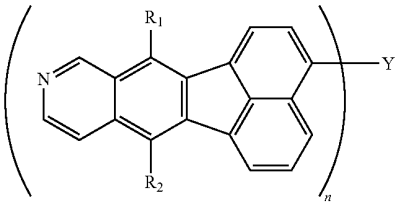
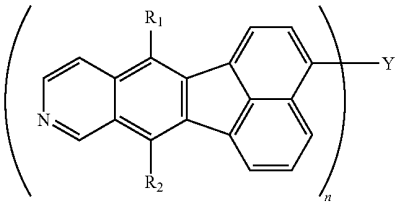
Compd. No.	n	R1	R2	Y
1116	2			
1117	2		CH_3—	
1118	2		C_4H_9—	
1119	2			

TABLE 9-continued

Compd. No.	n	R1	R2	Y
1120	2		CH_3—	
1121	2		C_4H_9—	
1122	2			
1123	2		CH_3—	
1124	2		C_4H_9—	

Compound Example 3





In the compound example:

[6] Y represents a linking group which is divalent or more and is formed of a fused polycyclic aromatic group such as a naphthylene group, an anthrylene group, or a fluorenylene group; and

[7] R_1 and R_2 each represent an aryl group such as a phenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group.

When R_1 and R_2 are different from each other, R_1 and R_2 shown in the following tables may be replaced with each other.

TABLE 10

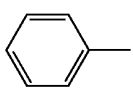
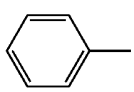
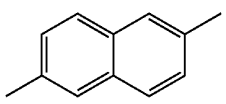
Compd. No.	n	R1	R2	Y
1201	2			

TABLE 10-continued

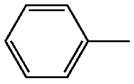
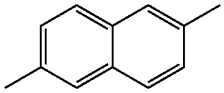
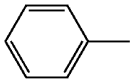
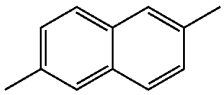
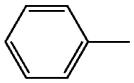
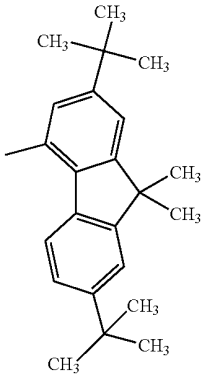
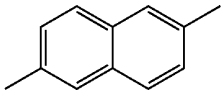
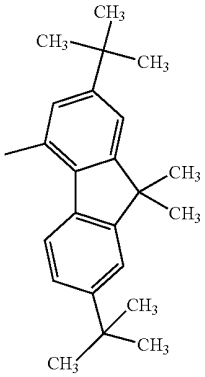
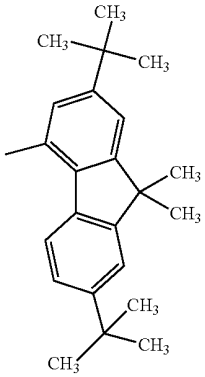
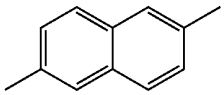
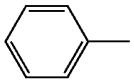
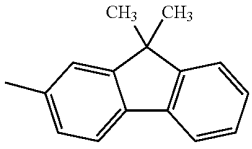
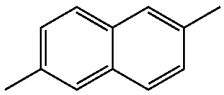
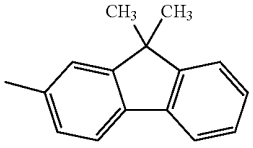
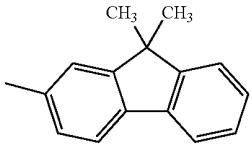
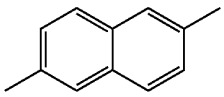
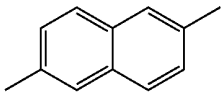
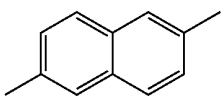
Compd. No.	n	R1	R2	Y
1202	2		CH_3—	
1203	2		C_4H_9—	
1204	2			
1205	2			
1206	2			
1207	2			
1208	2	CH_3—	CH_3—	
1209	2	C_4H_9—	C_4H_9—	

TABLE 10-continued

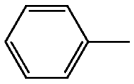
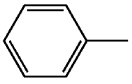
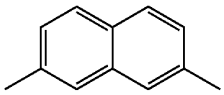
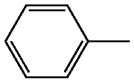
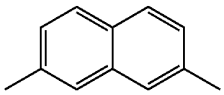
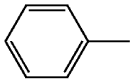
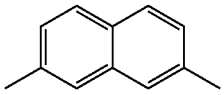
Compd. No.	n	R1	R2	Y
1210	2			
1211	2		CH_3—	
1212	2		C_4H_9—	

TABLE 11

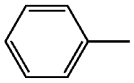
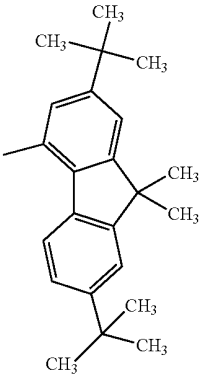
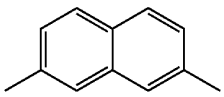
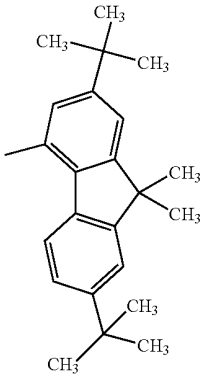
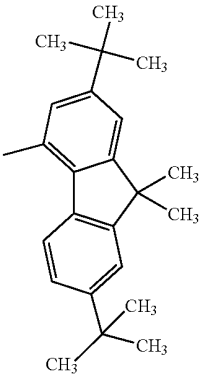
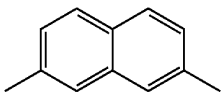
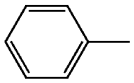
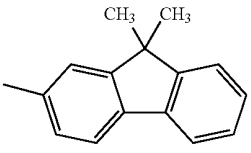
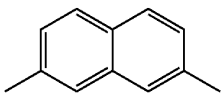
Compd. No.	n	R1	R2	Y
1213	2			
1214	2			
1215	2			

TABLE 11-continued

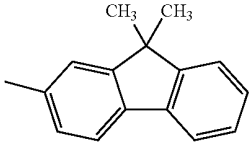
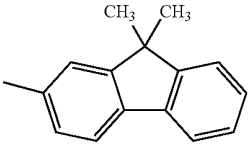
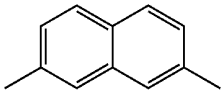
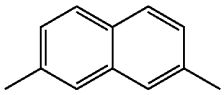
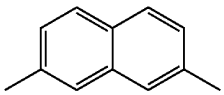
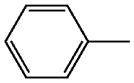
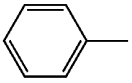
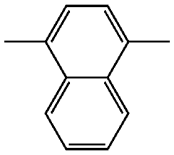
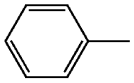
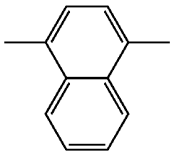
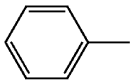
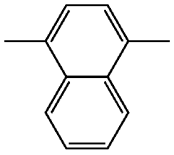
Compd. No.	n	R1	R2	Y
1216	2			
1217	2	CH_3—	CH_3—	
1218	2	C_4H_9—	C_4H_9—	
1219	2			
1220	2		CH_3—	
1221	2		C_4H_9—	

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TABLE 12

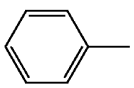
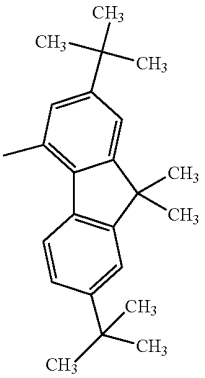
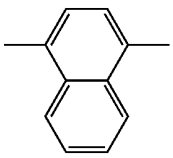
Compd. No.	n	R1	R2	Y
1222	2			

TABLE 12-continued

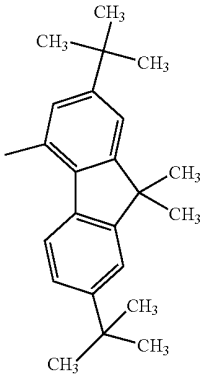
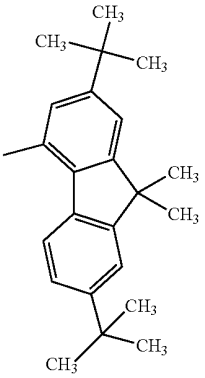
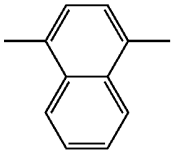
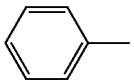
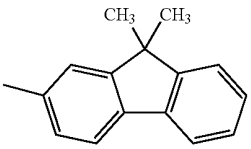
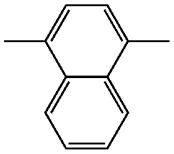
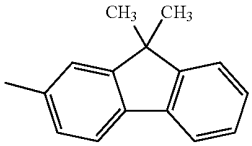
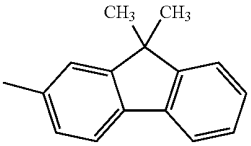
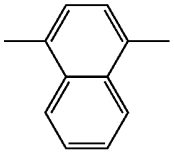
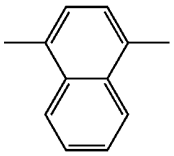
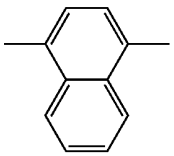
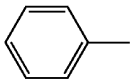
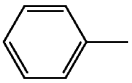
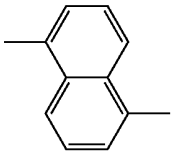
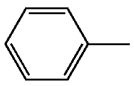
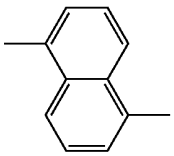
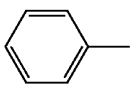
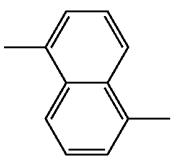
Compd. No.	n	R1	R2	Y
1223	2			
1224	2			
1225	2			
1226	2	CH_3—	CH_3—	
1227	2	C_4H_9—	C_4H_9—	
1228	2			
1229	2		CH_3—	
1230	2		C_4H_9—	

TABLE 13

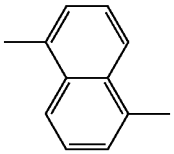
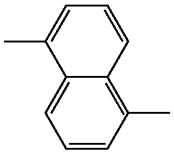
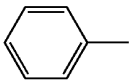
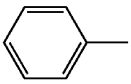
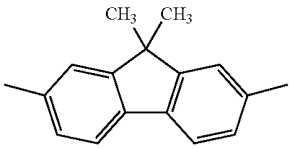
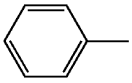
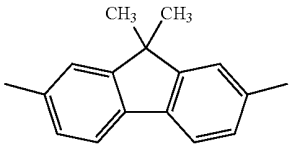
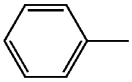
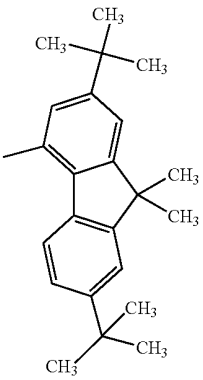
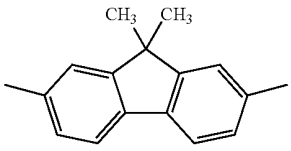
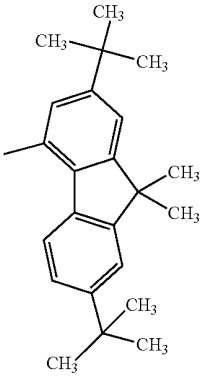
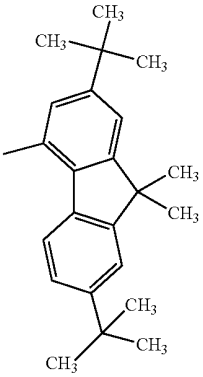
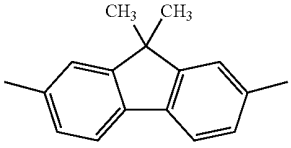
Compd. No.	n	R1	R2	Y
1231	2	CH_3—	CH_3—	
1232	2	C_4H_9—	C_4H_9—	
1233	2			
1234	2		C_4H_9—	
1235	2			
1236	2			

TABLE 13-continued

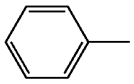
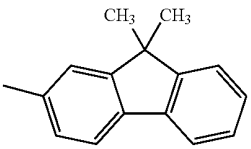
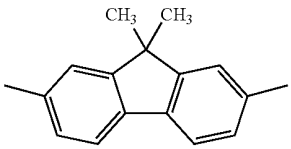
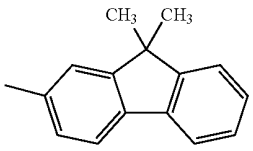
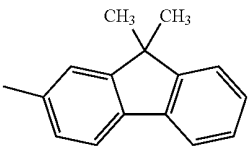
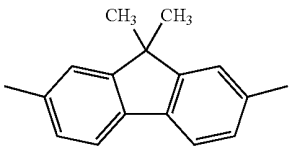
Compd. No.	n	R1	R2	Y
1237	2			
1238	2			

TABLE 14

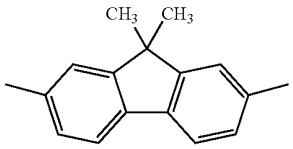
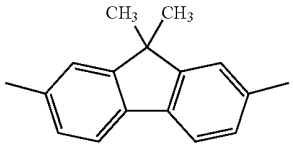
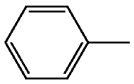
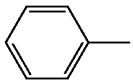
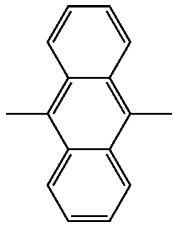
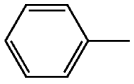
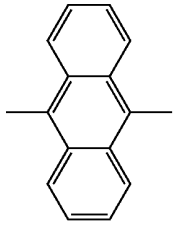
Compd. No.	n	R1	R2	Y
1239	2	CH_3—	CH_3—	
1240	2	C_4H_9—	C_4H_9—	
1241	2			
1242	2		C_4H_9—	

TABLE 14-continued

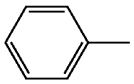
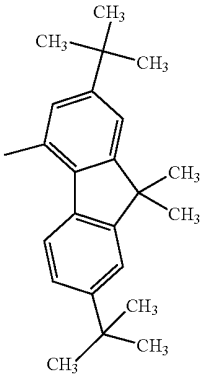
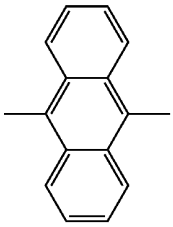
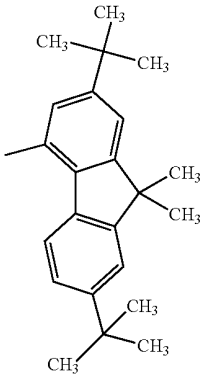
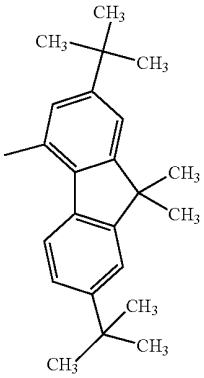
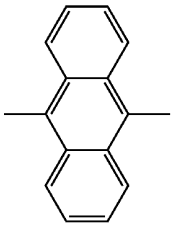
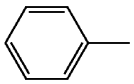
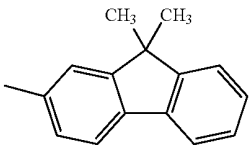
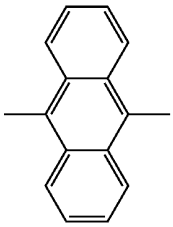
Compd. No.	n	R1	R2	Y
1243	2			
1244	2			
1245	2			

TABLE 15

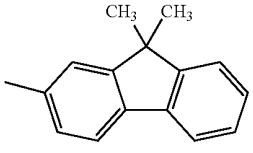
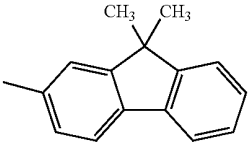
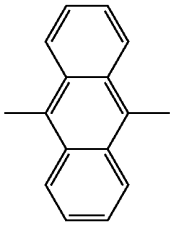
Compd. No.	n	R1	R2	Y
1246	2			

TABLE 15-continued

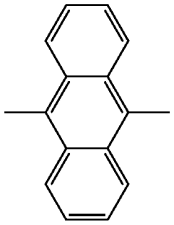
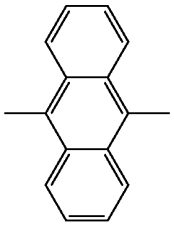
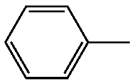
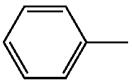
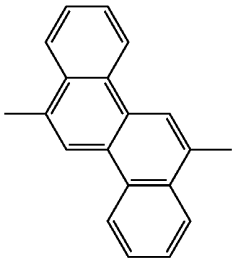
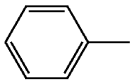
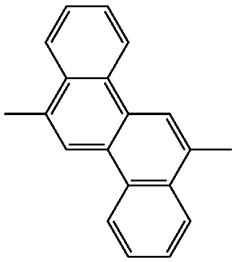
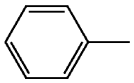
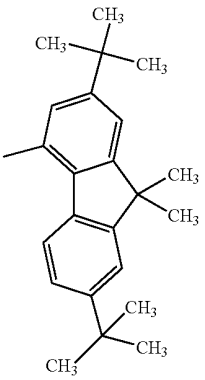
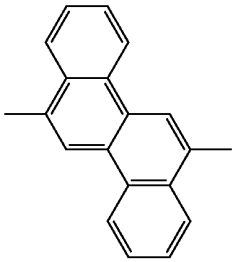
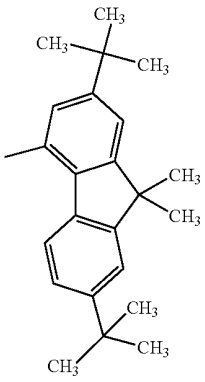
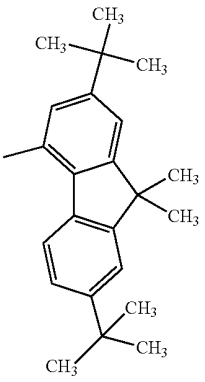
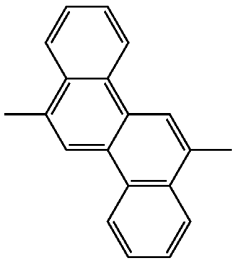
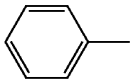
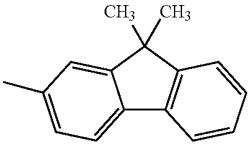
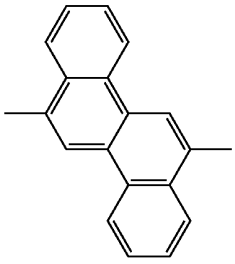
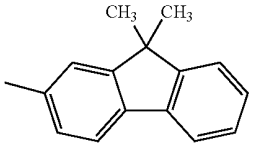
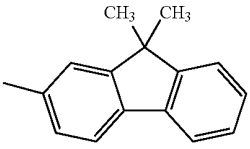
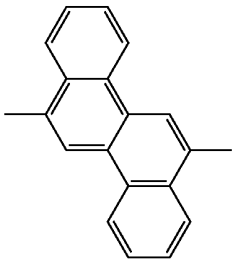
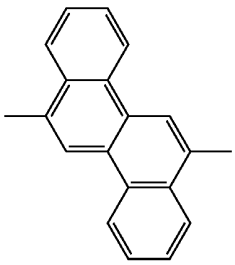
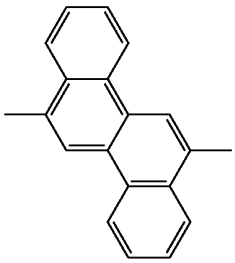
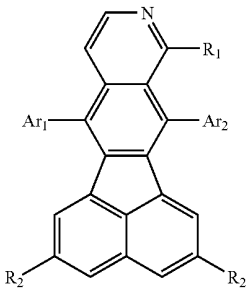
Compd. No.	n	R1	R2	Y
1247	2	CH_3—	CH_3—	
1248	2	C_4H_9—	C_4H_9—	
1249	2			
1250	2		C_4H_9—	
1251	2			

TABLE 16

Compd. No.	n	R1	R2	Y
1252	2			
1253	2			
1254	2			
1255	2	CH_3—	CH_3—	
1256	2	C_4H_9—	C_4H_9—	

Compound Example 4



wherein:

[8] Ar_1 and Ar_2 each represent an aryl group such as a phenyl group or a biphenyl group, or a fused polycyclic aromatic group with three or less rings such as a naphthyl group, a fluorenyl group, or a phenanthryl group; and

R_1 and R_2 each represent a hydrogen atom, or an alkyl group such as a methyl group, an ethyl group, or a tertiary butyl group.

When Ar_1 and Ar_2 are different from each other, Ar_1 and Ar_2 shown in the following tables may be replaced with each other.

TABLE 17

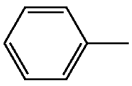
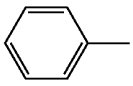
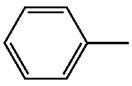
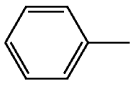
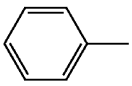
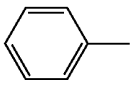
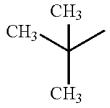
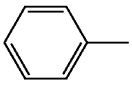
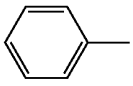
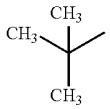
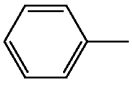
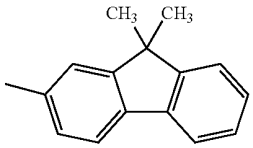
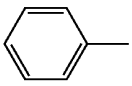
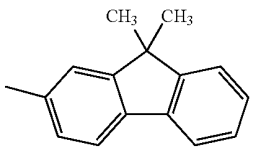
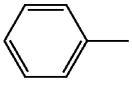
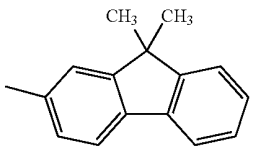
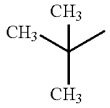
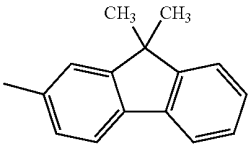
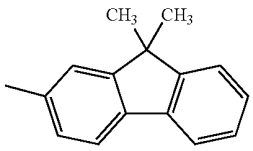
Compd. No.	Ar1	Ar2	R1	R2
1301			H—	H—
1302			CH_3—	H—
1303			CH_3—	
1304			H—	
1305			CH_3—	H—
1306			CH_3—	H—
1307			H—	
1308			H—	H—

TABLE 17-continued

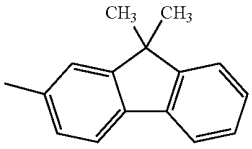
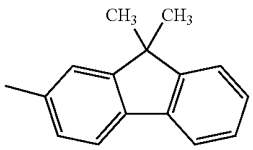
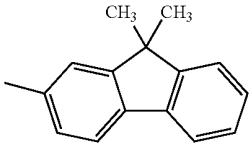
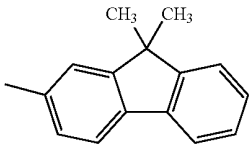
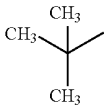
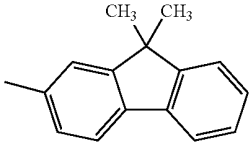
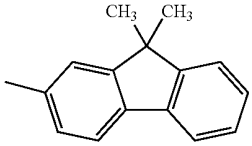
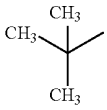
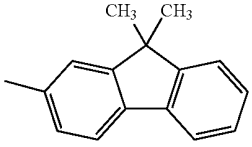
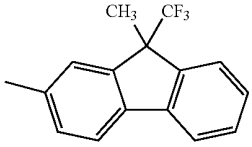
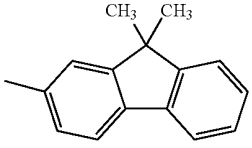
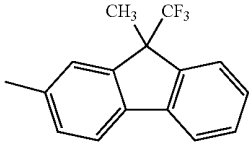
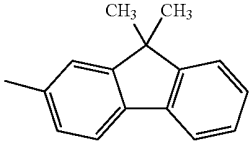
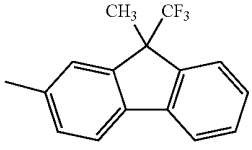
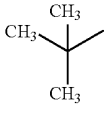
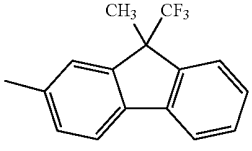
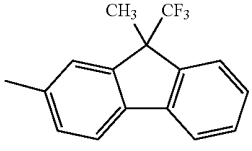
Compd. No.	Ar1	Ar2	R1	R2
1309			CH_3—	H—
1310			H—	
1311			CH_3—	
1312			H—	H—
1313			CH_3—	H—
1314			H—	
1315			H—	H—

TABLE 18

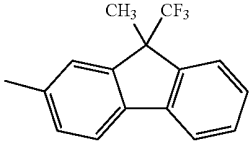
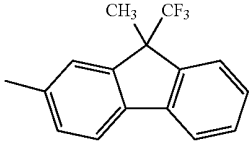
Compd. No.	Ar1	Ar2	R1	R2
1316			CH_3—	H—

TABLE 18-continued

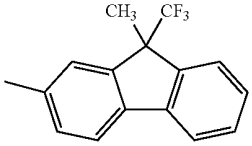
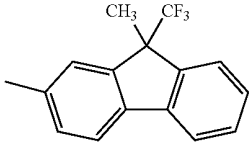
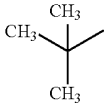
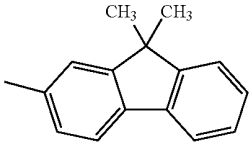
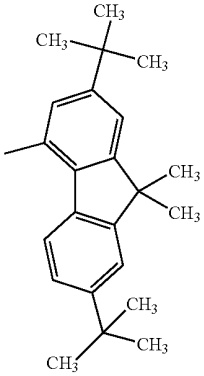
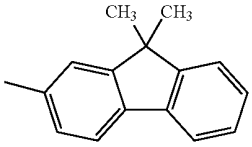
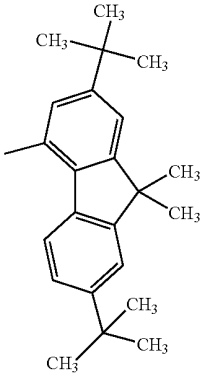
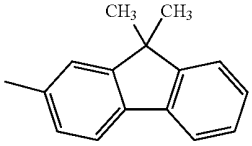
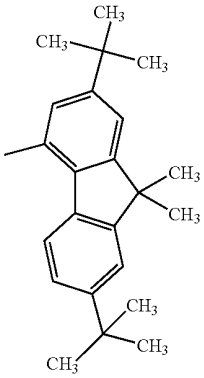
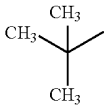
Compd. No.	Ar1	Ar2	R1	R2
1317			H—	
1318			H—	H—
1319			CH_3—	H—
1320			H—	

TABLE 18-continued

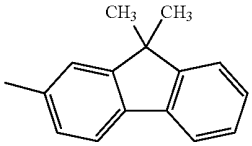
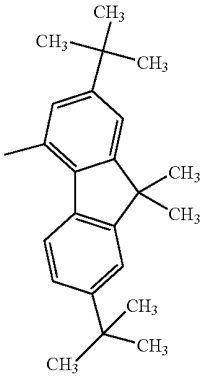
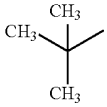
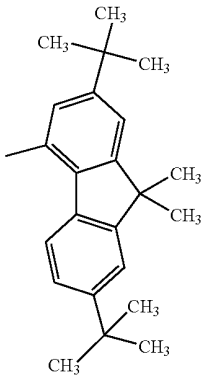
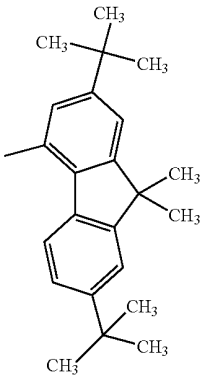
Compd. No.	Ar1	Ar2	R1	R2
1321			CH_3—	
1322			H—	H—

TABLE 19

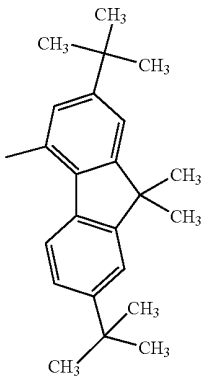
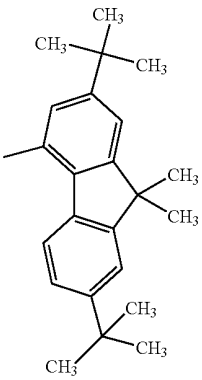
Compd. No.	Ar1	Ar2	R1	R2
1323			CH_3—	H—

TABLE 19-continued

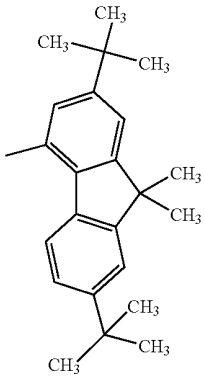
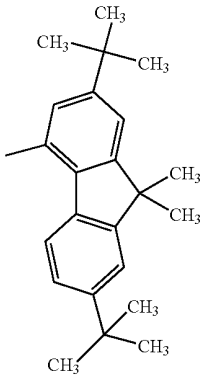
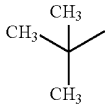
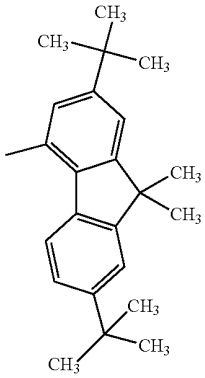
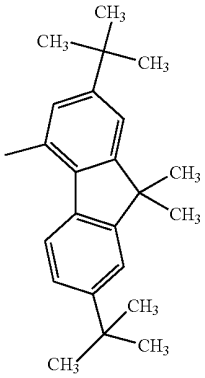
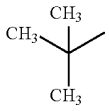
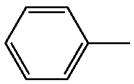
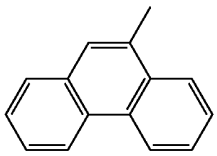
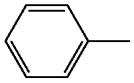
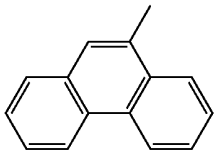
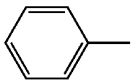
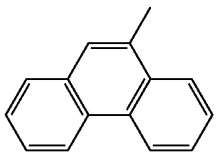
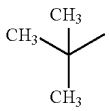
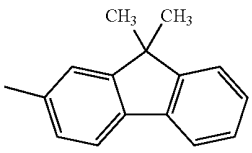
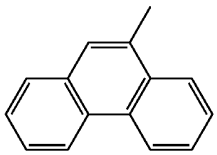
Compd. No.	Ar1	Ar2	R1	R2
1324			H—	
1325			CH_3—	
1326			H—	H—
1327			CH_3—	H—
1328			H—	
1329			H—	H—

TABLE 19-continued

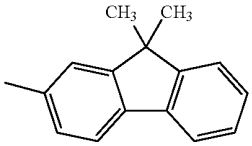
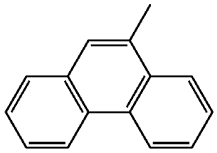
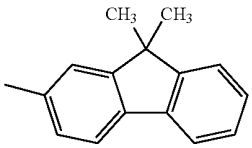
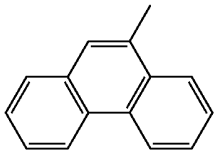
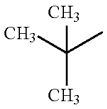
Compd. No.	Ar1	Ar2	R1	R2
1330			CH_3—	H—
1331			H—	

TABLE 20

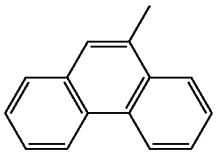
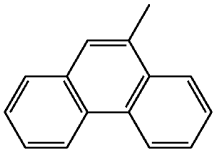
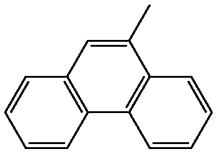
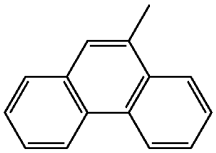
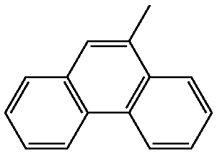
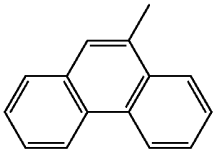
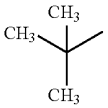
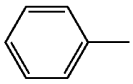
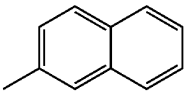
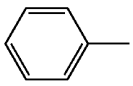
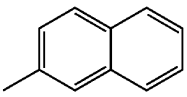
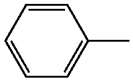
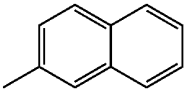
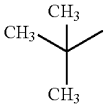
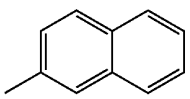
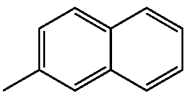
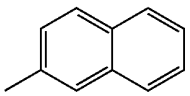
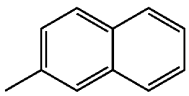
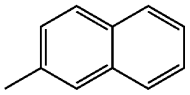
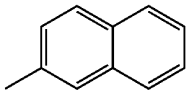
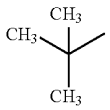
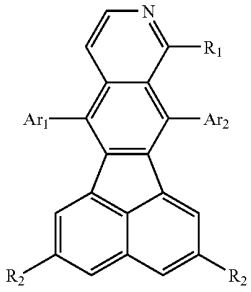
Compd. No.	Ar1	Ar2	R1	R2
1332			H—	H—
1333			CH_3—	H—
1334			H—	
1335			H—	H—
1336			CH_3—	H—
1337			H—	
1338			H—	H—

TABLE 20-continued

Compd. No.	Ar1	Ar2	R1	R2
1339			CH_3—	H—
1340			H—	

Compound Example 5



wherein:

[8] At least one of Ar_1 and Ar_2 represents a fused polycyclic aromatic group with four or more rings such as a fluoranthenyl group, a pyrenyl group, or a chrysenyl group; and

R_1 and R_2 each represent a hydrogen atom, or an alkyl group such as a methyl group, an ethyl group, or a tertiary butyl group.

When Ar_1 and Ar_2 are different from each other, Ar_1 and Ar_2 shown in the following tables may be replaced with each other.

TABLE 21

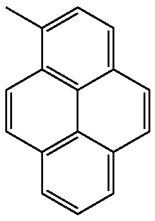
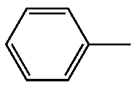
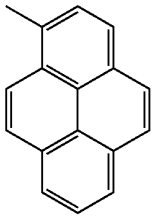
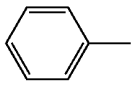
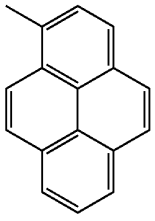
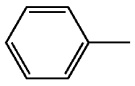
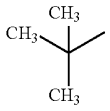
Compd. No.	Ar1	Ar2	R1	R2
1401			H—	H—
1402			CH_3—	H—
1403			H—	

TABLE 21-continued

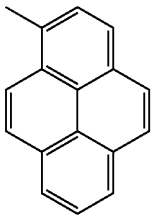
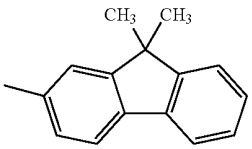
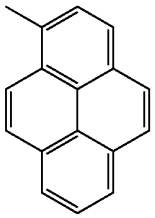
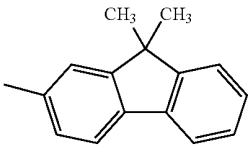
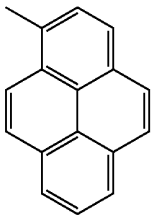
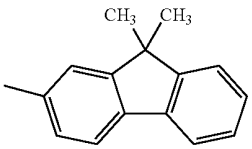
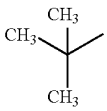
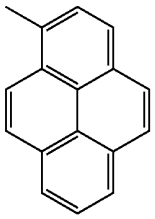
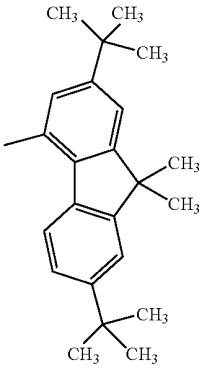
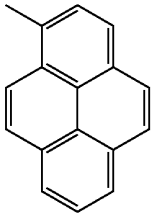
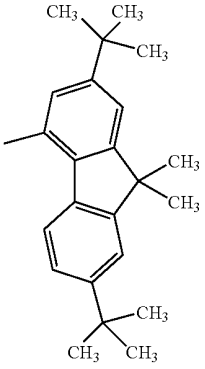
Compd. No.	Ar1	Ar2	R1	R2
1404			H—	H—
1405			CH_3—	H—
1406			H—	
1407			H—	H—
1408			CH_3—	H—

TABLE 21-continued

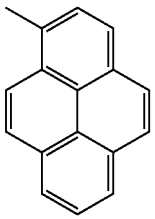
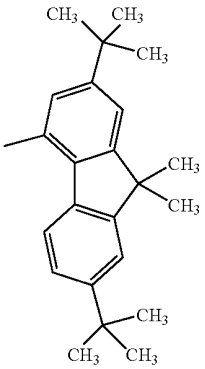
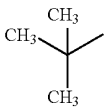
Compd. No.	Ar1	Ar2	R1	R2
1409			H—	

TABLE 22

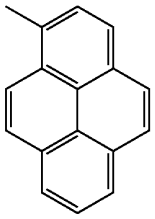
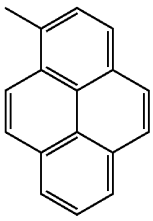
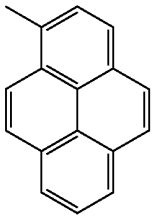
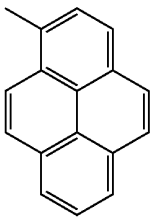
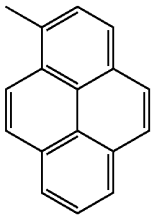
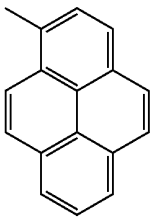
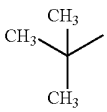
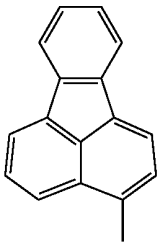
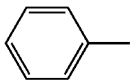
Compd. No.	Ar1	Ar2	R1	R2
1410			H—	H—
1411			CH_3—	H—
1412			H—	
1413			H—	H—

TABLE 22-continued

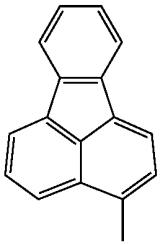
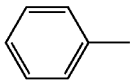
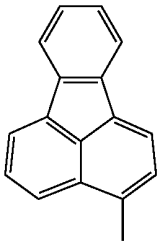
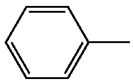
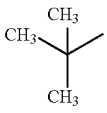
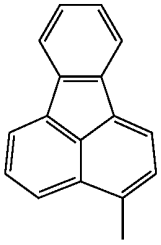
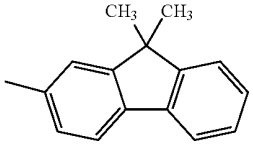
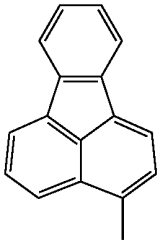
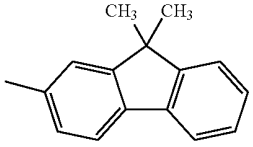
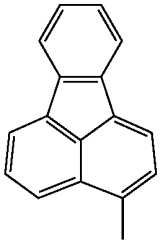
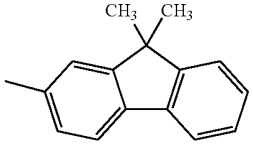
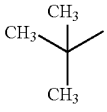
Compd. No.	Ar1	Ar2	R1	R2
1414			CH_3—	H—
1415			H—	
1416			H—	H—
1417			CH_3—	H—
1418			H—	

TABLE 22-continued

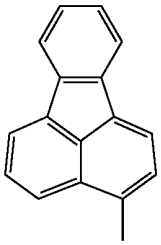
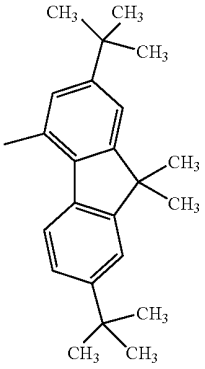
Compd. No.	Ar1	Ar2	R1	R2
1419			H—	H—

TABLE 23

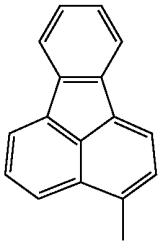
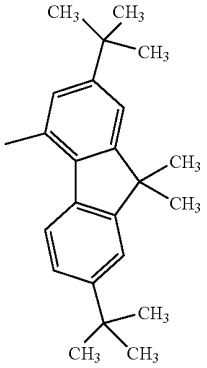
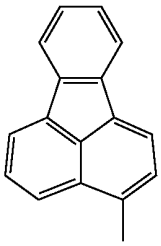
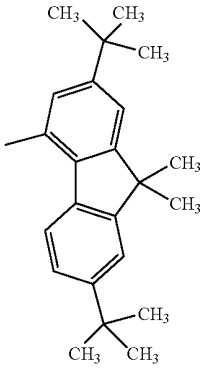
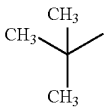
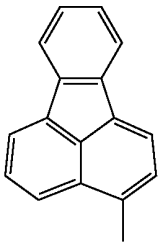
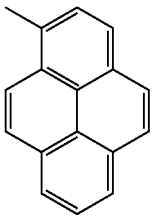
Compd. No.	Ar1	Ar2	R1	R2
1420			CH_3—	H—
1421			H—	
1422			H—	H—

TABLE 23-continued

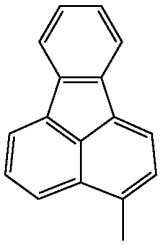
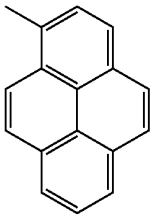
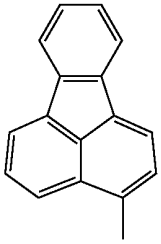
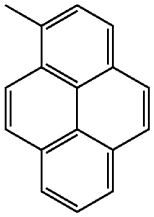
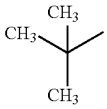
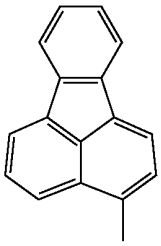
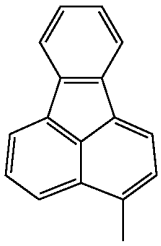
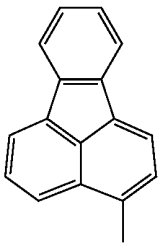
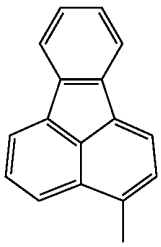
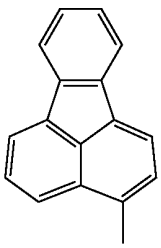
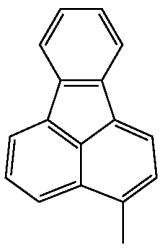
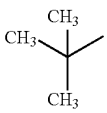
Compd. No.	Ar1	Ar2	R1	R2
1423			CH_3—	H—
1424			H—	
1425			H—	H—
1426			CH_3—	H—
1427			H—	

TABLE 23-continued

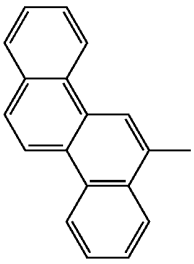
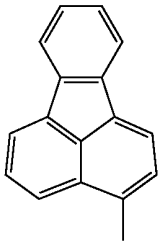
Compd. No.	Ar1	Ar2	R1	R2
1428			H—	H—

TABLE 24

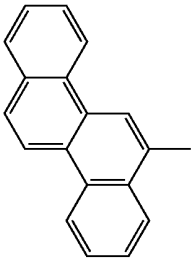
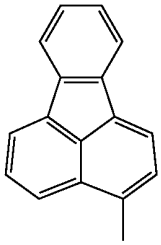
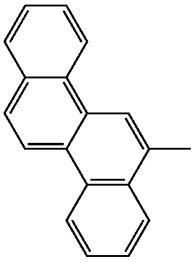
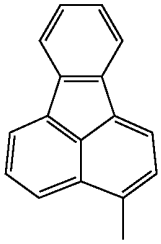
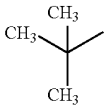
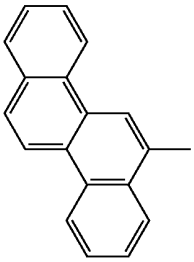
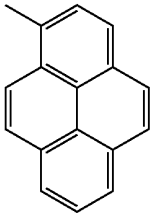
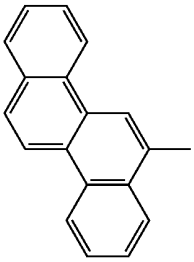
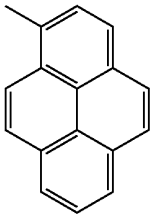
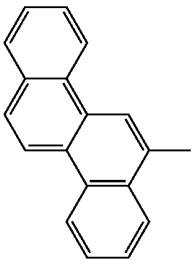
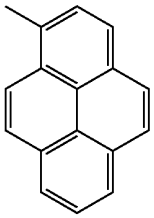
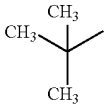
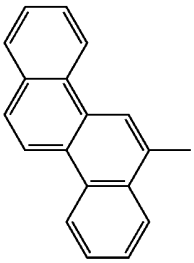
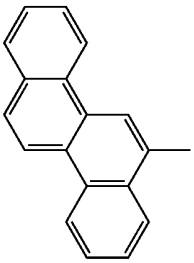
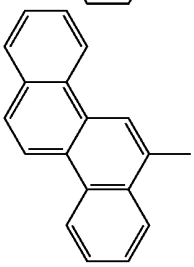
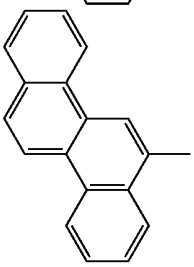
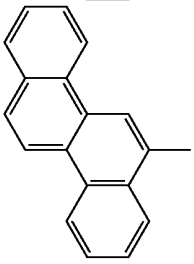
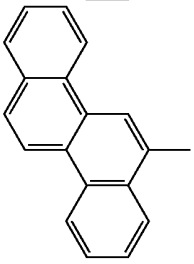
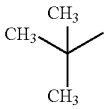
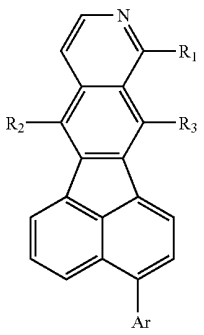
Compd. No.	Ar1	Ar2	R1	R2
1429			CH_3—	H—
1430			H—	
1431			H—	H—
1432			CH_3—	H—

TABLE 24-continued

Compd. No.	Ar1	Ar2	R1	R2
1433			H—	
1434			H—	H—
1435			CH_3—	H—
1436			H—	

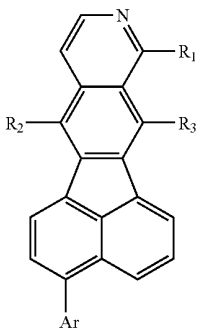
Compound Example 6

[9]



-continued

[10]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group; and

Ar represents a fused polycyclic aromatic group such as a naphthyl group, a fluorenyl group, a pyrenyl group, a fluoranthenyl group, or a benzofluoranthenyl group.

When R_2 and R_3 are different from each other, R_2 and R_3 shown in the following tables may be replaced with each other.

TABLE 25

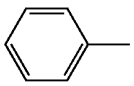
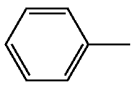
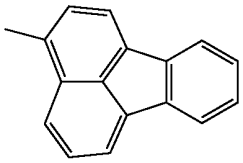
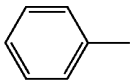
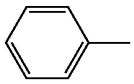
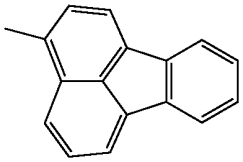
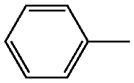
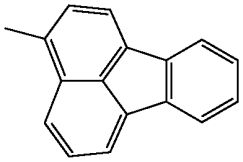
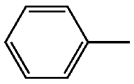
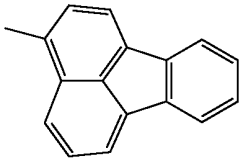
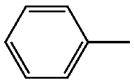
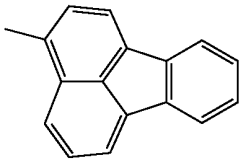
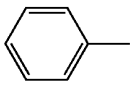
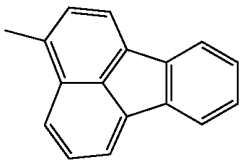
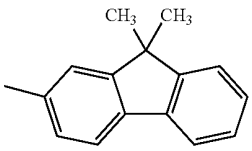
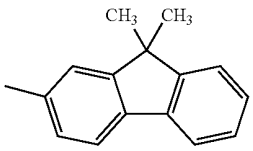
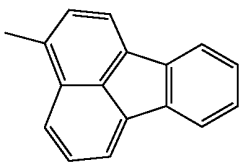
Compd. No.	R1	R2	R3	Ar
1501	H—			
1502	CH_3—			
1503	H—		CH_3—	
1504	CH_3—		CH_3—	
1505	H—		C_4H_9—	
1506	CH_3—		C_4H_9—	
1507	H—			

TABLE 25-continued

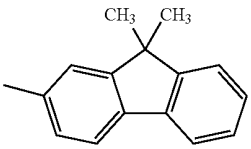
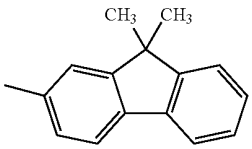
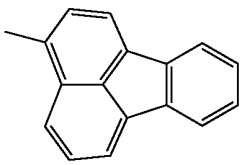
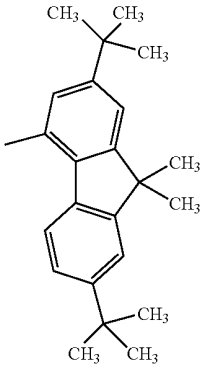
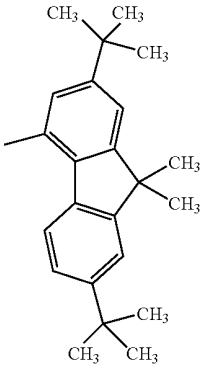
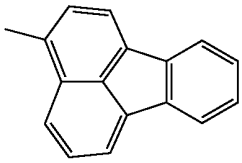
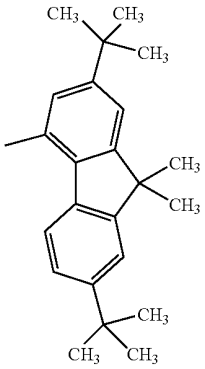
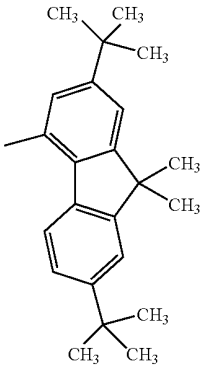
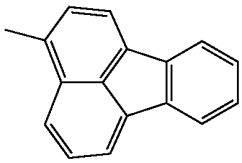
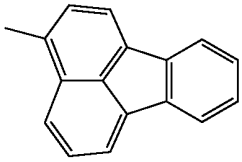
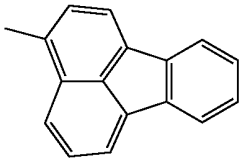
Compd. No.	R1	R2	R3	Ar
1508	CH_3—			
1509	H—			
1510	CH_3—			
1511	H—	CH_3—	CH_3—	
1512	CH_3—	CH_3—	CH_3—	

TABLE 26

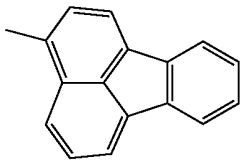
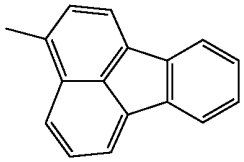
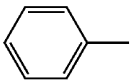
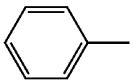
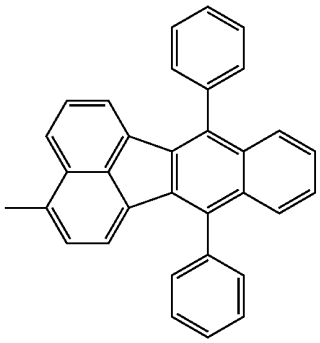
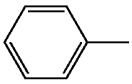
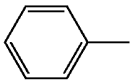
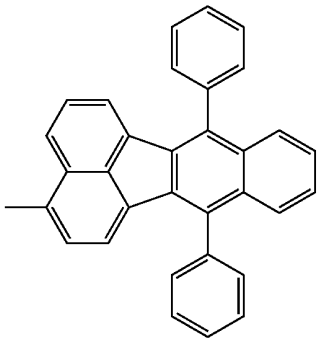
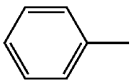
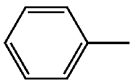
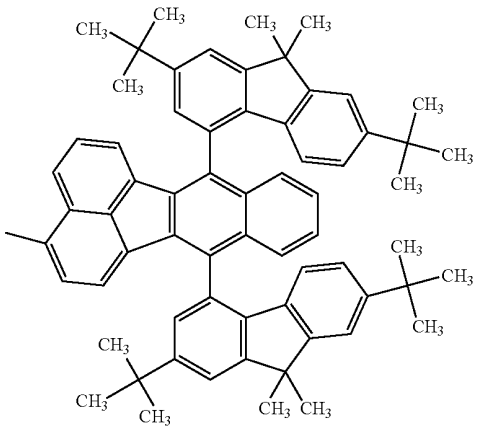
Compd. No.	R1	R2	R3	Ar
1513	H—	C_4H_9—	C_4H_9—	
1514	CH_3—	C_4H_9—	C_4H_9—	
1515	H—			
1516	CH_3—			
1517	H—			

TABLE 26-continued

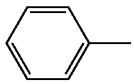
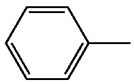
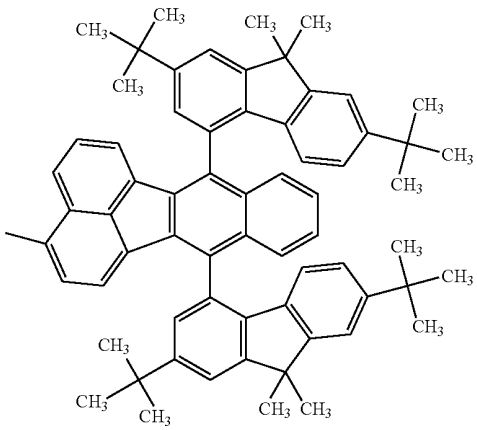
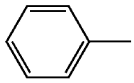
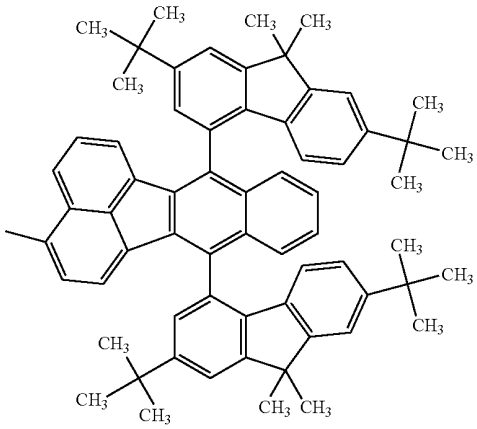
Compd. No.	R1	R2	R3	Ar
1518	CH_3—			
1519	H—		CH_3—	

TABLE 27

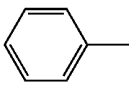
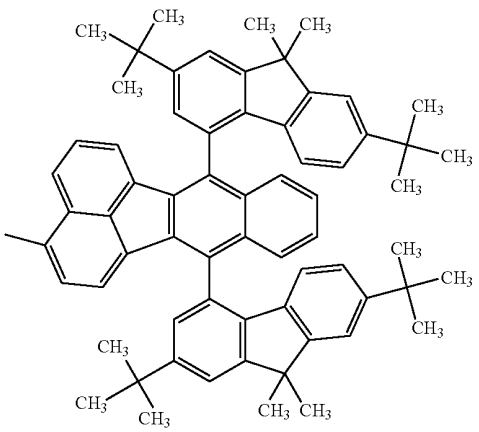
Compd. No.	R1	R2	R3	Ar
1520	CH_3—		CH_3—	

TABLE 27-continued

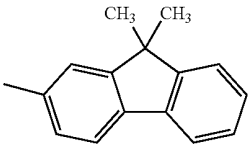
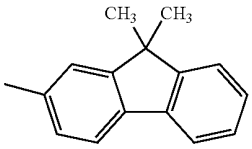
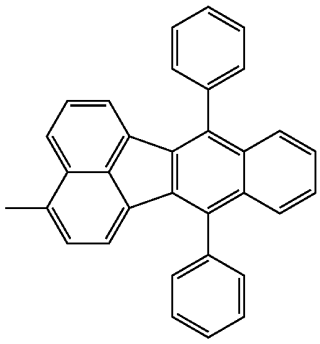
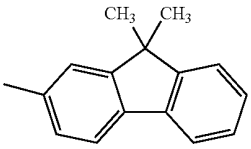
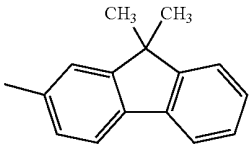
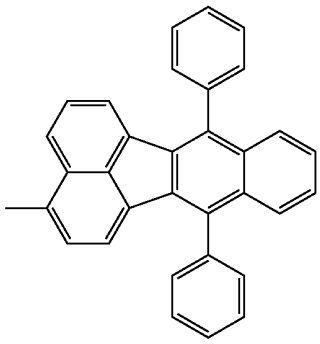
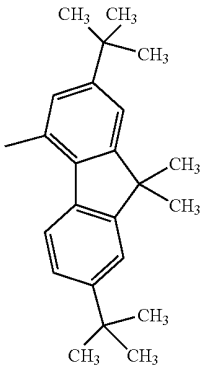
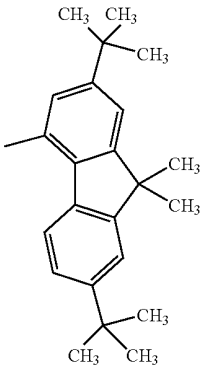
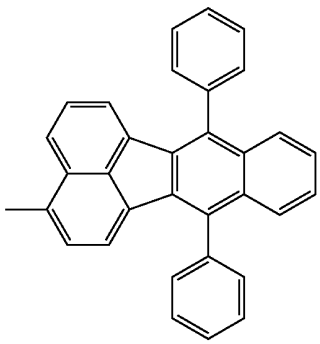
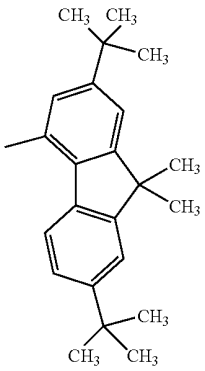
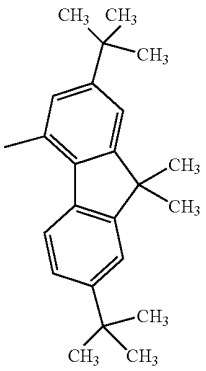
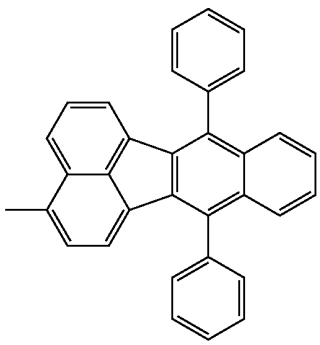
Compd. No.	R1	R2	R3	Ar
1521	H—			
1522	CH_3—			
1523	H—			
1524	CH_3—			

TABLE 27-continued

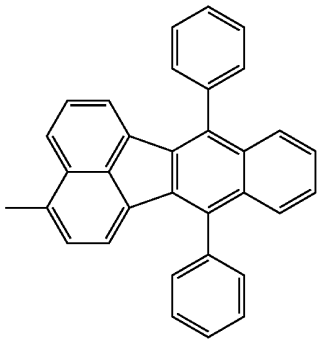
Compd. No.	R1	R2	R3	Ar
1525	H—	CH_3—	CH_3—	

TABLE 28

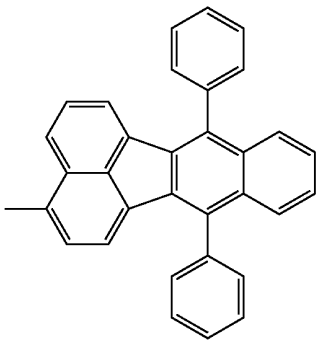
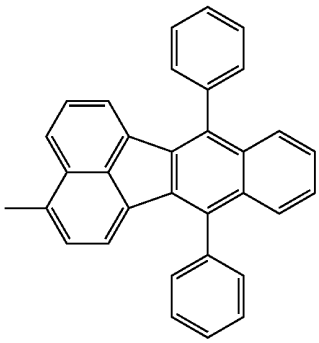
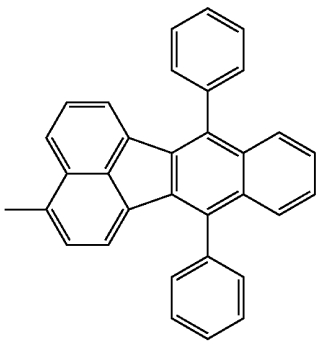
Compd. No.	R1	R2	R3	Ar
1526	CH_3—	CH_3—	CH_3—	
1527	H—	C_4H_9—	C_4H_9—	
1528	CH_3—	C_4H_9—	C_4H_9—	

TABLE 28-continued

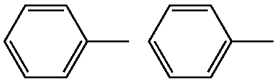
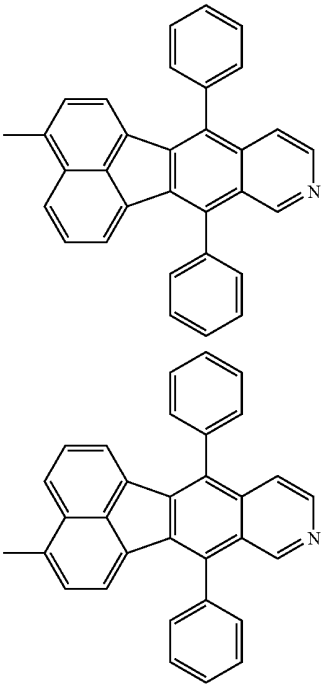
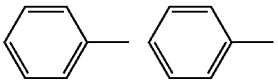
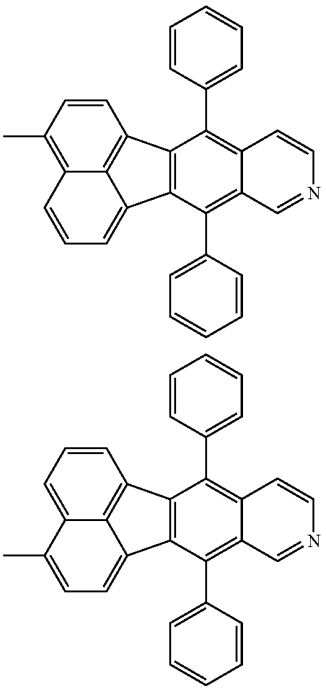
Compd. No.	R1	R2	R3	Ar
1529	H—			
1530	CH_3—			

TABLE 29

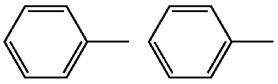
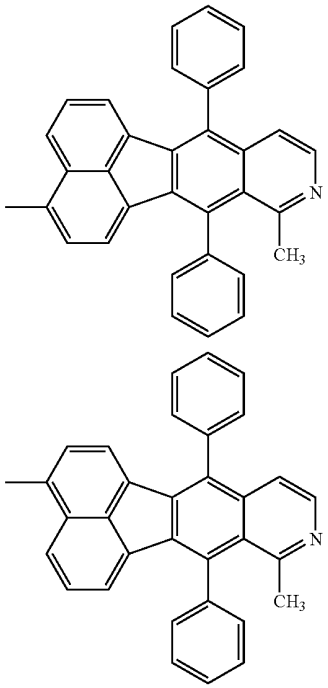
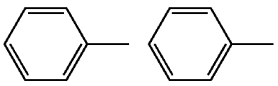
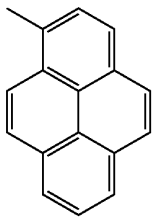
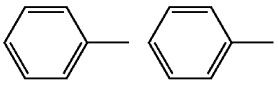
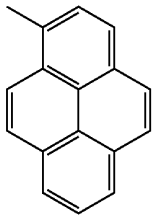
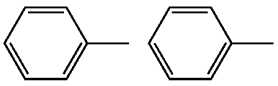
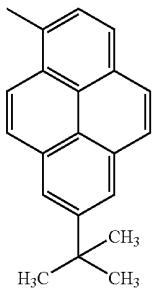
Compd. No.	R1	R2	R3	Ar
1531	CH_3—			
1532	H—			
1533	CH_3—			
1534	H—			

TABLE 29-continued

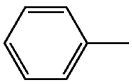
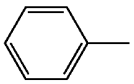
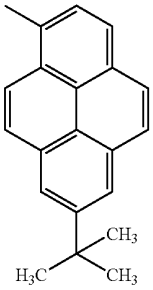
Compd. No.	R1	R2	R3	Ar
1535	CH_3—			

TABLE 30

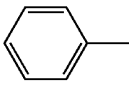
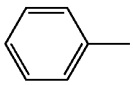
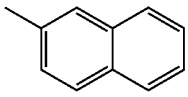
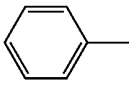
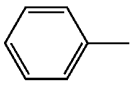
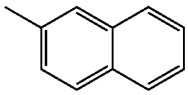
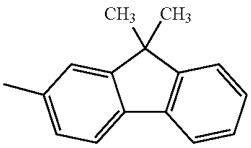
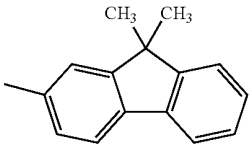
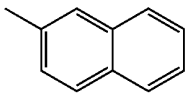
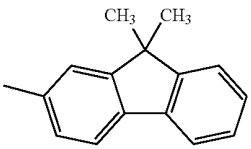
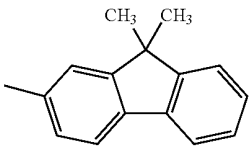
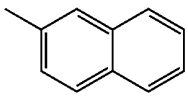
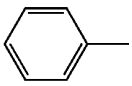
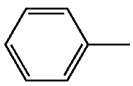
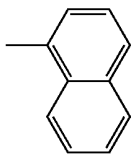
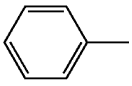
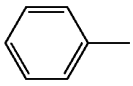
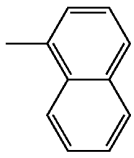
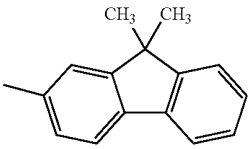
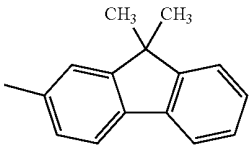
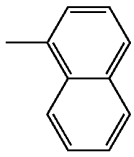
Compd. No.	R1	R2	R3	Ar
1536	H—			
1537	CH_3—			
1538	H—			
1539	CH_3—			
1540	H—			
1541	CH_3—			
1542	H—			

TABLE 30-continued

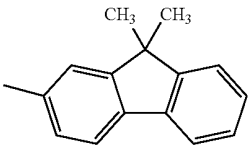
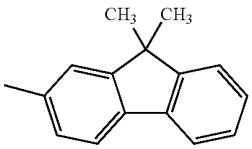
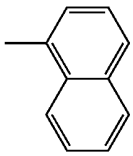
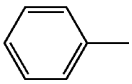
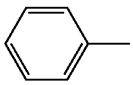
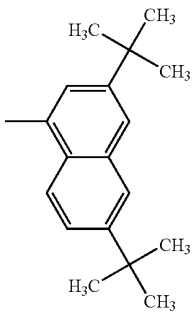
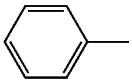
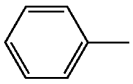
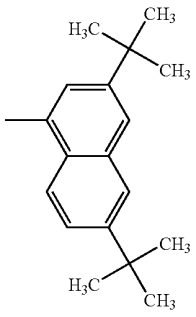
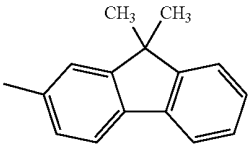
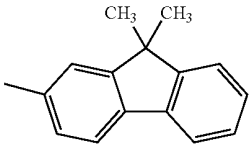
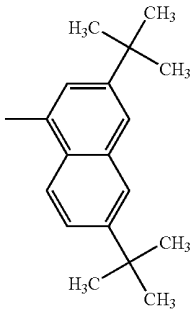
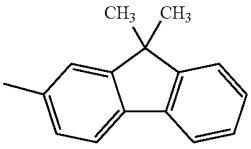
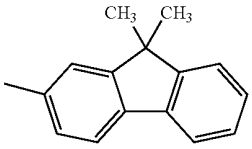
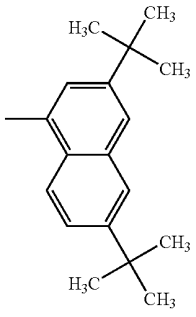
Compd. No.	R1	R2	R3	Ar
1543	CH_3—			
1544	H—			
1545	CH_3—			
1546	H—			
1547	CH_3—			

TABLE 31

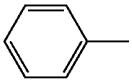
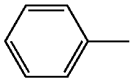
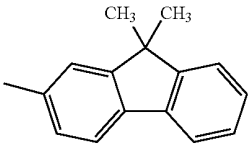
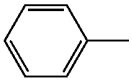
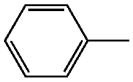
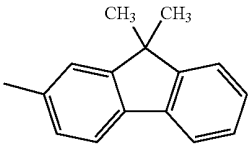
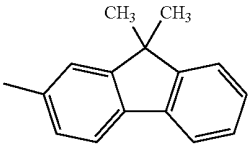
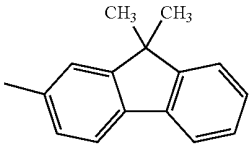
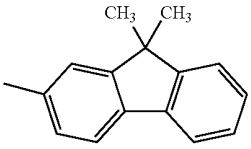
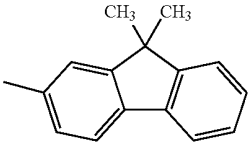
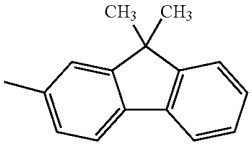
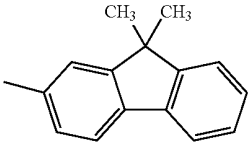
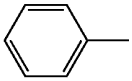
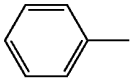
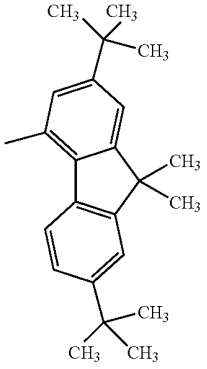
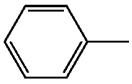
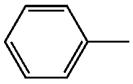
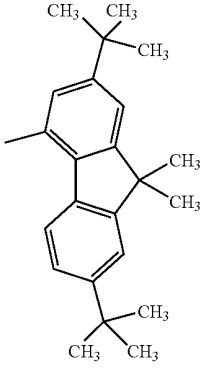
Compd. No.	R1	R2	R3	Ar
1548	H—			
1549	CH_3—			
1550	H—			
1551	CH_3—			
1552	H—			
1553	CH_3—			

TABLE 31-continued

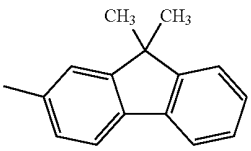
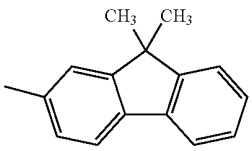
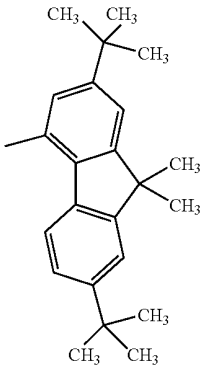
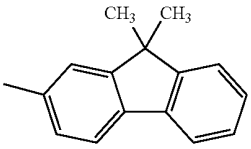
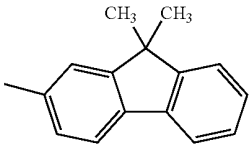
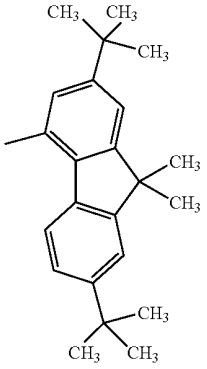
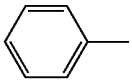
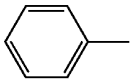
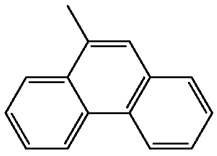
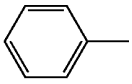
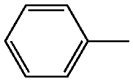
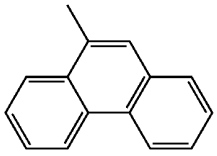
Compd. No.	R1	R2	R3	Ar
1554	H—			
1555	CH_3—			
1556	H—			
1557	CH_3—			

TABLE 32

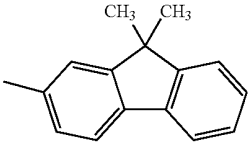
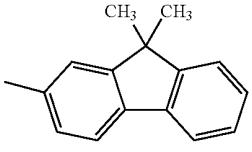
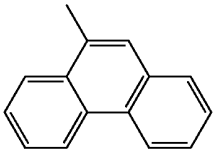
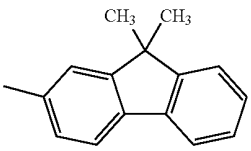
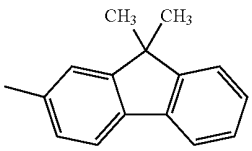
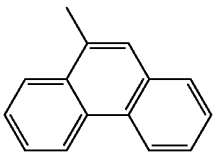
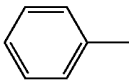
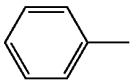
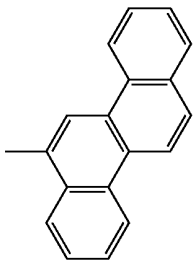
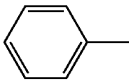
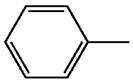
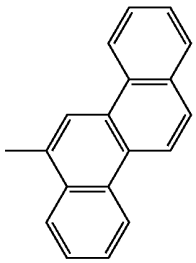
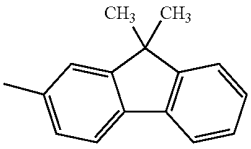
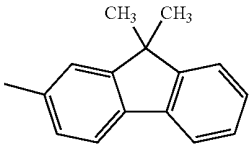
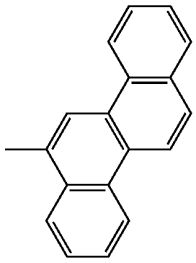
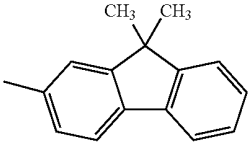
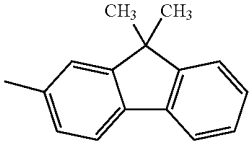
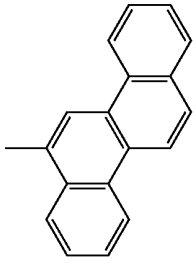
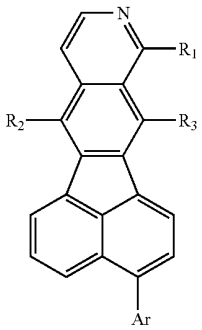
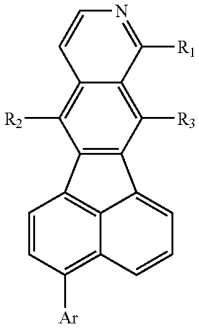
Compd. No.	R1	R2	R3	Ar
1558	H—			

TABLE 32-continued

Compd. No.	R1	R2	R3	Ar
1559	CH_3—			
1560	H—			
1561	CH_3—			
1562	H—			
1563	CH_3—			

Compound Example 7





wherein:

[9]

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group; and

[10]

Ar represents a substituted amino group such as a diphenylamino group.

When R_2 and R_3 are different from each other, R_2 and R_3 shown in the following tables may be replaced with each other.

TABLE 33

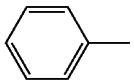
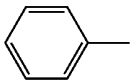
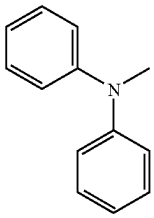
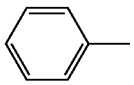
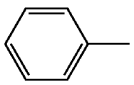
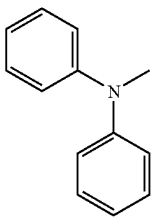
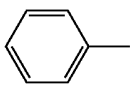
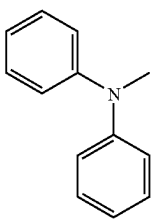
Compd. No.	R1	R2	R3	Ar
1601	H—			
1602	CH_3—			
1603	H—		CH_3—	

TABLE 33-continued

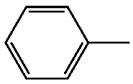
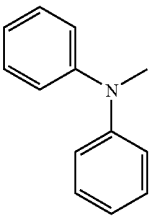
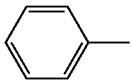
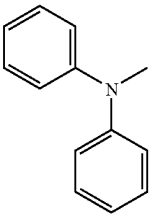
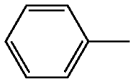
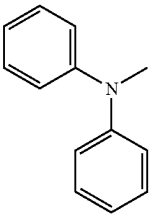
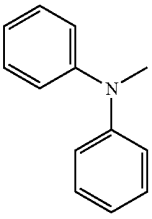
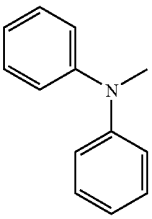
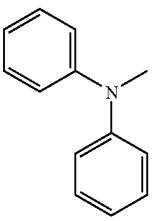
Compd. No.	R1	R2	R3	Ar
1604	CH_3—		CH_3—	
1605	H—		C_4H_9—	
1606	CH_3—		C_4H_9—	
1607	H—	CH_3—	CH_3—	
1608	CH_3—	CH_3—	CH_3—	
1609	H—	C_4H_9—	C_4H_9—	

TABLE 33-continued

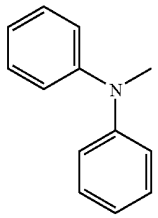
Compd. No.	R1	R2	R3	Ar
1610	CH_3—	C_4H_9—	C_4H_9—	

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TABLE 34

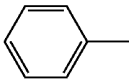
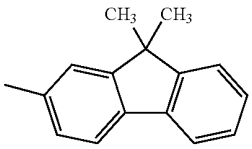
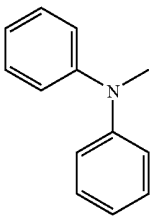
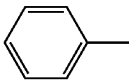
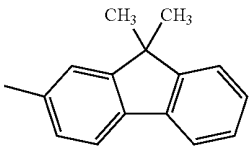
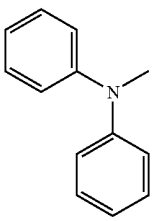
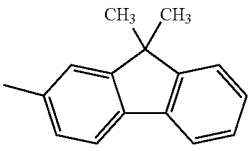
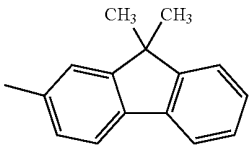
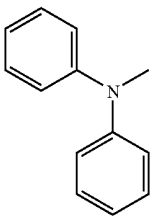
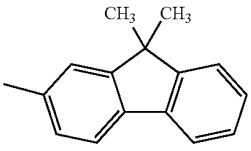
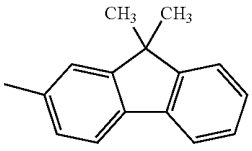
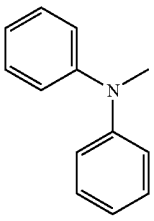
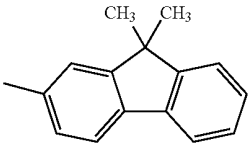
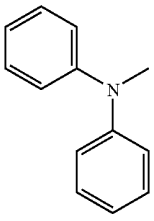
Compd. No.	R1	R2	R3	Ar
1611	H—			
1612	CH_3—			
1613	H—			
1614	CH_3—			
1615	H—		CH_3—	

TABLE 34-continued

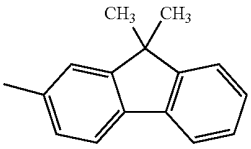
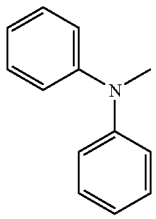
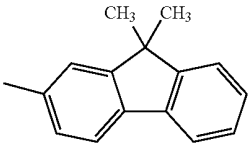
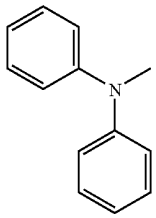
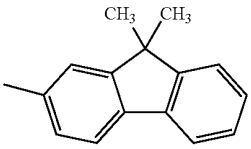
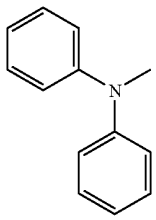
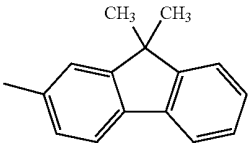
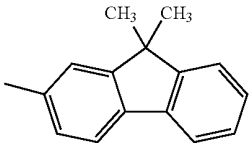
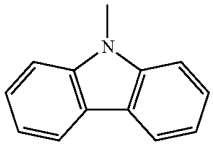
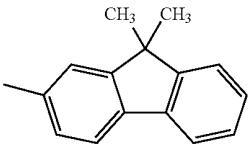
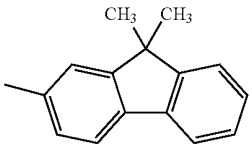
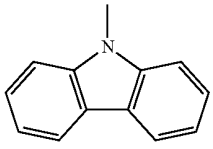
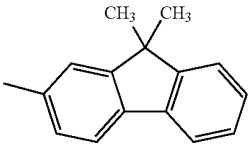
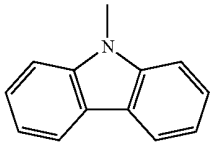
Compd. No.	R1	R2	R3	Ar
1616	CH_3—		CH_3—	
1617	H—		C_4H_9—	
1618	CH_3—		C_4H_9—	
1619	H—			
1620	CH_3—			
1621	H—		CH_3—	

TABLE 35

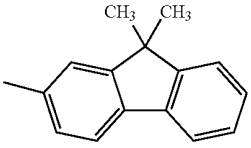
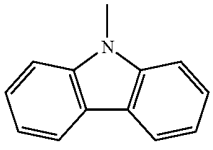
Compd. No.	R1	R2	R3	Ar
1622	CH_3—		CH_3—	

TABLE 35-continued

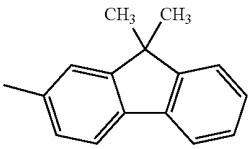
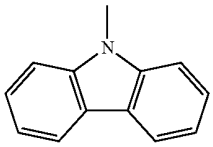
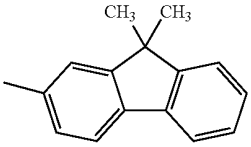
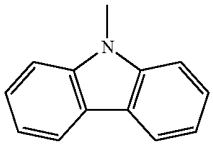
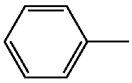
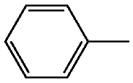
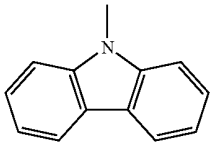
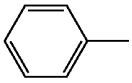
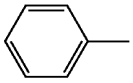
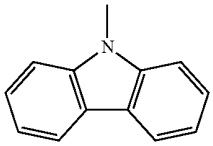
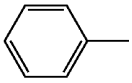
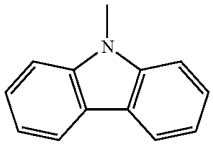
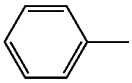
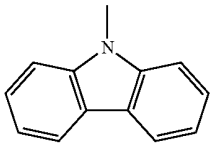
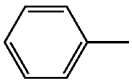
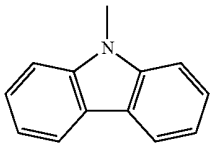
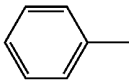
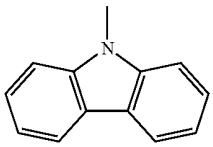
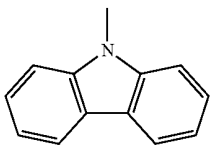
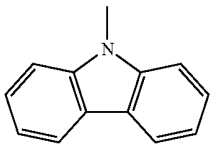
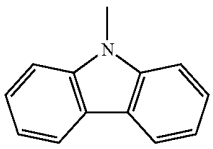
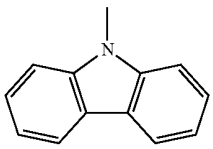
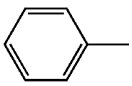
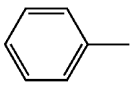
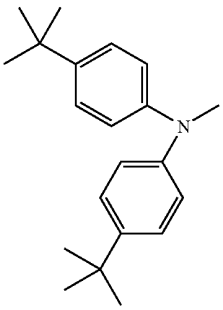
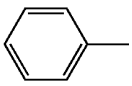
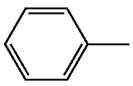
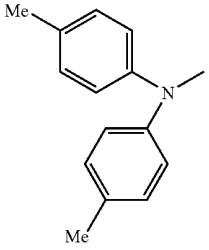
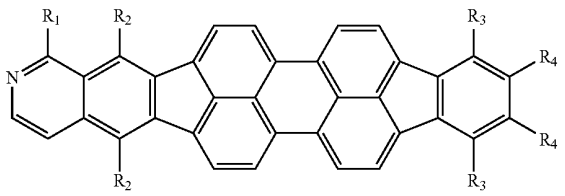
Compd. No.	R1	R2	R3	Ar
1623	H—		C_4H_9—	
1624	CH_3—		C_4H_9—	
1625	H—			
1626	CH_3—			
1627	H—		CH_3—	
1628	CH_3—		CH_3—	
1629	H—		C_4H_9—	
1630	CH_3—		C_4H_9—	
1631	H—	CH_3—	CH_3—	

TABLE 35-continued

Compd. No.	R1	R2	R3	Ar
1632	CH_3—	CH_3—	CH_3—	
1633	H—	C_4H_9—	C_4H_9—	
1634	CH_3—	C_4H_9—	C_4H_9—	
1635	H—			
1636	H—			

Compound Example 8

[11]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 represents an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_3 and R_4 each represent a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 36

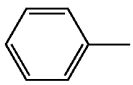
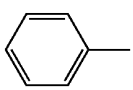
Compd. No.	R1	R2	R3	R4
1701	H—		H—	H—
1702	CH_3—		H—	H—

TABLE 36-continued

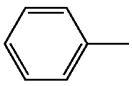
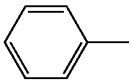
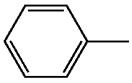
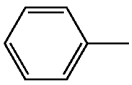
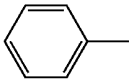
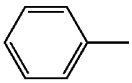
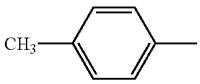
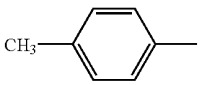
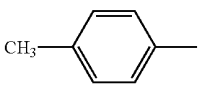
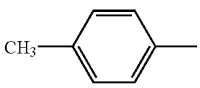
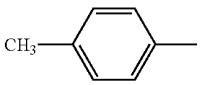
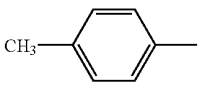
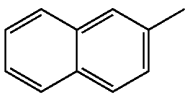
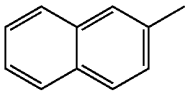
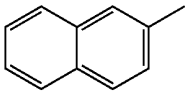
Compd. No.	R1	R2	R3	R4
1703	H—		CH_3—	CH_3—
1704	CH_3—		CH_3—	CH_3—
1705	H—		CH_3—	C_2H_5—
1706	CH_3—		CH_3—	C_2H_5—
1707	H—		CH_3—	H—
1708	CH_3—		CH_3—	H—
1709	H—		H—	H—
1710	CH_3—		H—	H—
1711	H—		CH_3—	H—
1712	CH_3—		CH_3—	H—
1713	H—		C_2H_5—	H—
1714	CH_3—		C_2H_5—	H—
1715	H—		H—	H—
1716	CH_3—		H—	H—
1717	H—		CH_3—	H—

TABLE 36-continued

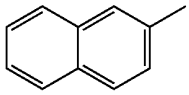
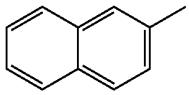
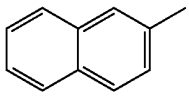
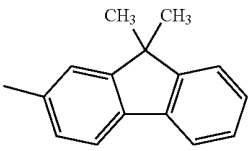
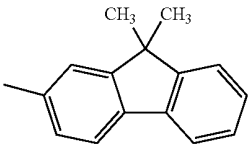
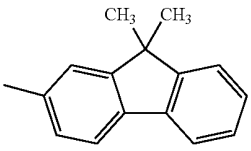
Compd. No.	R1	R2	R3	R4
1718	CH_3—		CH_3—	H—
1719	H—		C_2H_5—	H—
1720	CH_3—		C_2H_5—	H—
1721	H—		H—	H—
1722	CH_3—		H—	H—
1723	H—		CH_3—	H—

TABLE 37

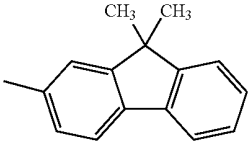
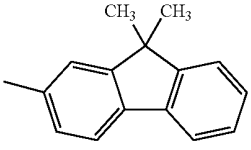
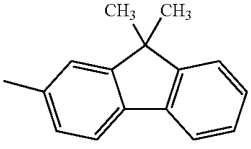
Compd. No.	R1	R2	R3	R4
1724	CH_3—		CH_3—	H—
1725	H—		C_2H_5—	H—
1726	CH_3—		C_2H_5—	H—

TABLE 37-continued

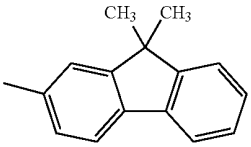
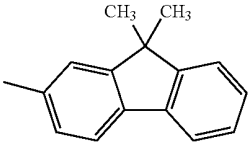
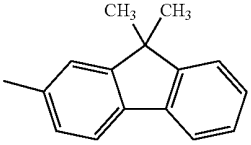
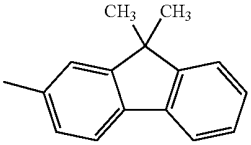
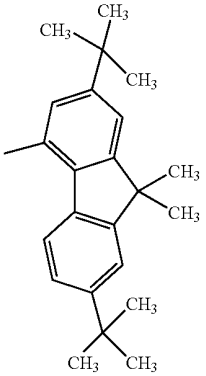
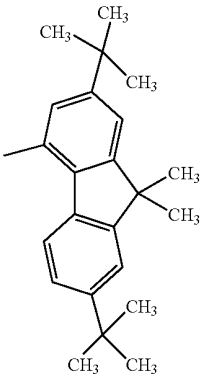
Compd. No.	R1	R2	R3	R4
1727	H—		CH_3—	CH_3—
1728	CH_3—		CH_3—	CH_3—
1729	H—		C_2H_5—	C_2H_5—
1730	CH_3—		C_2H_5—	C_2H_5—
1731	H—		H—	H—
1732	CH_3—		H—	H—

TABLE 37-continued

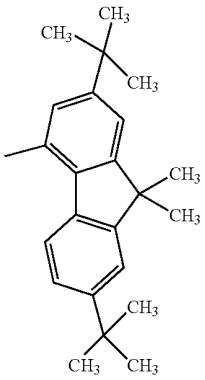
Compd. No.	R1	R2	R3	R4
1733	H—		CH_3—	H—

TABLE 38

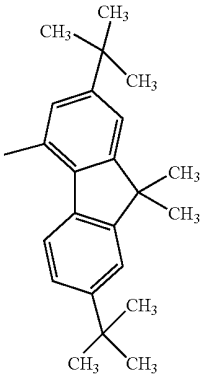
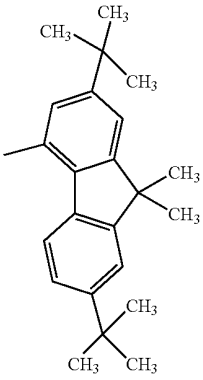
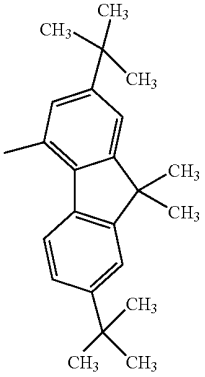
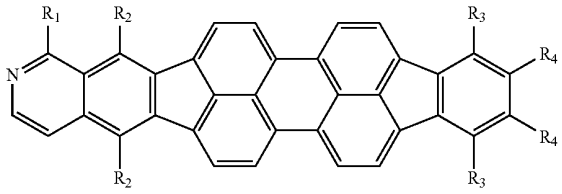
Compd. No.	R1	R2	R3	R4
1734	CH_3—		CH_3—	H—
1735	H—		CH_3—	CH_3—

TABLE 38-continued

Compd. No.	R1	R2	R3	R4
1736	CH_3—		CH_3—	CH_3—

Compound Example 9

[11]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 and R_3 represent each an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_4 represents a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 39

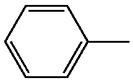
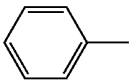
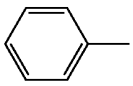
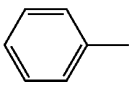
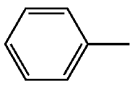
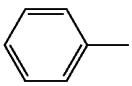
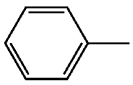
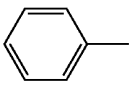
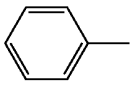
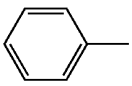
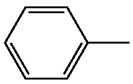
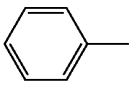
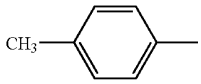
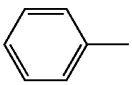
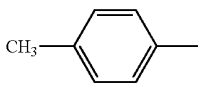
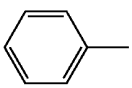
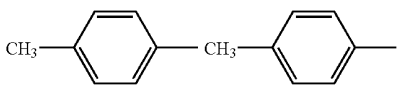
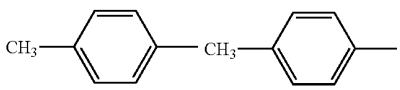
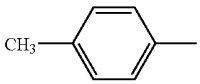
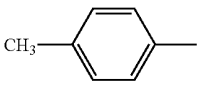
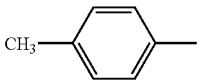
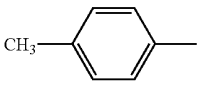
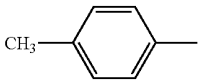
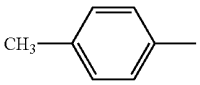
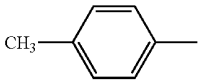
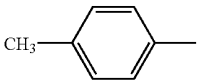
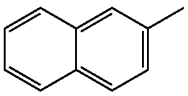
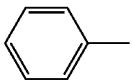
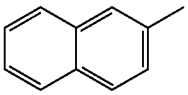
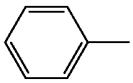
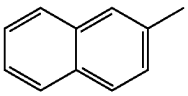
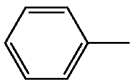
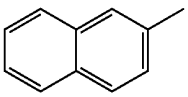
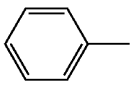
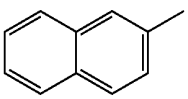
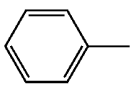
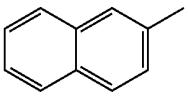
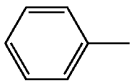
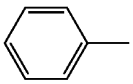
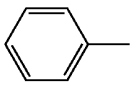
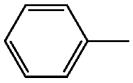
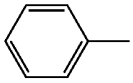
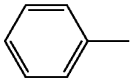
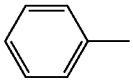
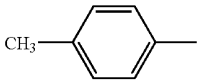
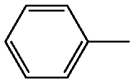
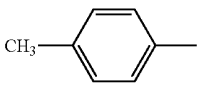
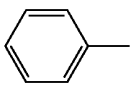
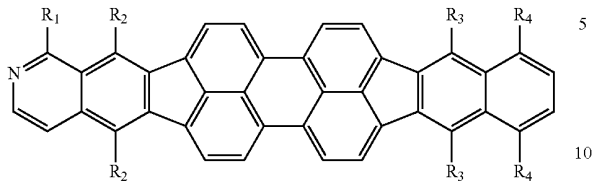
Compd. No.	R1	R2	R3	R4
1801	H—			H—
1802	CH_3—			H—
1803	H—			CH_3—
1804	CH_3—			CH_3—
1805	H—			C_2H_5—
1806	CH_3—			C_2H_5—
1807	H—			H—
1808	CH_3—			H—
1809	H—			H—
1810	CH_3—			H—

TABLE 39-continued

Compd. No.	R1	R2	R3	R4
1811	H—			CH_3—
1812	CH_3—			CH_3—
1813	H—			C_2H_5—
1814	CH_3—			C_2H_5—
1815	H—			H—
1816	CH_3—			H—
1817	H—			CH_3—
1818	CH_3—			CH_3—
1819	H—			C_2H_5—
1820	CH_3—			C_2H_5—
1821	H—			H—
1822	H—			H—
1823	H—			H—
1824	H—			H—
1825	H—			H—

Compound Example 10

[12]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_4 represents a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 40

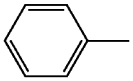
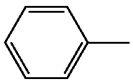
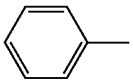
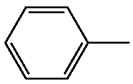
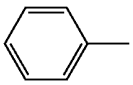
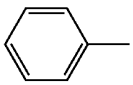
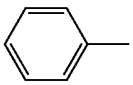
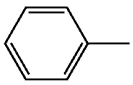
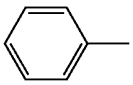
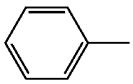
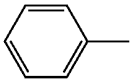
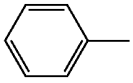
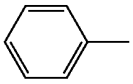
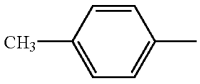
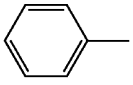
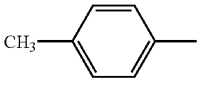
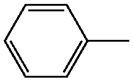
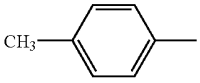
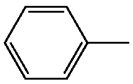
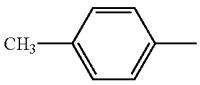
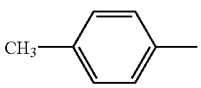
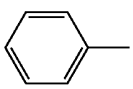
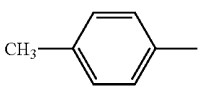
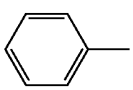
Compd. No.	R1	R2	R3	R4
1901	H—			H—
1902	CH_3—			H—
1903	H—			CH_3—
1904	CH_3—			CH_3—
1905	H—			C_2H_5—
1906	CH_3—			C_2H_5—
1907	H—			H—
1908	CH_3—			H—
1909	H—			CH_3—
1910	CH_3—			CH_3—
1911	H—			H—
1912	CH_3—			H—

TABLE 40-continued

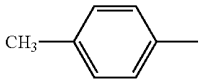
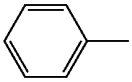
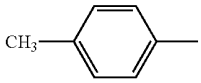
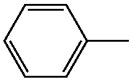
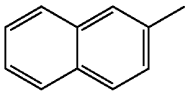
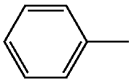
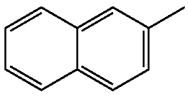
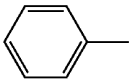
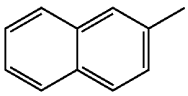
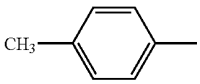
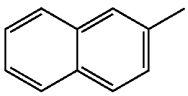
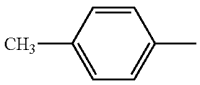
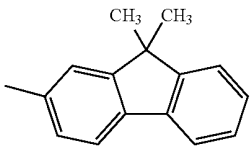
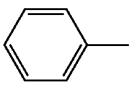
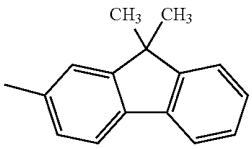
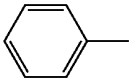
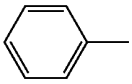
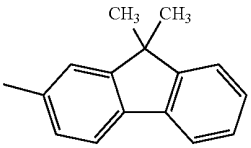
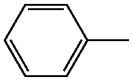
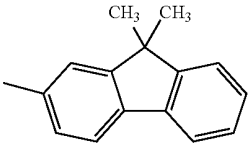
Compd. No.	R1	R2	R3	R4
1913	H—			CH_3—
1914	CH_3—			CH_3—
1915	H—			H—
1916	CH_3—			H—
1917	H—			H—
1918	CH_3—			H—
1919	H—			H—
1920	CH_3—			H—
1921	H—			H—
1922	CH_3—			H—

TABLE 41

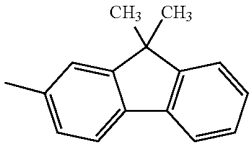
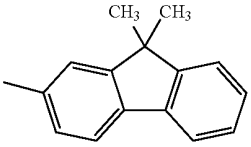
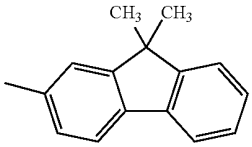
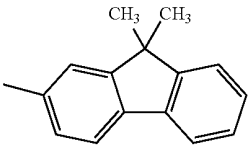
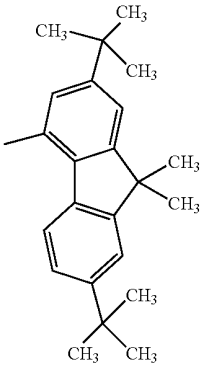
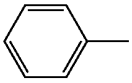
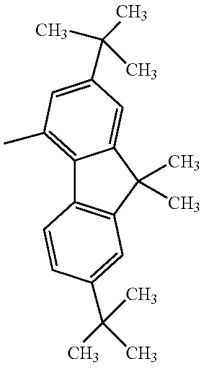
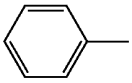
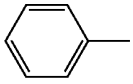
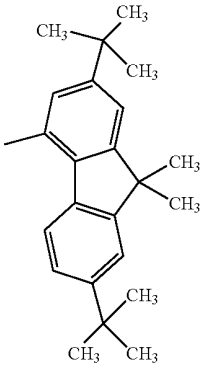
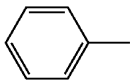
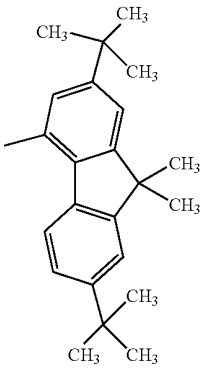
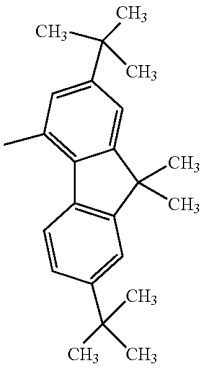
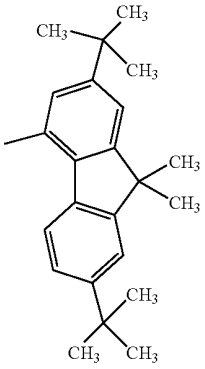
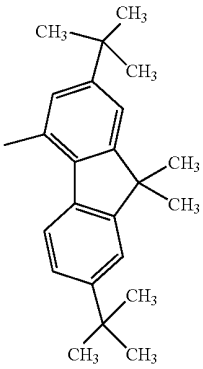
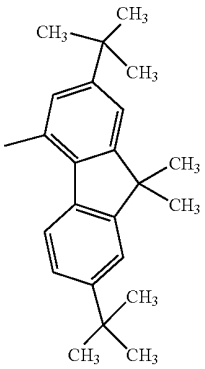
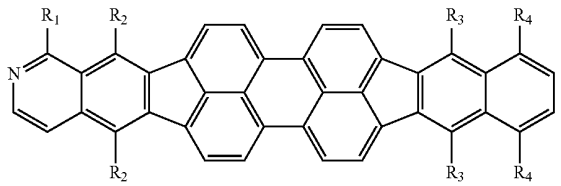
Compd. No.	R1	R2	R3	R4
1923	H—			H—
1924	CH_3—			H—
1925	H—			H—
1926	CH_3—			H—
1927	H—			H—

TABLE 41-continued

Compd. No.	R1	R2	R3	R4
1928	CH_3—			H—
1929	H—			H—
1930	CH_3—			H—

Compound Example 11

[12]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 represents an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_3 and R_4 each represent a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 42

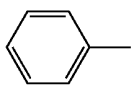
Compd. No.	R1	R2	R3	R4
2001	H—		CH_3—	H—

TABLE 42-continued

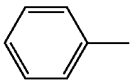
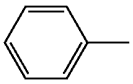
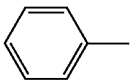
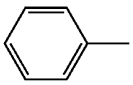
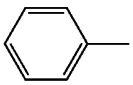
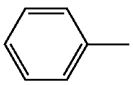
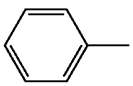
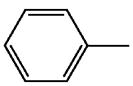
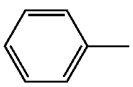
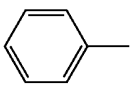
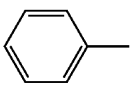
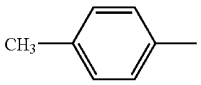
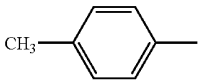
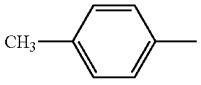
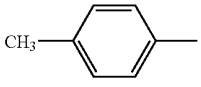
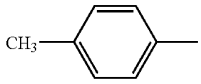
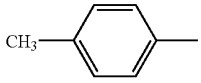
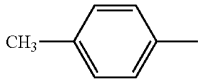
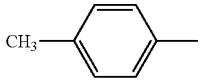
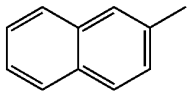
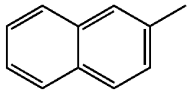
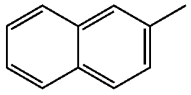
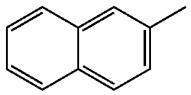
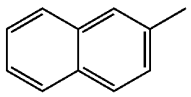
Compd. No.	R1	R2	R3	R4
2002	CH_3—		CH_3—	H—
2003	H—		CH_3—	CH_3—
2004	CH_3—		CH_3—	CH_3—
2005	H—		CH_3—	C_2H_5—
2006	CH_3—		CH_3—	C_2H_5—
2007	H—		H—	H—
2008	CH_3—		H—	H—
2009	H—		H—	CH_3—
2010	CH_3—		H—	CH_3—
2011	H—		H—	C_2H_5—
2012	CH_3—		H—	C_2H_5—
2013	H—		H—	H—
2014	CH_3—		H—	H—
2015	H—		H—	CH_3—
2016	CH_3—		H—	CH_3—
2017	H—		CH_3—	H—
2018	CH_3—		CH_3—	H—
2019	H—		CH_3—	CH_3—
2020	CH_3—		CH_3—	CH_3—
2021	H—		CH_3—	H—
2022	CH_3—		CH_3—	H—
2023	H—		CH_3—	CH_3—
2024	CH_3—		CH_3—	CH_3—
2025	H—		H—	H—

TABLE 43

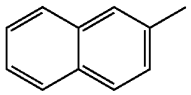
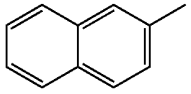
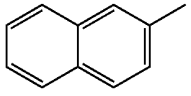
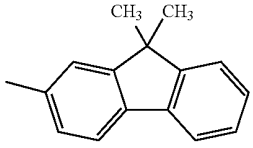
Compd. No.	R1	R2	R3	R4
2026	CH_3—		H—	H—
2027	H—		H—	CH_3—
2028	CH_3—		H—	CH_3—
2029	H—		H—	H—

TABLE 43-continued

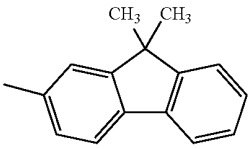
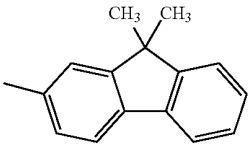
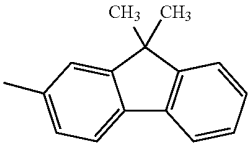
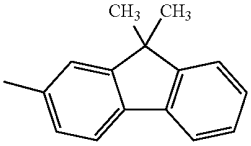
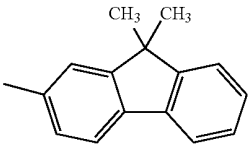
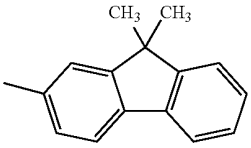
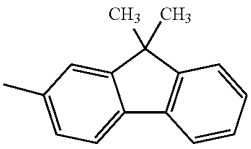
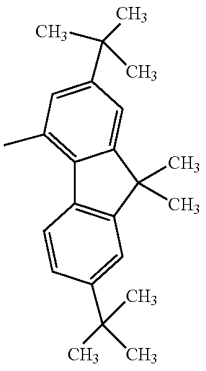
Compd. No.	R1	R2	R3	R4
2030	CH_3—		H—	H—
2031	H—		H—	CH_3—
2032	CH_3—		H—	CH_3—
2033	H—		CH_3—	H—
2034	CH_3—		CH_3—	H—
2035	H—		CH_3—	CH_3—
2036	CH_3—		CH_3—	CH_3—
2037	H—		CH_3—	H—

TABLE 43-continued

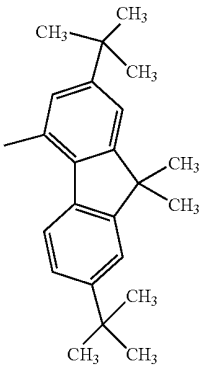
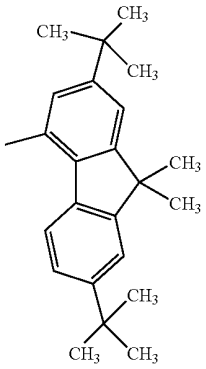
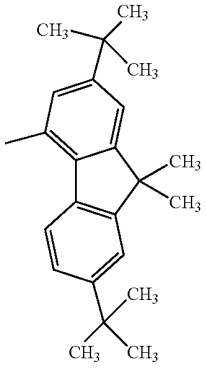
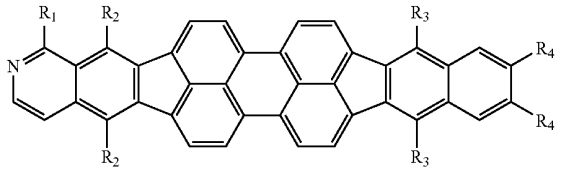
Compd. No.	R1	R2	R3	R4
2038	CH_3—		CH_3—	H—

TABLE 44

Compd. No.	R1	R2	R3	R4
2039	H—		H—	H—
2040	CH_3—		H—	H—

Compound Example 12

[13]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group; and

R_2 to R_4 each represent an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group.

TABLE 45

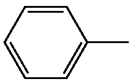
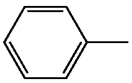
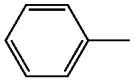
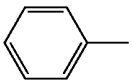
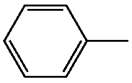
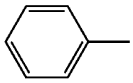
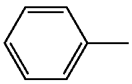
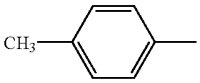
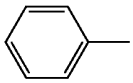
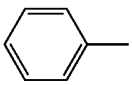
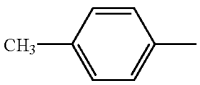
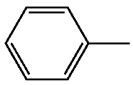
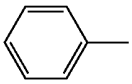
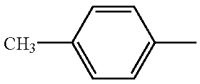
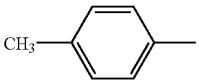
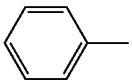
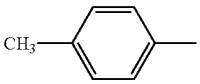
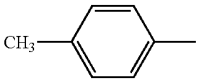
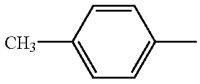
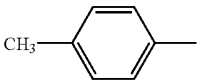
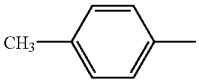
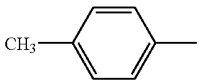
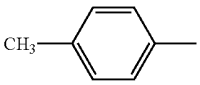
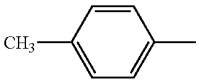
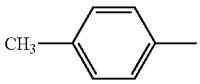
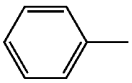
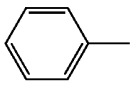
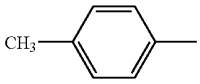
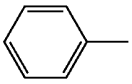
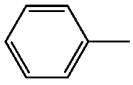
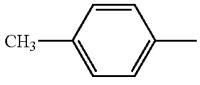
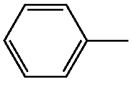
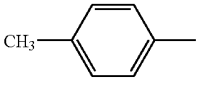
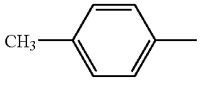
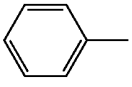
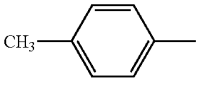
Compd. No.	R1	R2	R3	R4
2101	H—			
2102	CH_3—			
2103	H—			
2104	CH_3—			
2105	H—			
2106	CH_3—			
2107	H—			
2108	CH_3—			
2109	H—			
2110	CH_3—			
2111	H—			
2112	CH_3—			

TABLE 45-continued

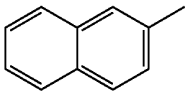
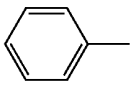
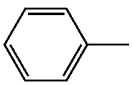
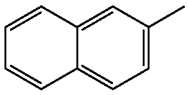
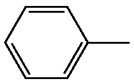
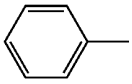
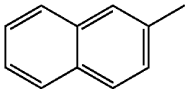
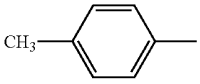
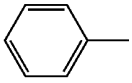
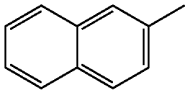
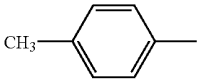
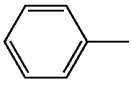
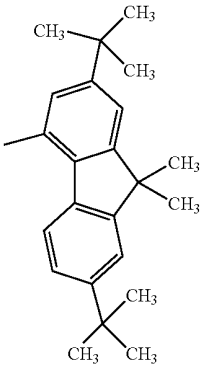
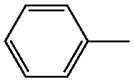
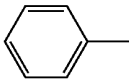
Compd. No.	R1	R2	R3	R4
2113	H—			
2114	CH_3—			
2115	H—			
2116	CH_3—			
2117	H—			

TABLE 46

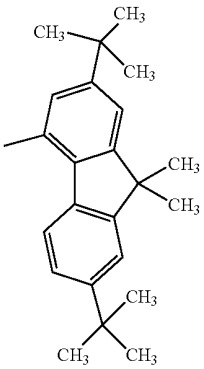
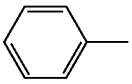
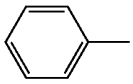
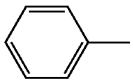
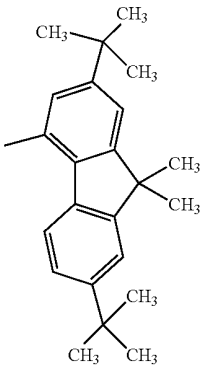
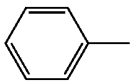
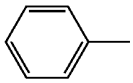
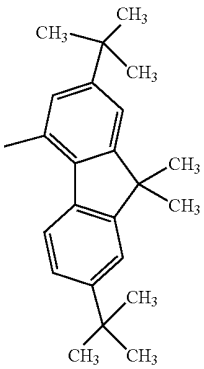
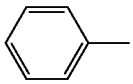
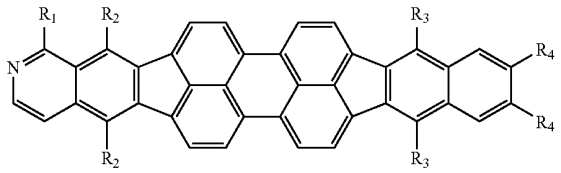
Compd. No.	R1	R2	R3	R4
2118	CH_3—			

TABLE 46-continued

Compd. No.	R1	R2	R3	R4
2119	H—			
2120	CH_3—			

Compound Example 13

[13]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 represents an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_3 and R_4 each represent an alkyl group such as a methyl group.

TABLE 47

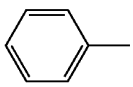
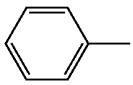
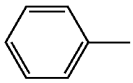
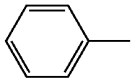
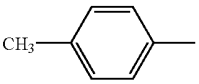
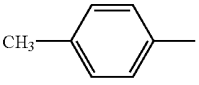
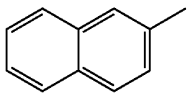
Compd. No.	R1	R2	R3	R4
2201	H—		CH_3—	CH_3—
2202	CH_3—		CH_3—	CH_3—
2203	H—		CH_3—	C_2H_5—
2204	CH_3—		CH_3—	C_2H_5—
2205	H—		CH_3—	CH_3—
2206	CH_3—		CH_3—	CH_3—
2207	H—		CH_3—	CH_3—

TABLE 47-continued

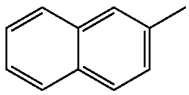
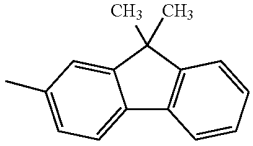
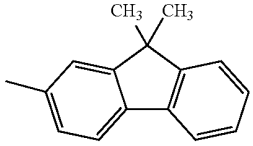
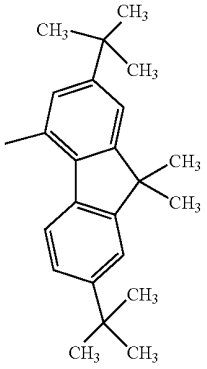
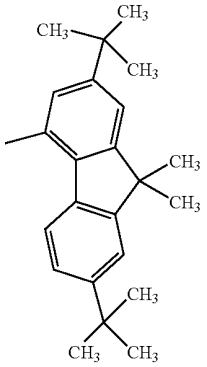
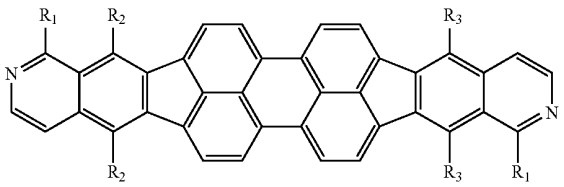
Compd. No.	R1	R2	R3	R4
2208	CH_3—		CH_3—	CH_3—
2209	H—		CH_3—	CH_3—
2210	CH_3—		CH_3—	CH_3—
2211	H—		CH_3—	CH_3—

TABLE 47-continued

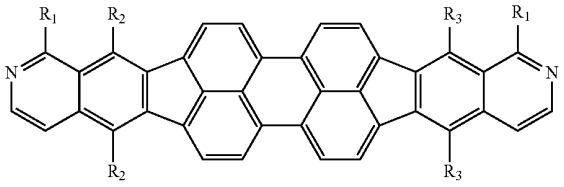
Compd. No.	R1	R2	R3	R4
2212	CH_3—		CH_3—	CH_3—

Compound Example 14

[14]



[15]



wherein:

R_1, represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group or a tolyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group.

TABLE 48

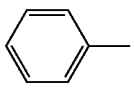
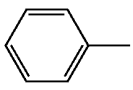
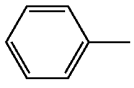
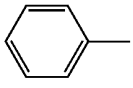
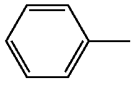
Compd. No.	R1	R2	R3
2301	H—		
2302	CH_3—		
2303	H—		CH_3—

TABLE 48-continued

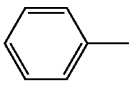
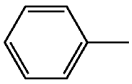
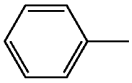
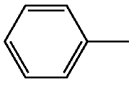
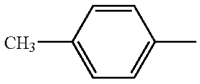
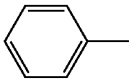
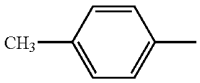
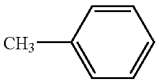
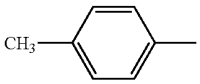
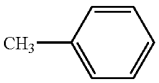
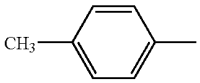
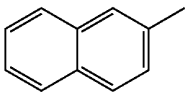
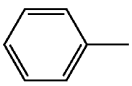
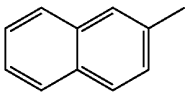
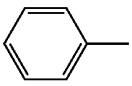
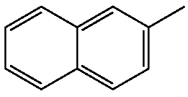
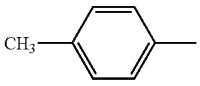
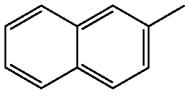
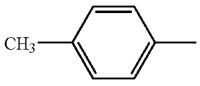
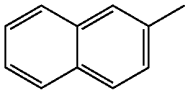
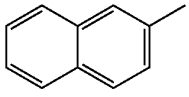
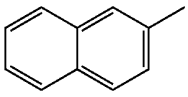
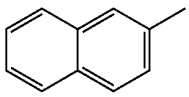
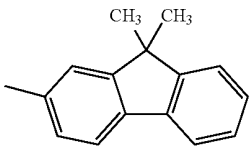
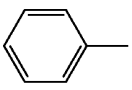
Compd. No.	R1	R2	R3
2304	CH_3—		CH_3—
2305	H—		C_4H_9—
2306	CH_3—		C_4H_9—
2307	H—		
2308	CH_3—		
2309	H—		
2310	CH_3—		
2311	H—		
2312	CH_3—		
2313	H—		
2314	CH_3—		
2315	H—		
2316	CH_3—		
2317	H—		

TABLE 48-continued

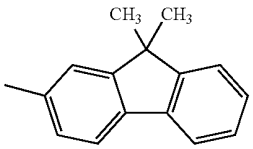
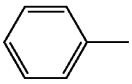
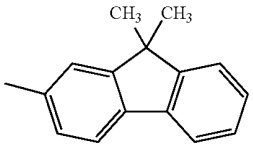
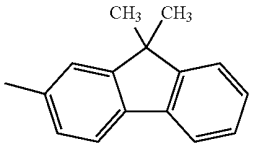
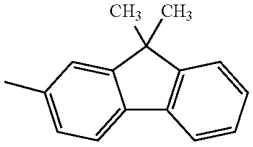
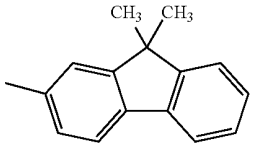
Compd. No.	R1	R2	R3
2318	CH_3—		
2319	H—		CH_3—
2320	CH_3—		CH_3—
2321	H—		

TABLE 49

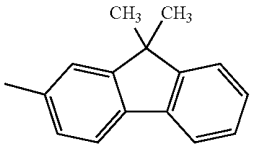
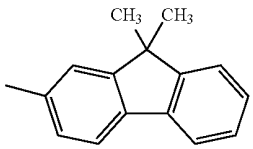
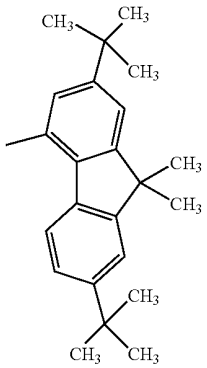
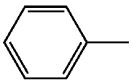
Compd. No.	R1	R2	R3
2322	CH_3—		
2323	H—		

TABLE 49-continued

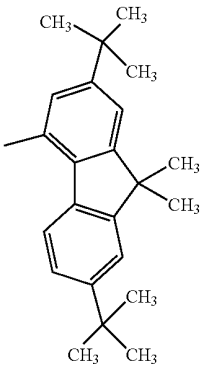
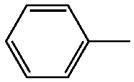
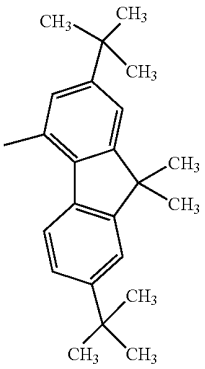
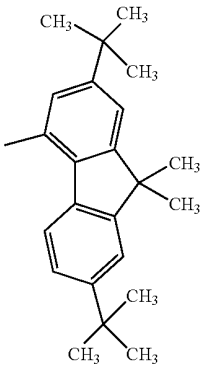
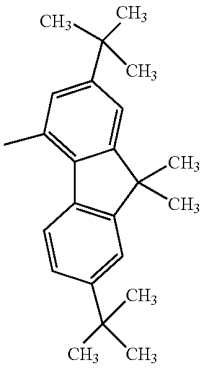
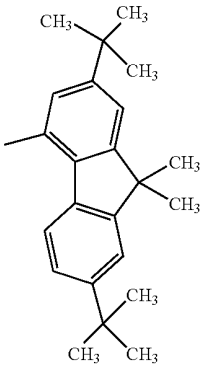
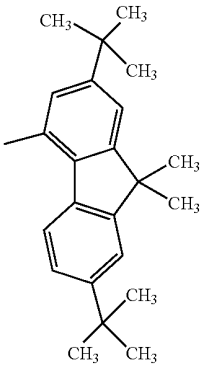
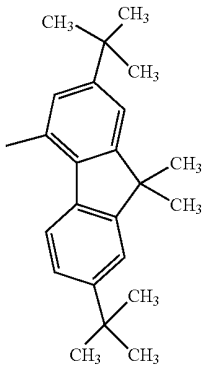
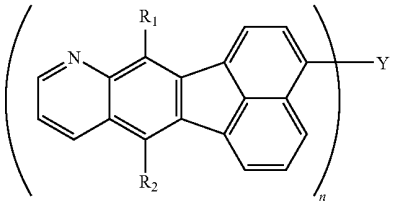
Compd. No.	R1	R2	R3
2324	CH_3—		
2325	H—		
2326	CH_3—		
2327	H—		CH_3—

TABLE 49-continued

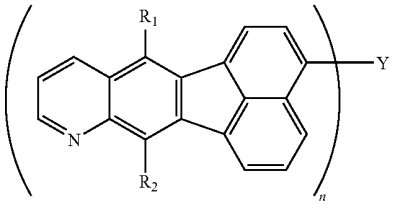
Compd. No.	R1	R2	R3
2328	CH_3—		CH_3—

Compound Example 15

[16]



[17]



wherein:

Y represents a linking group which is divalent or more such as a phenylene group or a biphenylene group; and

R_1 and R_2 each represent an aryl group such as a phenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group or a butyl group.

When R_1 and R_2 are different from each other, R_1 and R_2 shown in the following tables may be replaced with each other.

TABLE 50

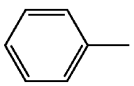
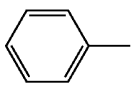
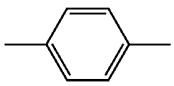
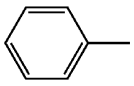
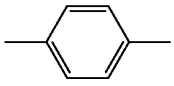
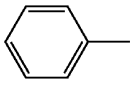
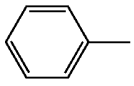
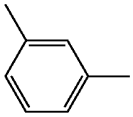
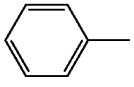
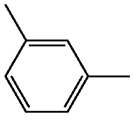
Compd. No.	n	R1	R2	Y
2401	2			
2402	2		CH_3—	
2403	2			
2404	2		CH_3—	

TABLE 50-continued

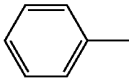
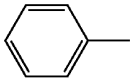
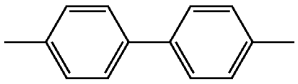
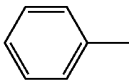
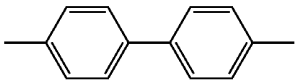
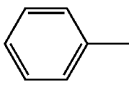
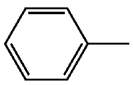
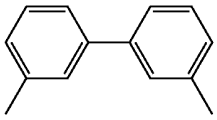
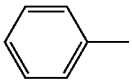
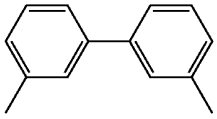
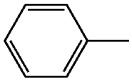
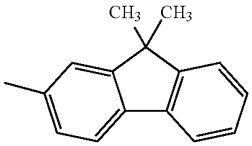
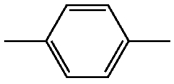
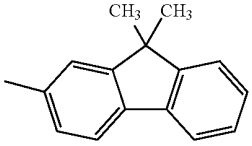
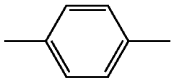
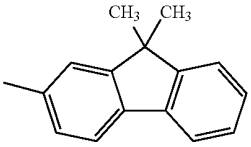
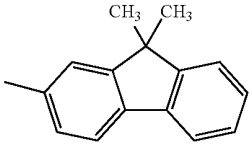
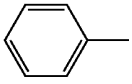
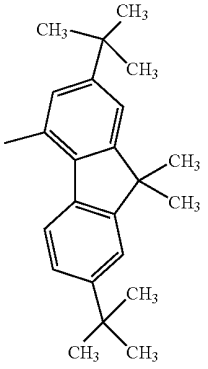
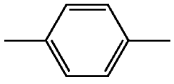
Compd. No.	n	R1	R2	Y
2405	2			
2406	2		CH_3—	
2407	2			
2408	2		CH_3—	
2409	2			
2410	2	CH_3—		
2411	2			
2412	2			

TABLE 51

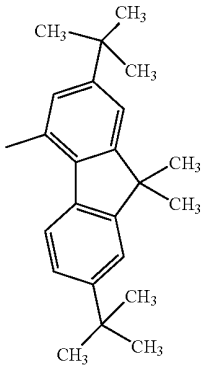
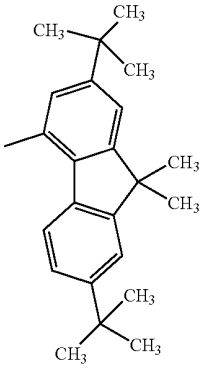
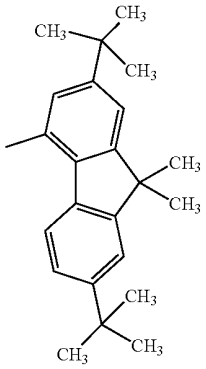
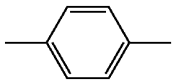
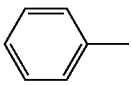
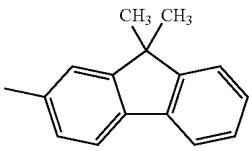
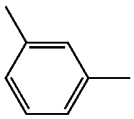
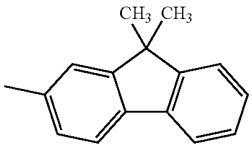
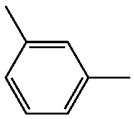
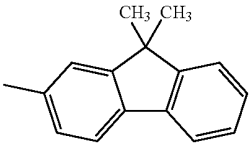
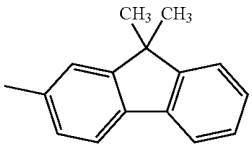
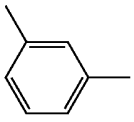
Compd. No.	n	R1	R2	Y
2413	2	CH_3—		
2414	2			
2415	2			
2416	2	CH_3—		
2417	2			

TABLE 51-continued

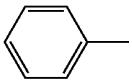
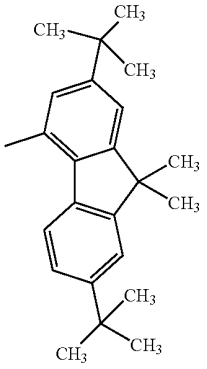
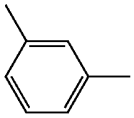
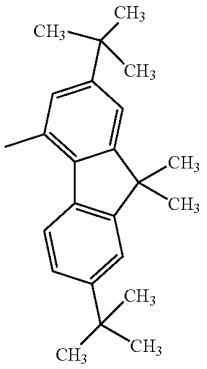
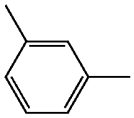
Compd. No.	n	R1	R2	Y
2418	2			
2419	2	CH_3—		

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TABLE 52

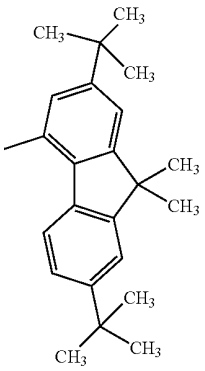
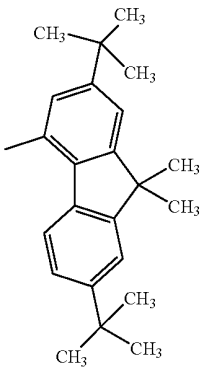
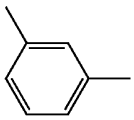
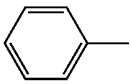
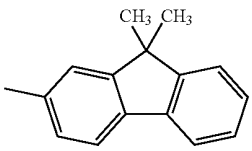
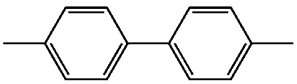
Compd. No.	n	R1	R2	Y
2420	2			
2421	2			

TABLE 52-continued

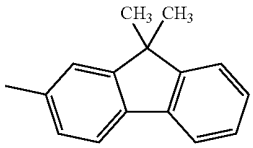
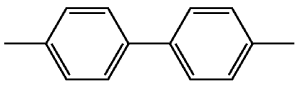
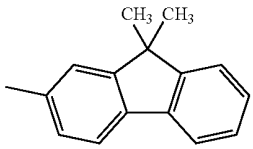
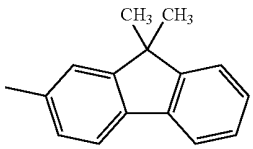
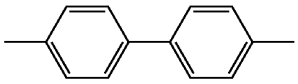
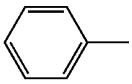
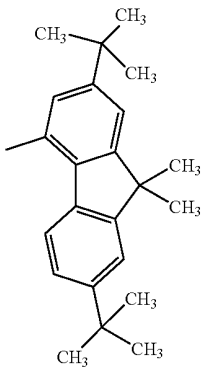
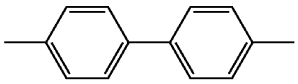
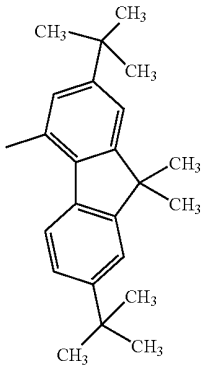
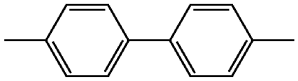
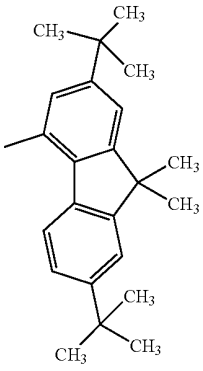
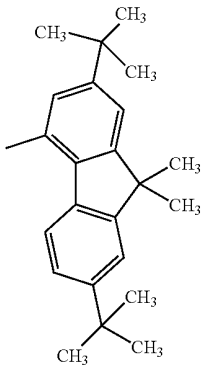
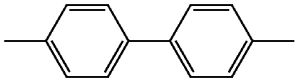
Compd. No.	n	R1	R2	Y
2422	2	CH_3—		
2423	2			
2424	2			
2425	2	CH_3—		
2426	2			

TABLE 53

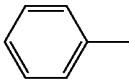
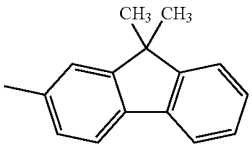
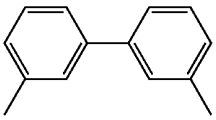
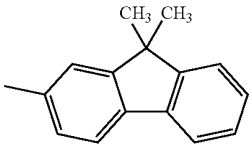
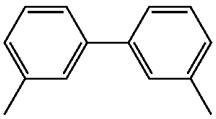
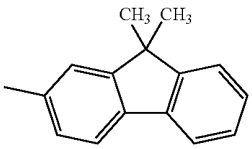
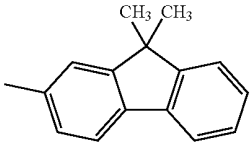
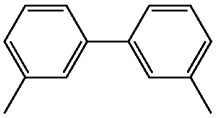
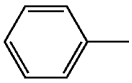
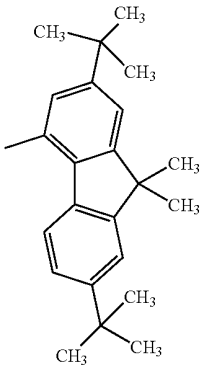
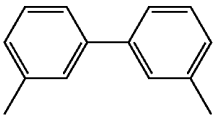
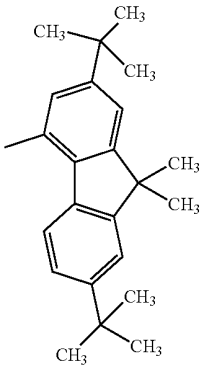
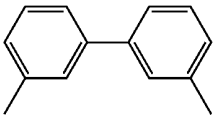
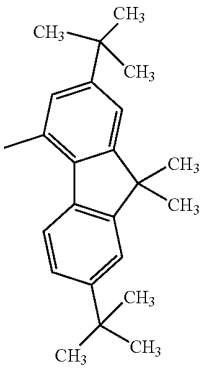
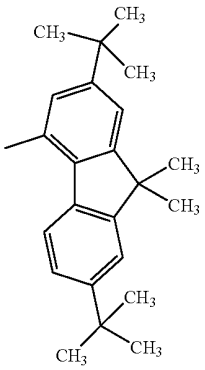
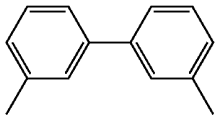
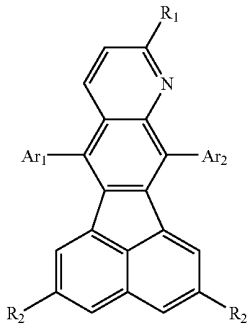
Compd.No.	n	R1	R2	Y
2427	2			
2428	2	CH_3—		
2429	2			
2430	2			
2431	2	CH_3—		

TABLE 53-continued

Compd.No.	n	R1	R2	Y
2432	2			

Compound Example 16



[18] wherein:

Ar_1 and Ar_2 each represent an aryl group such as a phenyl group or a biphenyl group, or a fused polycyclic aromatic group with three or less rings such as a naphthyl group or a fluorenyl group; and

R_1 and R_2 each represent a hydrogen atom, or an alkyl group such as a methyl group, an ethyl group, or a tertiary butyl group.

When Ar_1 and Ar_2 are different from each other, Ar_1 and Ar_2 shown in the following tables may be replaced with each other.

TABLE 54

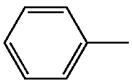
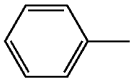
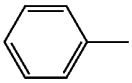
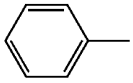
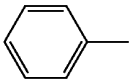
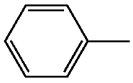
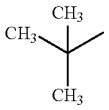
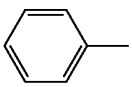
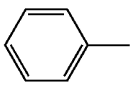
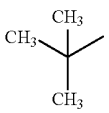
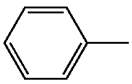
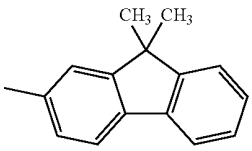
Compd. No.	Ar1	Ar2	R1	R2
2501			H—	H—
2502			CH_3—	H—
2503			H—	
2504			CH_3—	
2505			H—	H—

TABLE 54-continued

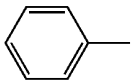
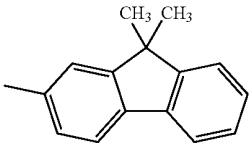
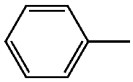
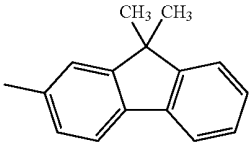
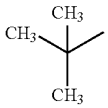
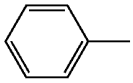
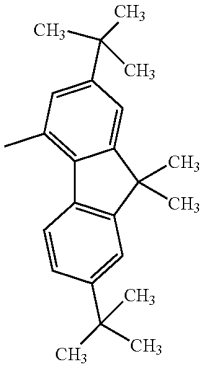
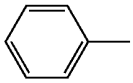
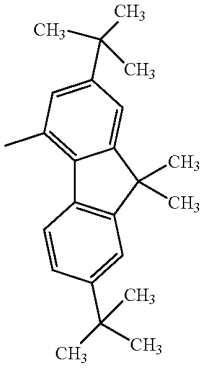
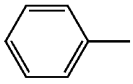
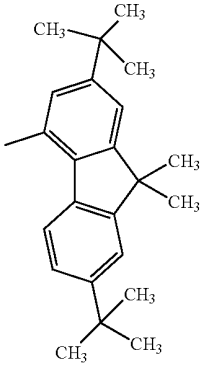
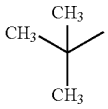
Compd. No.	Ar1	Ar2	R1	R2
2506			CH_3—	H—
2507			H—	
2508			H—	H—
2509			CH_3—	H—
2510			H—	

TABLE 54-continued

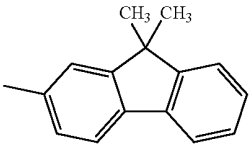
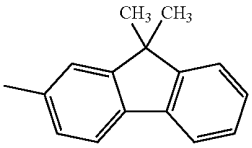
Compd. No.	Ar1	Ar2	R1	R2
2511			H—	H—

TABLE 55

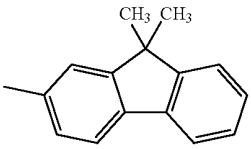
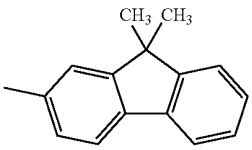
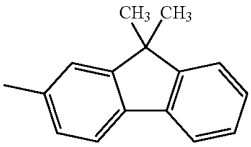
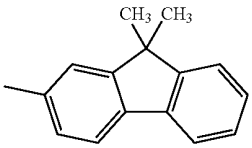
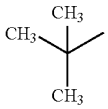
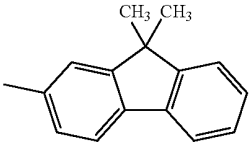
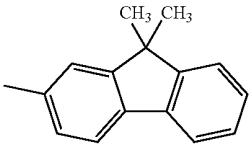
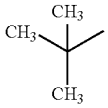
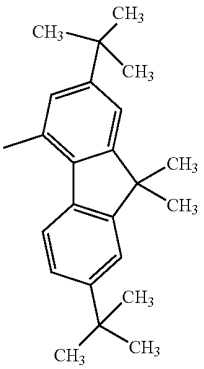
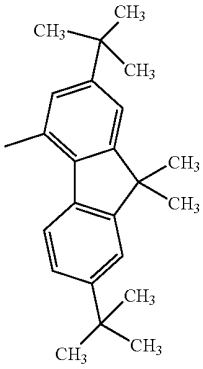
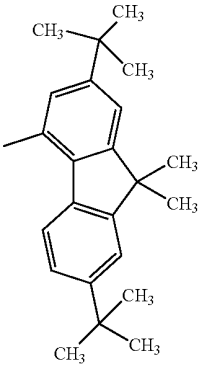
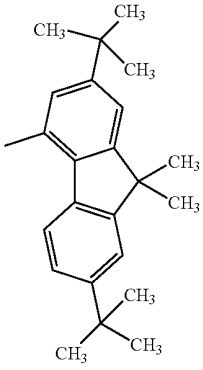
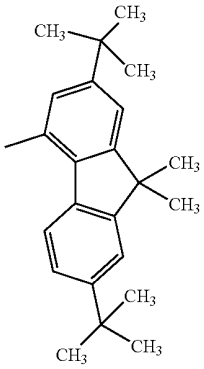
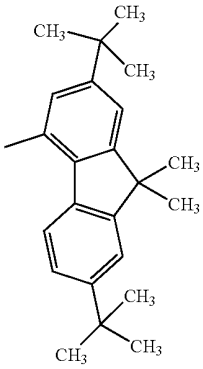
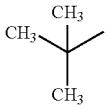
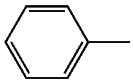
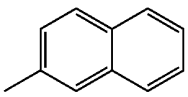
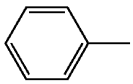
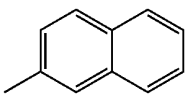
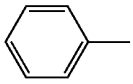
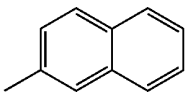
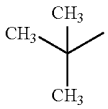
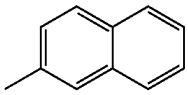
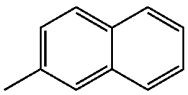
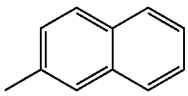
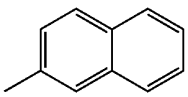
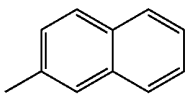
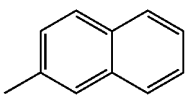
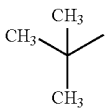
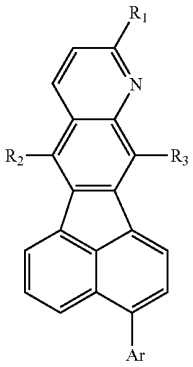
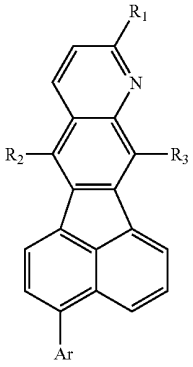
Compd. No.	Ar1	Ar2	R1	R2
2512			CH_3—	H—
2513			H—	
2314			CH_3—	
2315			H—	H—
2316			CH_3—	H—

TABLE 55-continued

Compd. No.	Ar1	Ar2	R1	R2
2517			H—	
2518			H—	H—
2519			CH_3—	H—
2520			H—	
2521			H—	H—
2522			CH_3—	H—
2523			H—	

Compound Example 17





wherein:

[19]

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group or a biphenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group; and

[20]

Ar represents a fused polycyclic aromatic group such as a fluoranthenyl group or a benzofluoranthenyl group.

When R_2 and R_3 are different from each other, R_2 and R_3 shown in the following tables may be replaced with each other.

TABLE 56

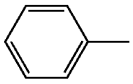
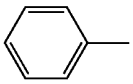
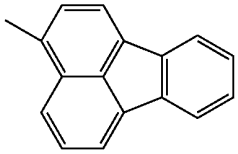
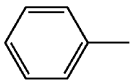
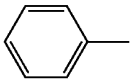
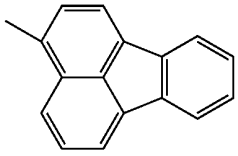
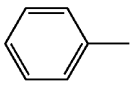
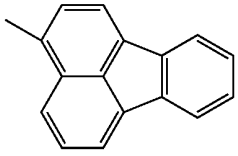
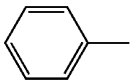
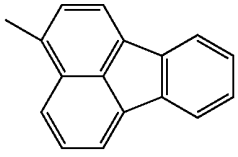
Compd. No.	R1	R2	R3	Ar
2601	H—			
2602	CH_3—			
2603	H—		CH_3—	
2604	CH_3—		CH_3—	

TABLE 56-continued

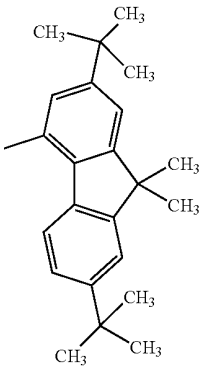
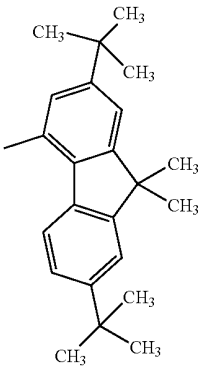
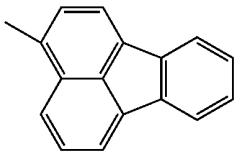
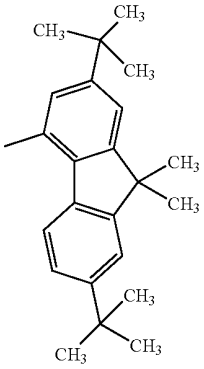
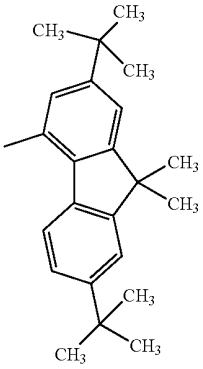
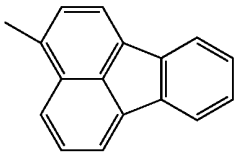
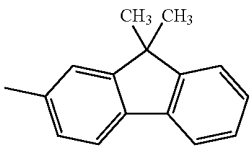
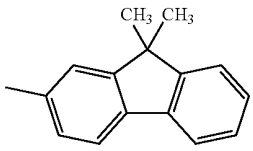
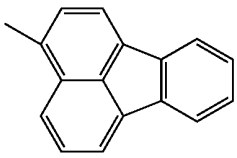
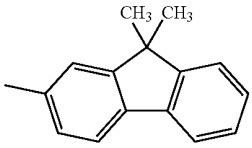
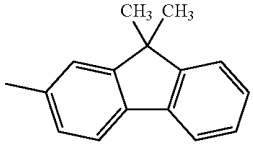
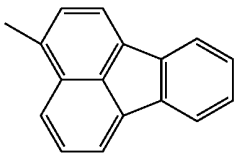
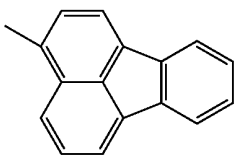
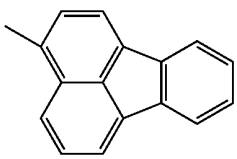
Compd. No.	R1	R2	R3	Ar
2605	H—			
2606	CH_3—			
2607	H—			
2608	CH_3—			
2609	H—	CH_3—	CH_3—	
2610	CH_3—	CH_3—	CH_3—	

TABLE 56-continued

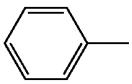
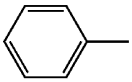
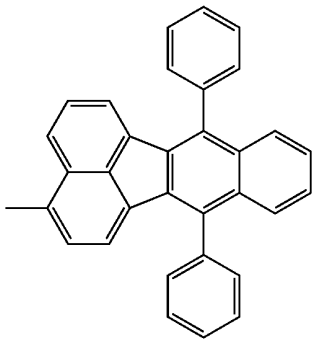
Compd. No.	R1	R2	R3	Ar
2611	H—			

TABLE 57

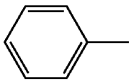
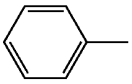
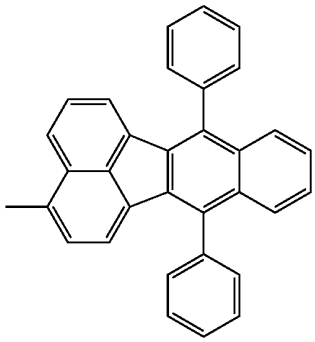
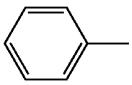
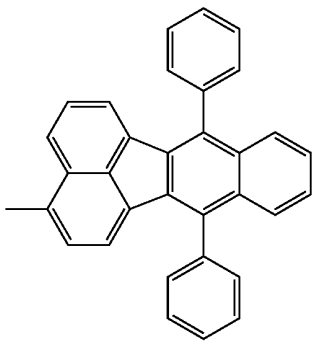
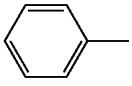
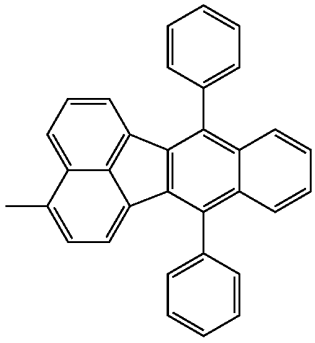
Compd. No.	R1	R2	R3	Ar
2612	CH_3—			
2613	H—		CH_3—	
2614	CH_3—		CH_3—	

TABLE 57-continued

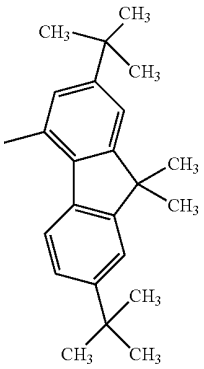
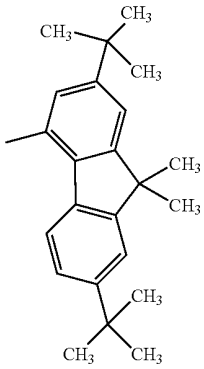
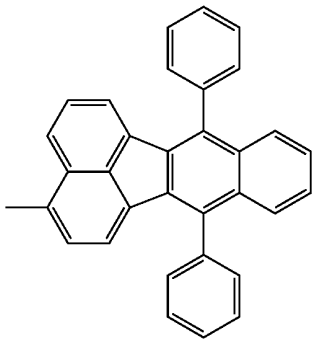
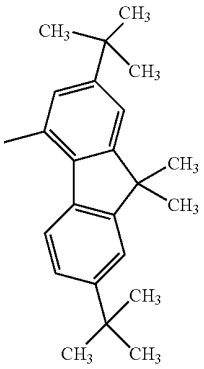
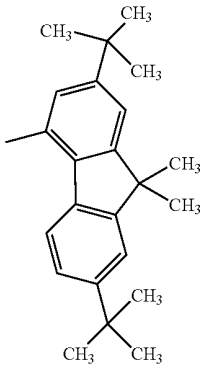
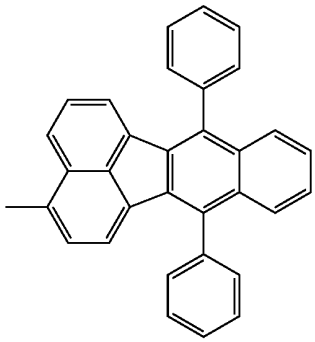
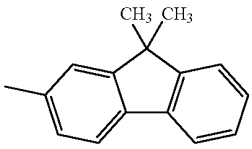
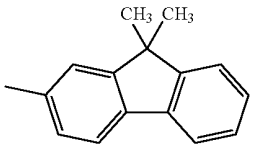
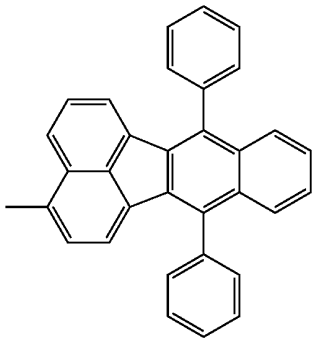
Compd. No.	R1	R2	R3	Ar
2615	H—			
2616	CH_3—			
2617	H—			

TABLE 58

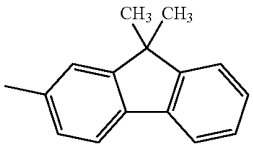
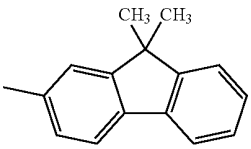
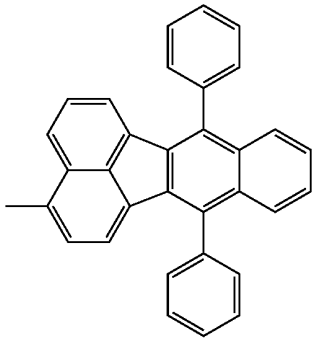
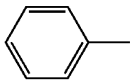
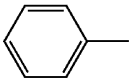
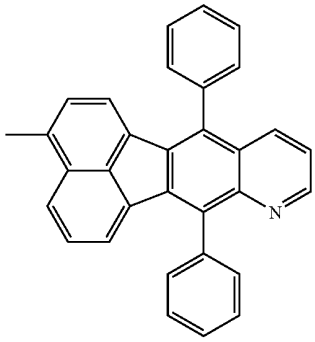
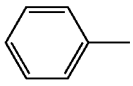
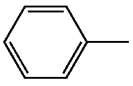
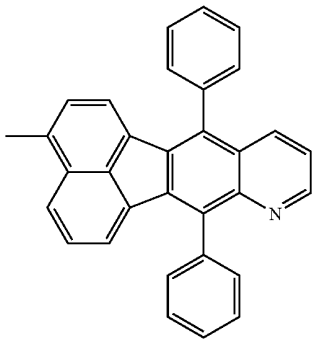
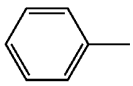
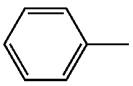
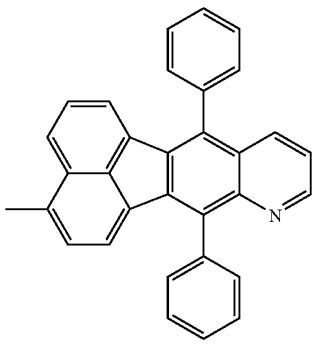
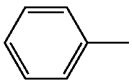
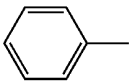
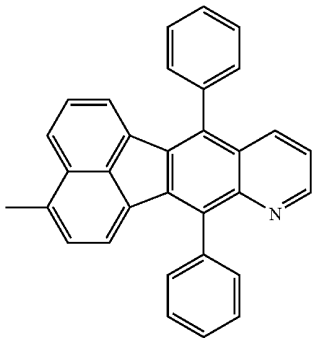
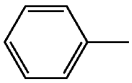
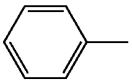
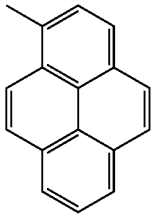
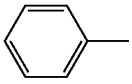
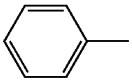
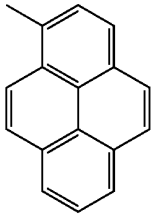
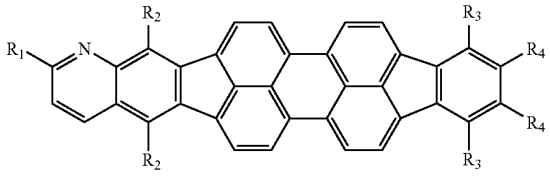
Compd. No.	R1	R2	R3	Ar
2618	CH_3—			
2619	H—			
2620	CH_3—			
2621	H—			

TABLE 58-continued

Compd. No.	R1	R2	R3	Ar
2622	CH_3—			
2623	H—			
2624	CH_3—			

Compound Example 18

[21]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 represents an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_3 and R_4 each represent a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 59

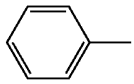
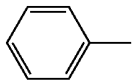
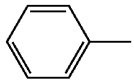
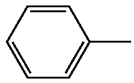
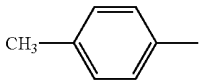
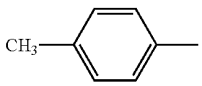
Compd. No.	R1	R2	R3	R4
2701	H—		H—	H—
2702	CH_3—		H—	H—
2703	H—		CH_3—	CH_3—
2704	CH_3—		CH_3—	CH_3—
2705	H—		H—	H—
2706	CH_3—		H—	H—

TABLE 59-continued

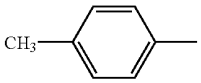
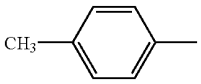
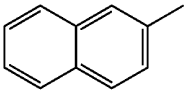
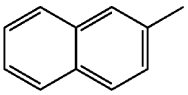
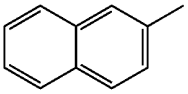
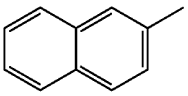
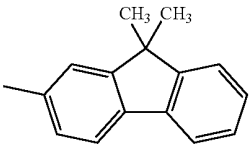
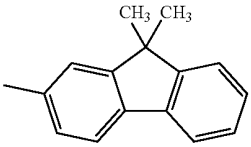
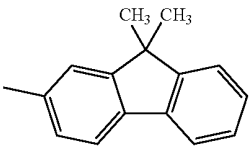
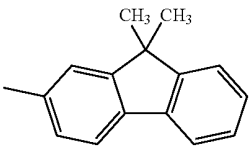
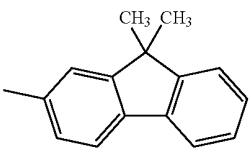
Compd. No.	R1	R2	R3	R4
2707	H—		CH_3—	H—
2708	CH_3—		CH_3—	H—
2709	H—		H—	H—
2710	CH_3—		H—	H—
2711	H—		CH_3—	H—
2712	CH_3—		CH_3—	H—
2713	H—		H—	H—
2714	CH_3—		H—	H—
2715	H—		CH_3—	H—
2716	CH_3—		CH_3—	H—
2717	H—		CH_3—	CH_3—

TABLE 59-continued

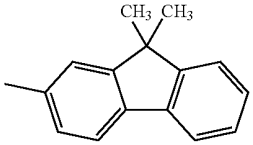
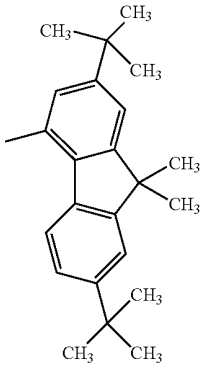
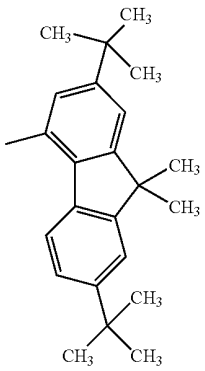
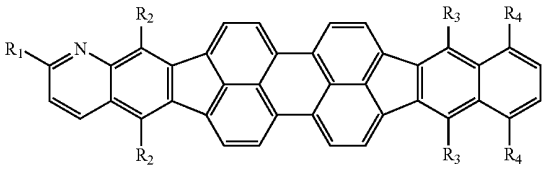
Compd. No.	R1	R2	R3	R4
2718	CH_3—		CH_3—	CH_3—

TABLE 60

Compd. No.	R1	R2	R3	R4
2719	H—		H—	H—
2720	CH_3—		H—	H—

Compound Example 19

[22]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group or a tolyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_4 represents a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 61

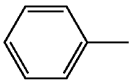
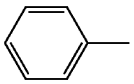
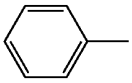
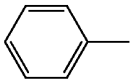
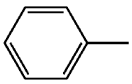
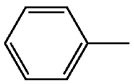
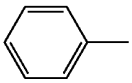
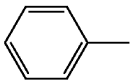
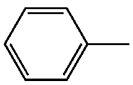
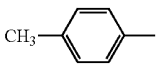
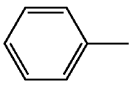
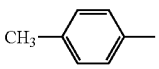
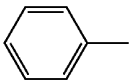
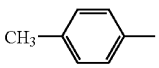
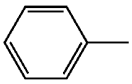
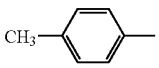
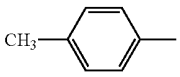
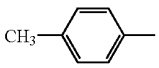
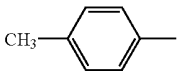
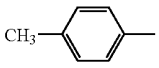
Compd. No.	R1	R2	R3	R4
2801	H—			H—
2802	CH_3—			H—
2803	H—			CH_3—
2804	CH_3—			CH_3—
2805	H—			H—
2806	CH_3—			H—
2807	H—			CH_3—
2808	CH_3—			CH_3—
2809	H—			H—
2810	CH_3—			H—

TABLE 61-continued

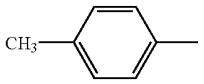
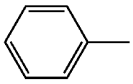
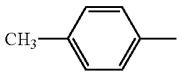
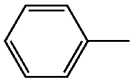
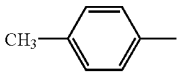
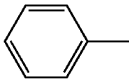
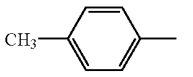
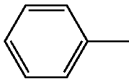
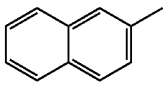
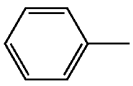
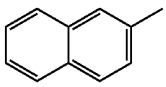
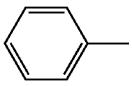
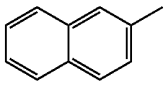
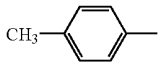
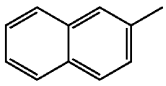
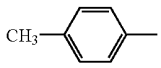
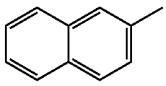
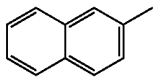
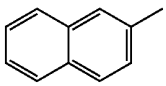
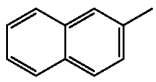
Compd. No.	R1	R2	R3	R4
2811	H—			H—
2812	CH_3—			H—
2813	H—			CH_3—
2814	CH_3—			CH_3—
2815	H—			H—
2816	CH_3—			H—
2817	H—			H—
2818	CH_3—			H—
2819	H—			H—
2820	CH_3—			H—

TABLE 62

Compd. No.	R1	R2	R3	R4
2821	H—			H—
2822	CH_3—			H—

TABLE 62-continued

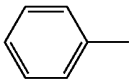
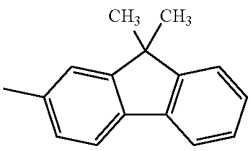
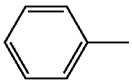
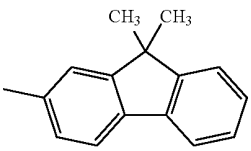
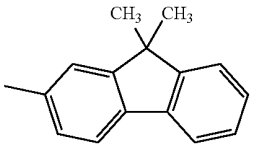
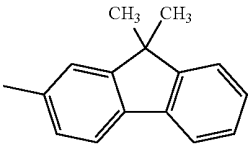
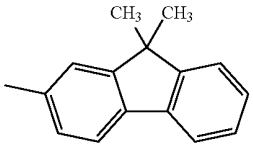
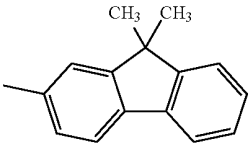
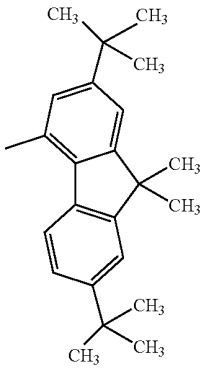
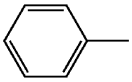
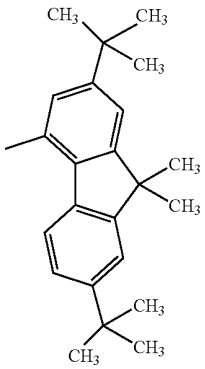
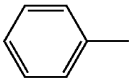
Compd. No.	R1	R2	R3	R4
2823	H—			H—
2824	CH_3—			H—
2825	H—			H—
2826	CH_3—			H—
2827	H—			H—
2828	CH_3—			H—

TABLE 62-continued

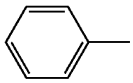
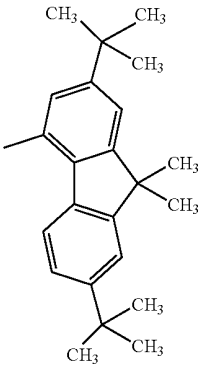
Compd. No.	R1	R2	R3	R4
2829	H—			H—

TABLE 63

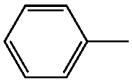
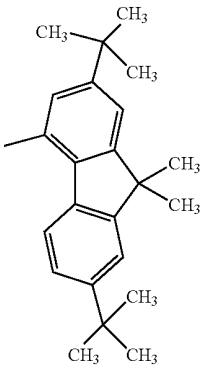
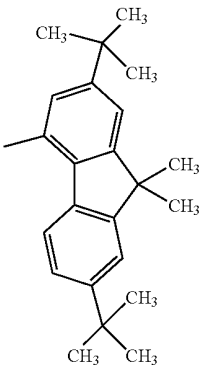
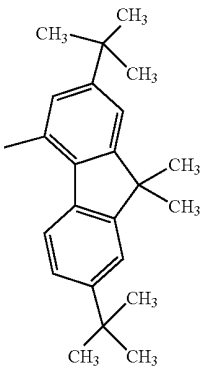
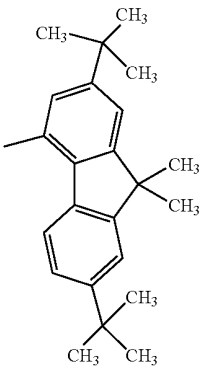
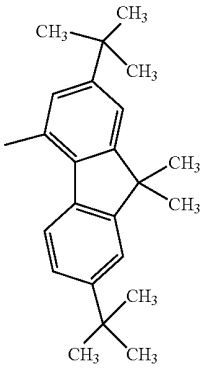
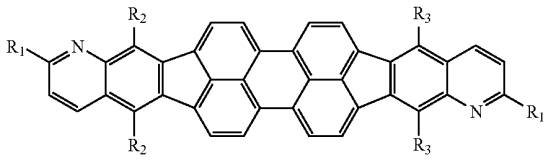
Compd.No.	R1	R2	R3	R4
2830	CH_3—			H—
2831	H—			H—

TABLE 63-continued

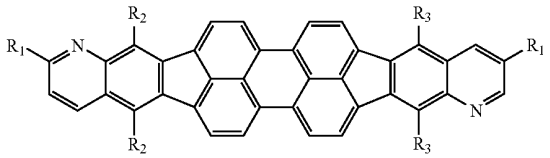
Compd.No.	R1	R2	R3	R4
2832	CH_3—			H—

Compound Example 20

[23]



[24]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group or a tolyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group.

TABLE 64

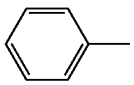
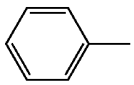
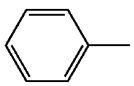
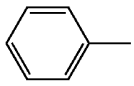
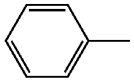
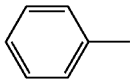
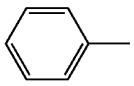
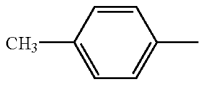
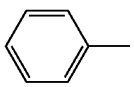
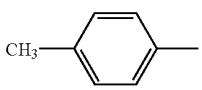
Compd.No.	R1	R2	R3
2901	H—		
2902	CH_3—		
2903	H—		CH_3—
2904	CH_3—		CH_3—
2905	H—		
2906	CH_3—		

TABLE 64-continued

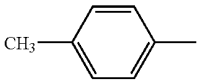
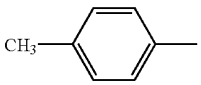
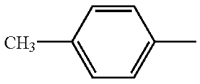
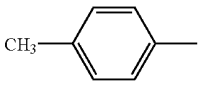
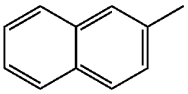
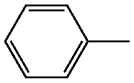
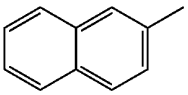
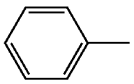
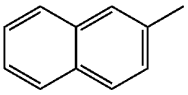
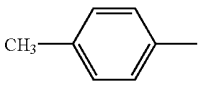
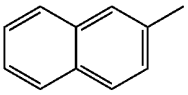
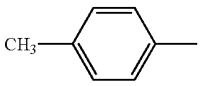
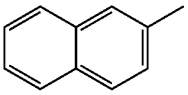
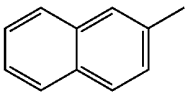
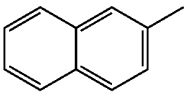
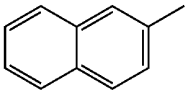
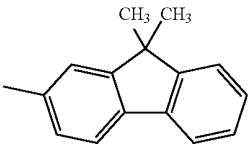
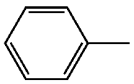
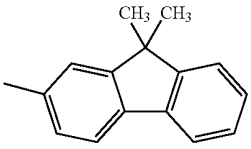
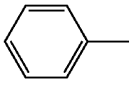
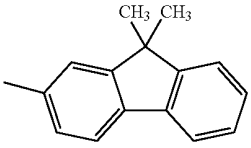
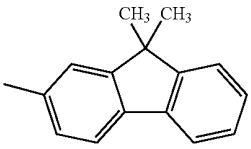
Compd.No.	R1	R2	R3
2907	H—		
2908	CH_3—		
2909	H—		
2910	CH_3—		
2911	H—		
2912	CH_3—		
2913	H—		
2914	CH_3—		
2915	H—		
2916	CH_3—		
2917	H—		CH_3—
2918	CH_3—		CH_3—

TABLE 64-continued

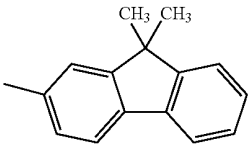
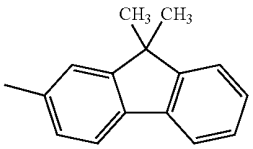
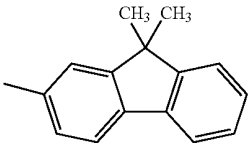
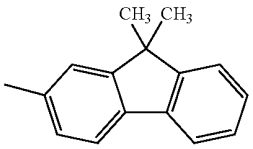
Compd.No.	R1	R2	R3
2919	H—		
2920	CH_3—		

TABLE 65

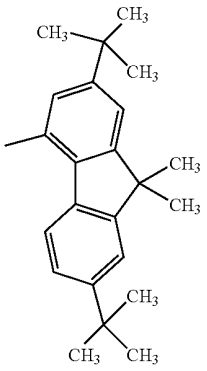
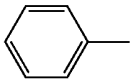
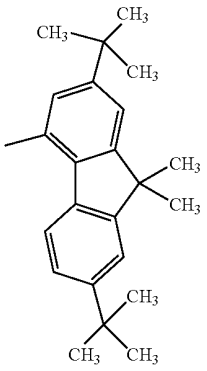
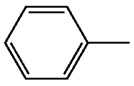
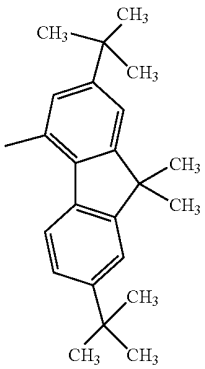
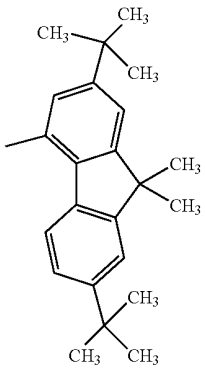
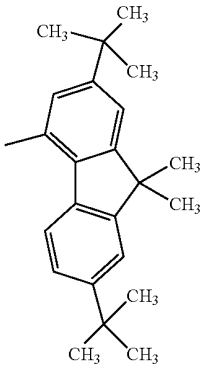
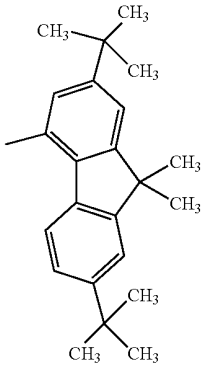
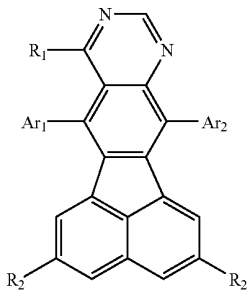
Compd.No.	R1	R2	R3
2921	H—		
2922	CH_3—		

TABLE 65-continued

Compd.No.	R1	R2	R3
2923	H—		
2924	CH_3—		

Compound Example 21



[25] wherein:

Ar_1 and Ar_2 each represent an aryl group such as a phenyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_1 and R_2 each represent a hydrogen atom, or an alkyl group such as a methyl group, an ethyl group, or a tertiary butyl group.

When Ar_1 and Ar_2 are different from each other, Ar_1 and Ar_2 shown in the following tables may be replaced with each other.

TABLE 66

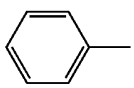
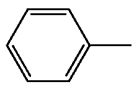
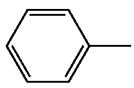
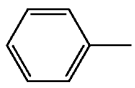
Compd.No.	Ar1	Ar2	R1	R2
3001			H—	H—
3002			CH_3—	H—

TABLE 66-continued

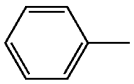
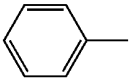
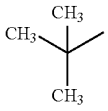
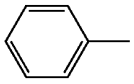
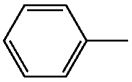
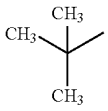
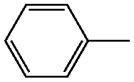
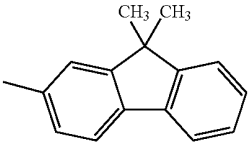
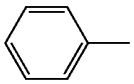
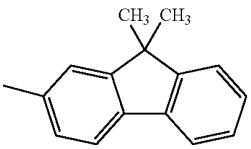
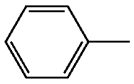
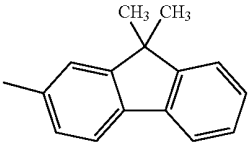
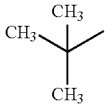
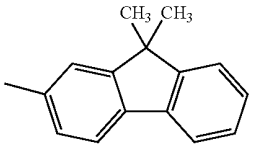
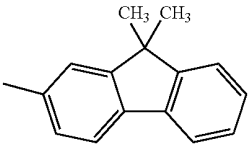
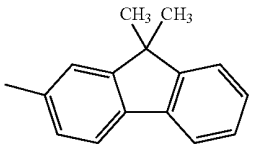
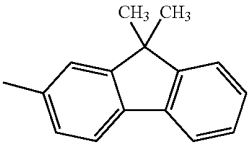
Compd.No.	Ar1	Ar2	R1	R2
3003			H—	
3004			CH_3—	
3005			H—	H—
3006			CH_3—	H—
3007			H—	
3008			H—	H—
3009			CH_3—	H—

TABLE 66-continued

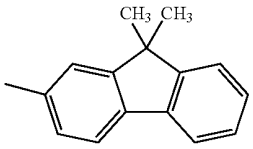
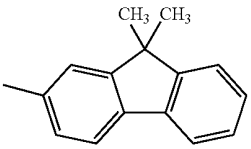
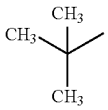
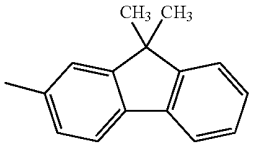
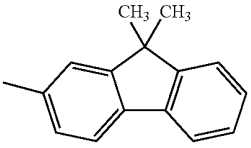
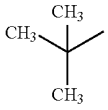
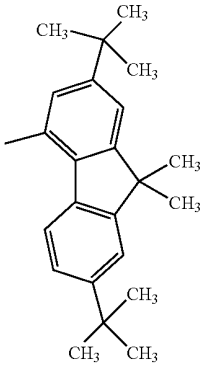
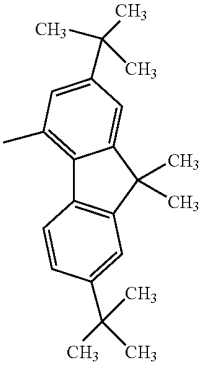
Compd.No.	Ar1	Ar2	R1	R2
3010			H—	
3011			CH_3—	
3012			H—	H—

TABLE 67

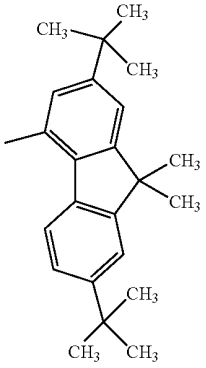
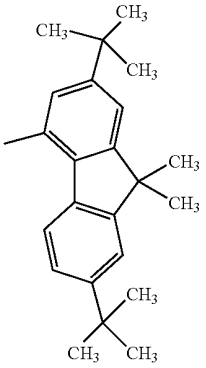
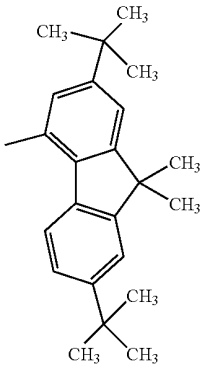
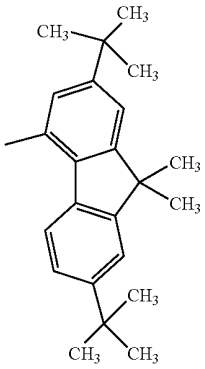
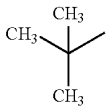
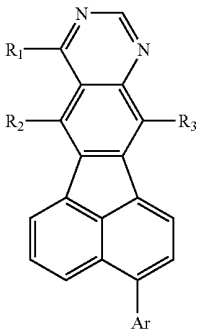
Compd.No.	Ar1	Ar2	R1	R2
3013			CH_3—	H—

TABLE 67-continued

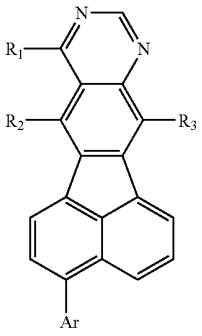
Compd.No.	Ar1	Ar2	R1	R2
3014			H—	

Compound Example 22

[26]



[27]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group; and

Ar represents a fused polycyclic aromatic group such as a fluoranthenyl group or a benzofluoranthenyl group.

When R_2 and R_3 are different from each other, R_2 and R_3 shown in the following tables may be replaced with each other.

TABLE 68

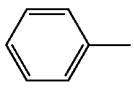
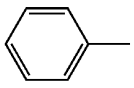
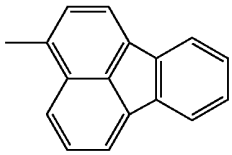
Compd.No.	R1	R2	R3	Ar
3101	H—			

TABLE 68-continued

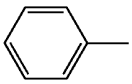
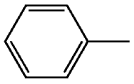
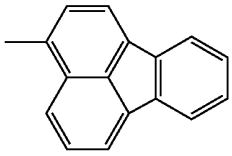
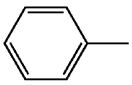
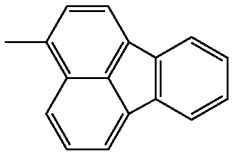
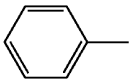
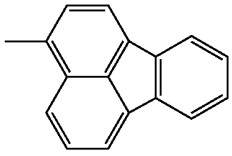
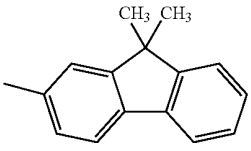
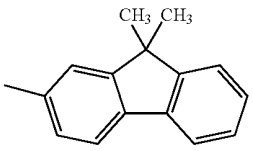
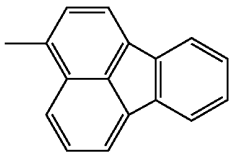
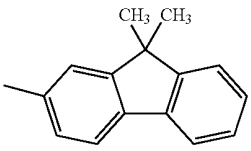
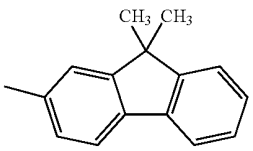
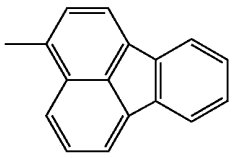
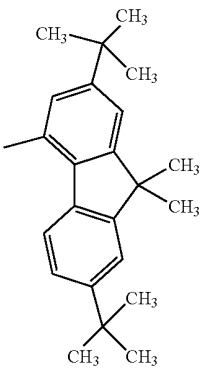
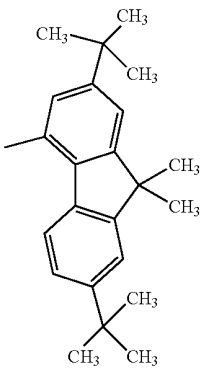
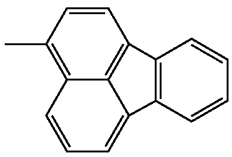
Compd.No.	R1	R2	R3	Ar
3102	CH_3—			
3103	H—		CH_3—	
3104	CH_3—		CH_3—	
3105	H—			
3106	CH_3—			
3107	H—			

TABLE 68-continued

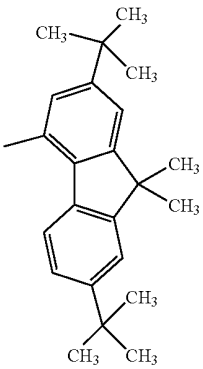
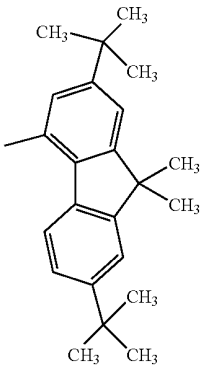
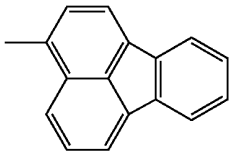
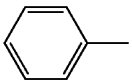
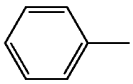
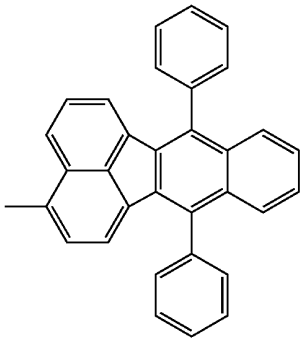
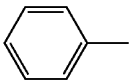
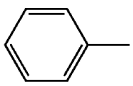
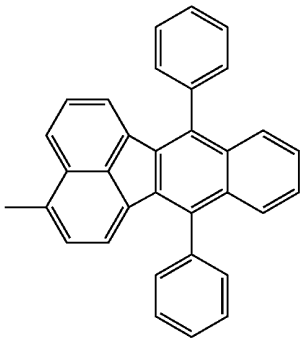
Compd.No.	R1	R2	R3	Ar
3108	CH_3—			
3109	H—			
3110	CH_3—			

TABLE 69

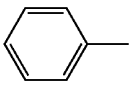
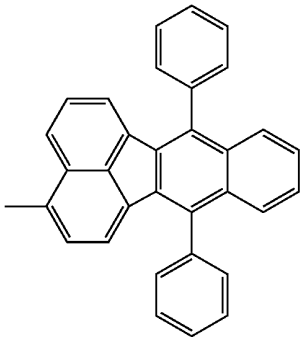
Compd.No.	R1	R2	R3	Ar
3111	H—		CH_3—	

TABLE 69-continued

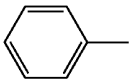
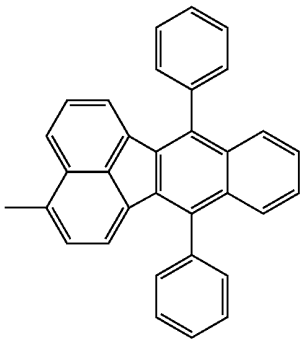
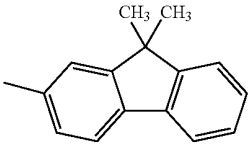
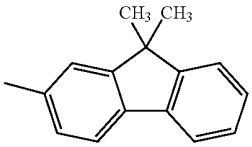
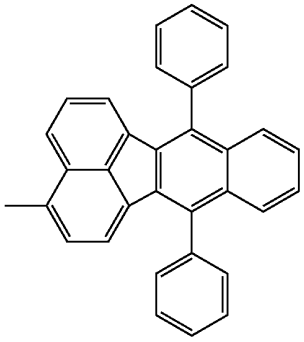
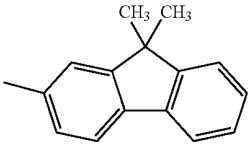
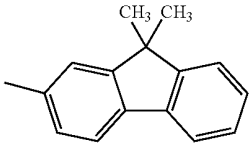
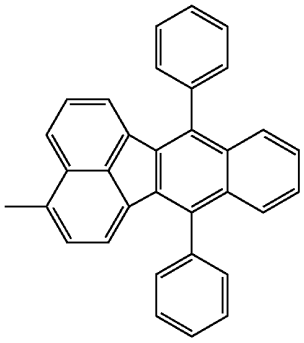
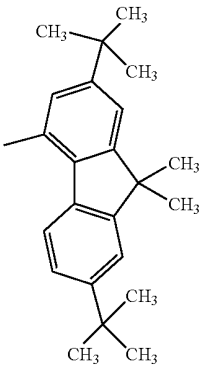
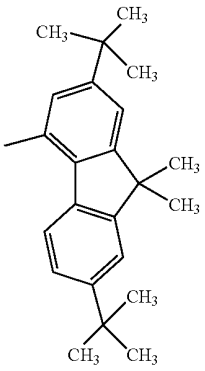
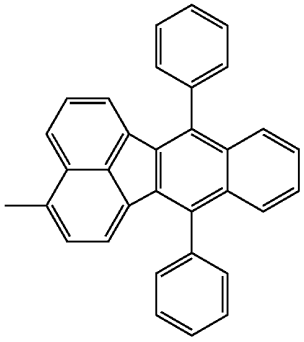
Compd.No.	R1	R2	R3	Ar
3112	CH_3—		CH_3—	
3113	H—			
3114	CH_3—			
3115	H—			

TABLE 69-continued

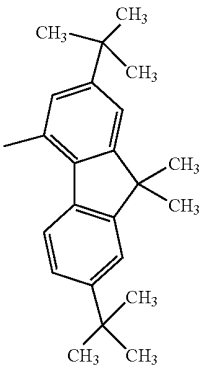
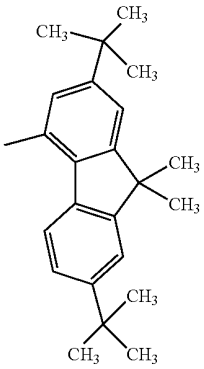
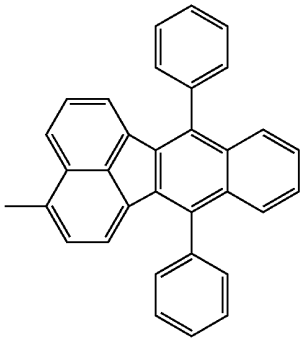
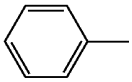
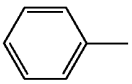
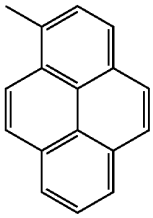
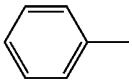
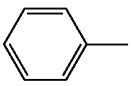
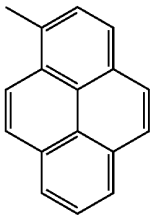
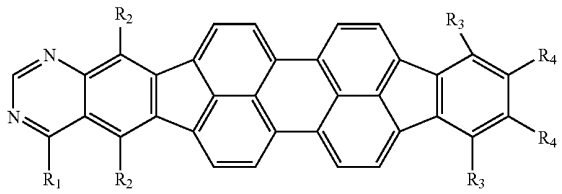
Compd.No.	R1	R2	R3	Ar
3116	CH_3—			

TABLE 70

Compd.No.	R1	R2	R3	Ar
3117	H—			
3118	CH_3—			

Compound Example 23

[28]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group or an ethyl group;

R_2 represents an aryl group such as a phenyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_3 and R_4 each represent a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 71

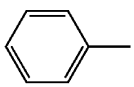
Compd.No.	R1	R2	R3	R4
3201	H—		H—	H—

TABLE 71-continued

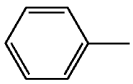
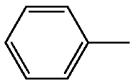
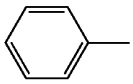
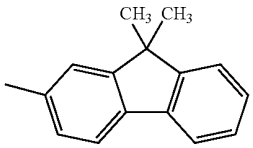
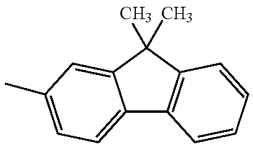
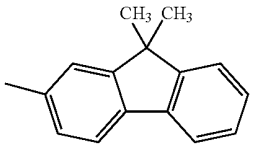
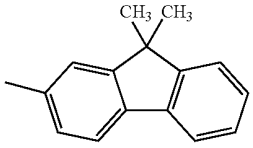
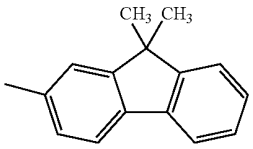
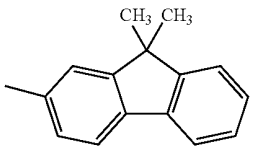
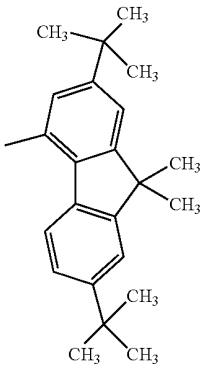
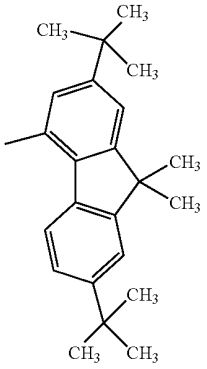
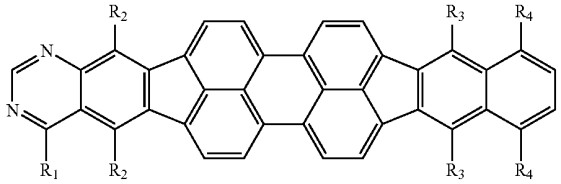
Compd.No.	R1	R2	R3	R4
3202	CH_3—		H—	H—
3203	H—		CH_3—	CH_3—
3204	CH_3—		CH_3—	CH_3—
3205	H—		H—	H—
3206	CH_3—		H—	H—
3207	H—		CH_3—	H—
3208	CH_3—		CH_3—	H—
3209	H—		CH_3—	CH_3—
3210	CH_3—		CH_3—	CH_3—

TABLE 71-continued

Compd.No.	R1	R2	R3	R4
3211	H—		H—	H—
3212	CH_3—		H—	H—

Compound Example 24

[29]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_4 represents a hydrogen atom, or an alkyl group such as a methyl group.

TABLE 72

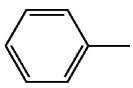
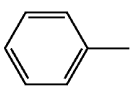
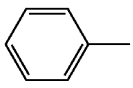
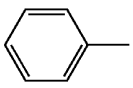
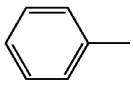
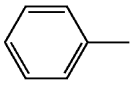
Compd.No.	R1	R2	R3	R4
3301	H—			H—
3302	CH_3—			H—
3303	H—			CH_3—

TABLE 72-continued

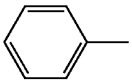
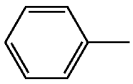
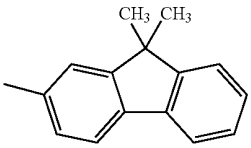
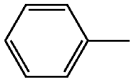
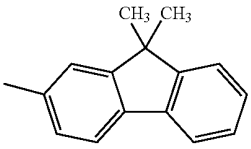
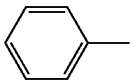
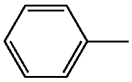
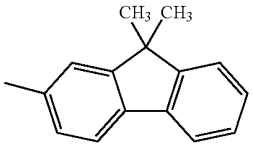
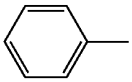
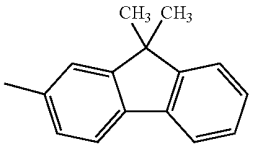
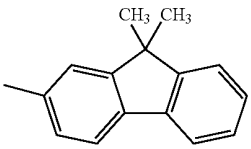
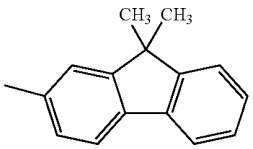
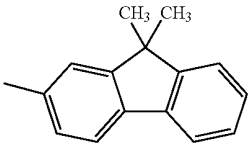
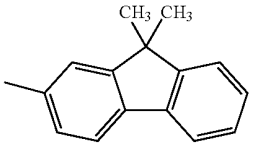
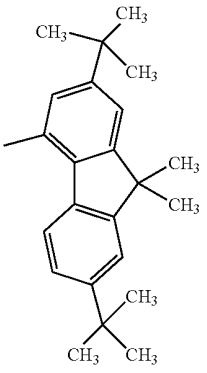
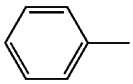
Compd.No.	R1	R2	R3	R4
3304	CH_3—			CH_3—
3305	H—			H—
3306	CH_3—			H—
3307	H—			H—
3308	CH_3—			H—
3309	H—			H—
3310	CH_3—			H—
3311	H—			H—

TABLE 72-continued

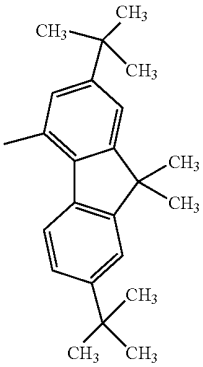
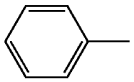
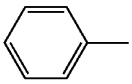
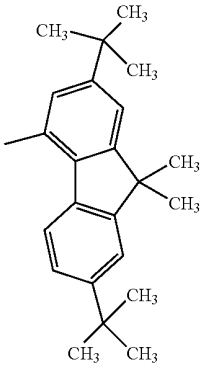
Compd.No.	R1	R2	R3	R4
3312	CH_3—			H—
3313	H—			H—

TABLE 73

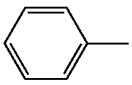
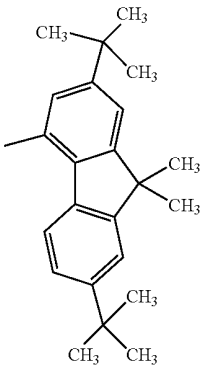
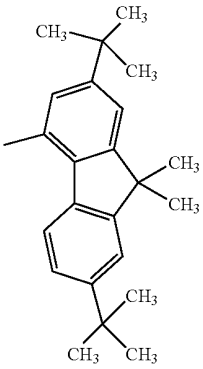
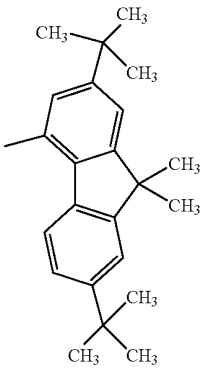
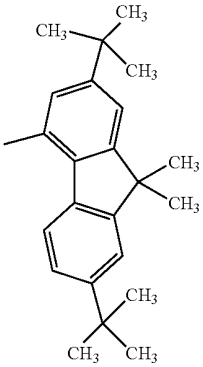
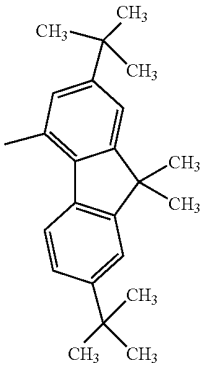
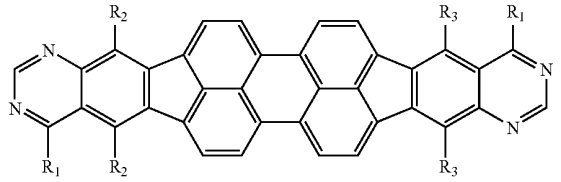
Compd.No.	R1	R2	R3	R4
3314	CH_3—			H—

TABLE 73-continued

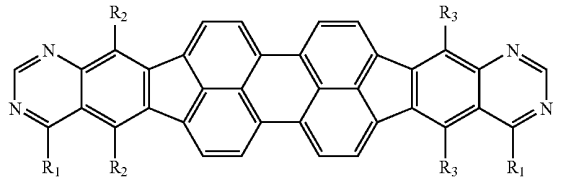
Compd.No.	R1	R2	R3	R4
3315	H—			H—
3316	CH_3—			H—

Compound Example 25

[30]



[31]



wherein:

R_1 represents a hydrogen atom, or an alkyl group such as a methyl group;

R_2 and R_3 each represent an aryl group such as a phenyl group or a tolyl group, a fused polycyclic aromatic group with three or less rings such as a fluorenyl group, or an alkyl group such as a methyl group.

TABLE 74

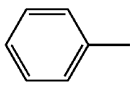
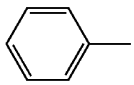
Compd.No.	R1	R2	R3
3401	H—		

TABLE 74-continued

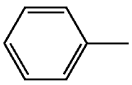
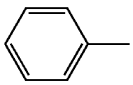
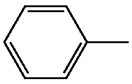
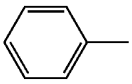
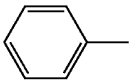
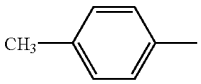
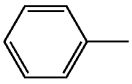
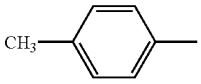
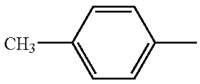
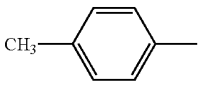
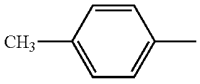
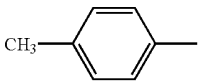
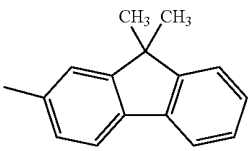
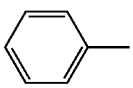
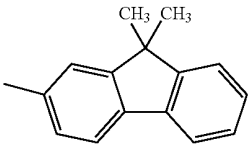
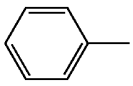
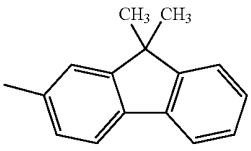
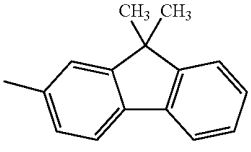
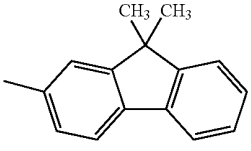
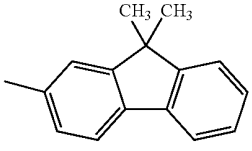
Compd.No.	R1	R2	R3
3402	CH_3—		
3403	H—		CH_3—
3404	CH_3—		CH_3—
3405	H—		
3406	CH_3—		
3407	H—		
3408	CH_3—		
3409	H—		
3410	CH_3—		
3411	H—		CH_3—
3412	CH_3—		CH_3—
3413	H—		

TABLE 74-continued

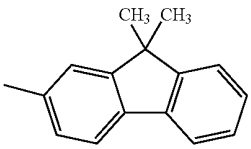
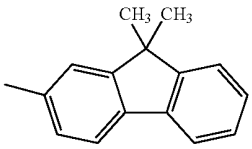
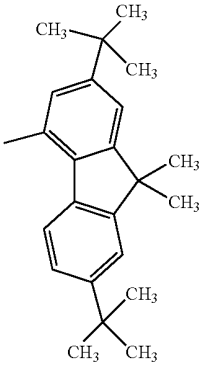
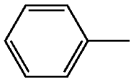
Compd.No.	R1	R2	R3
3414	CH_3—		
3415	H—		

TABLE 75

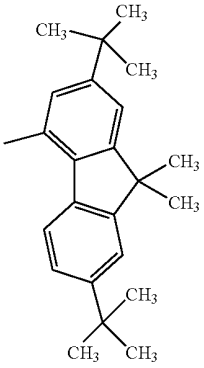
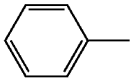
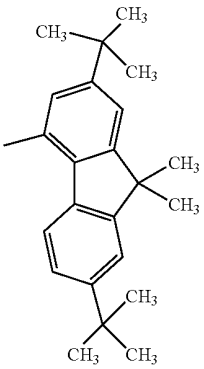
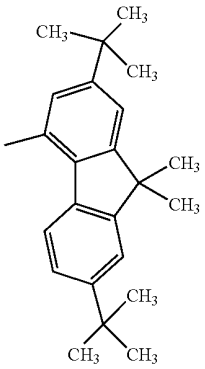
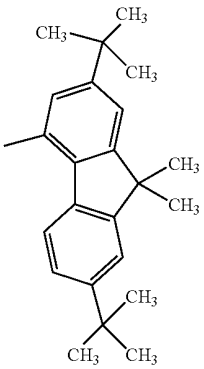
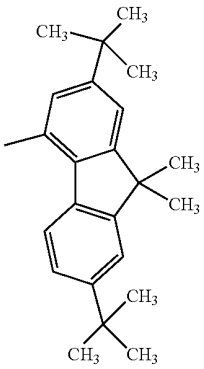
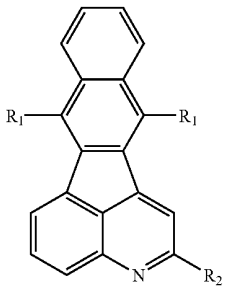
Compd.No.	R1	R2	R3
3416	CH_3—		
3417	H—		

TABLE 75-continued

Compd.No.	R1	R2	R3
3418	CH_3—		

Compound Example 26



[32]

wherein:

R_1 represents a hydrogen atom, an aryl group such as a phenyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_2 represents a hydrogen atom, an aryl group such as a phenyl group or a biphenyl group, or a fused polycyclic aromatic group such as a naphthyl group, a fluorenyl group, or a pyrenyl group.

TABLE 76

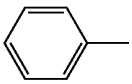
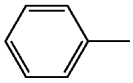
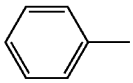
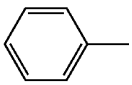
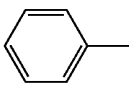
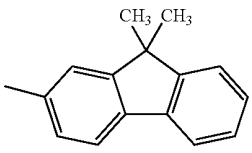
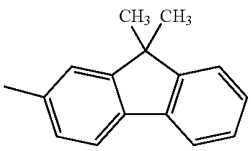
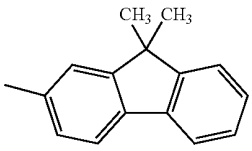
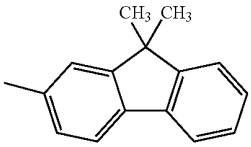
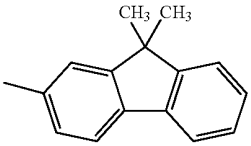
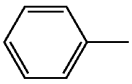
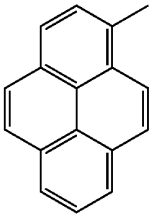
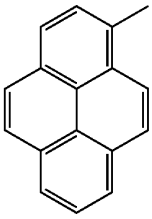
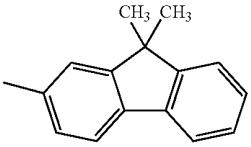
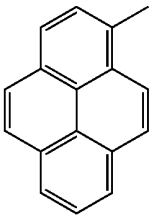
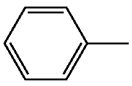
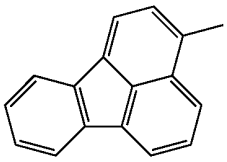
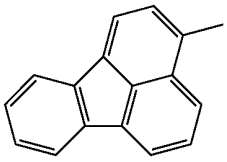
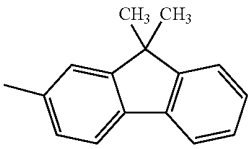
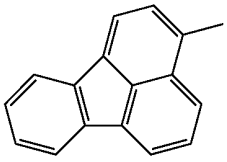
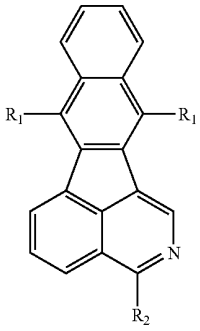
Compd.No.	R1	R2
3501		
3502	H—	
3503		H—
3504		
3505		

TABLE 76-continued

Compd.No.	R1	R2
3506	H—	
3507		H—
3508		
3509	H—	
3510		
3511		
3512	H—	
3513		

Compound Example 27



wherein:

[33]

R_1 represents a hydrogen atom, an aryl group such as a phenyl group, or a fused polycyclic aromatic group with three or less rings such as a fluorenyl group; and

R_2 represents a hydrogen atom, an aryl group such as a phenyl group or a biphenyl group, or a fused polycyclic aromatic group such as a naphthyl group, a fluorenyl group, or a pyrenyl group.

TABLE 77

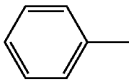
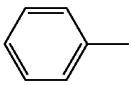
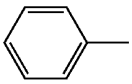
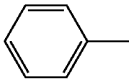
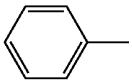
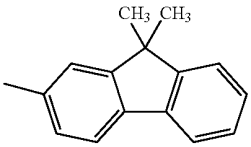
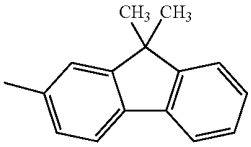
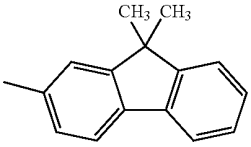
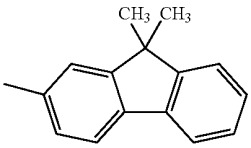
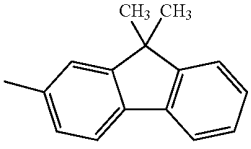
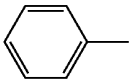
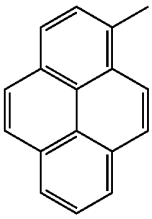
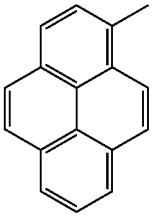
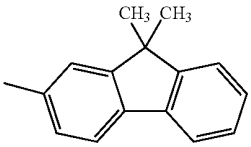
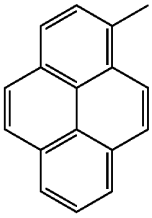
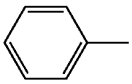
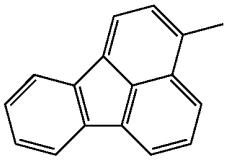
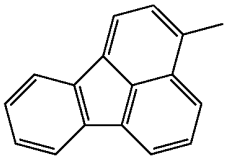
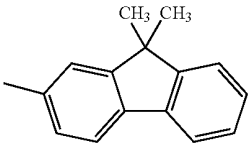
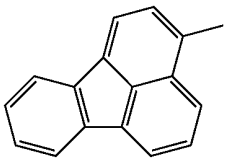
Compd.No.	R1	R2
3601		
3602	H—	
3603		H—
3604		
3605		
3606	H—	
3607		H—

TABLE 77-continued

Compd.No.	R1	R2
3608		
3609	H—	
3610		
3611		
3612	H—	
3613		

The fused heterocyclic compound of the present invention has a nitrogen-containing aromatic heterocyclic ring structure obtained by introducing at least one nitrogen atom into a specific position of a benzofluoranthene skeleton. Accordingly, a stable amorphous film can be formed of the compound, and the compound shows excellent electron transporting property. Those properties allow the compound to be suitably used as a charge transportable material in, for example, an electrophotographic photosensitive member, an organic electroluminescence device, a photoelectric conversion element, or an organic solar cell. In addition, the compound is suitable as a material for an organic electroluminescence device because the application of the compound to an organic electroluminescence device can contribute to an achievement of high luminous efficiency and a reduction in voltage at which the device is driven.

Next, an organic light emitting device of the present invention will be described in more detail.

The organic light emitting device of the present invention comprised a pair of electrodes composed of an anode and a cathode at least one of which is made of an electrode material transparent or semi-transparent; and at least a layer containing one or a plurality of organic compounds held between the pair of electrodes. The organic light emitting device of the present invention is preferably an electroluminescence device that emits light by applying voltage between the pair of electrodes.

In addition, at least one layer containing an organic compound, preferably at least one layer having a light emitting region, or more preferably a light emitting layer contains at least one kind of the above fused heterocyclic compound of the present invention.

In addition, when the layer containing the fused heterocyclic compound is formed of two or more compounds including a host and a guest, the host or the guest is preferably the fused heterocyclic compound of the present invention. It should be noted that the term "guest" as used in the present invention refers to a compound that emits light in response to recombination between a hole and an electron in the light emitting region of an organic EL device. The guest is incorporated into another compound (host) of which the light emitting region is formed.

When the fused heterocyclic compound of the present invention is used as a guest, the content of the compound is preferably 0.01 wt % or more to 80 wt % or less, more preferably 0.1 wt % or more to 30 wt % or less, or particularly preferably 0.1 wt % or more to 15 wt % or less. A guest material may be incorporated into the entirety of a layer formed of a host material uniformly or with a concentration gradient. Alternatively, the guest material may be partially incorporated into a certain region of the host material layer so that a region of the layer free of the guest material is present.

In addition, when the fused heterocyclic compound of the present invention is used as a guest, the layer preferably contains a host having an energy gap (value calculated from an optical absorption end of UV measurement) larger than that of the guest. In this case, energy transfer from the guest to the host can be controlled, and luminous efficiency can be enhanced as a result of light emission only from the guest.

In addition, when the fused heterocyclic compound of the present invention is used as a guest, the reduction potential of the guest is preferably higher than the reduction potential of the host by 0.3 V or more. In this case, the voltage at which the device is driven can be reduced, high luminance can be maintained for a long time period, and the deterioration of the device due to energization can be reduced.

Only a light emitting layer may be the layer containing the fused heterocyclic compound of the present invention. However, the layer containing the fused heterocyclic compound of the present invention is applicable to a layer except the light emitting layer (such as a hole injecting layer, a hole transporting layer, an electron injecting layer, an electron transporting layer, or an electron blocking layer) as required.

In the organic light emitting device of the present invention, the fused heterocyclic compound of the present invention is formed into an organic layer between the anode and the cathode by a vacuum vapor deposition method or a solution application method. The thickness of the organic layer is smaller than 10 μm, preferably 0.5 μm or less, or more preferably 0.01 μm or more to 0.5 μm or less.

FIGS. **1** to **5** each show a preferable example of the organic light emitting device of the present invention.

FIG. **1** is a sectional view showing an example of an organic light emitting device according to the present invention. As shown in FIG. **1**, the organic light emitting device has a structure in which an anode **2**, a light emitting layer **3**, and a cathode **4** are provided on a substrate **1** in this order. The electroluminescence device used herein is useful in the case where a compound having hole transporting property, electron transporting property, and light emitting property by itself is used or where compounds having the respective properties are used in a mixture.

FIG. **2** is a sectional view showing another example of the organic light emitting device according to the present invention. As shown in FIG. **2**, the organic light emitting device has a structure in which the anode **2**, a hole transport layer **5**, an electron transport layer **6**, and the cathode **4** are provided on the substrate **1** in this order. This structure is useful in the case where a material having one or both of hole transporting property and electron transporting property is used as a light emitting substance in each layer, and the light emitting substance is used in combination with a non-illuminant hole transporting substance or electron transporting substance. In this case, the light emitting layer is formed of either the hole transport layer **5** or the electron transport layer **6**.

FIG. **3** is a sectional view showing still another example of the organic light emitting device according to the present invention. As shown in FIG. **3**, the organic light emitting device has a structure in which the anode **2**, the hole transport layer **5**, the light emitting layer **3**, the electron transport layer **6**, and the cathode **4** are provided on the substrate **1** in this order. This organic light emitting device has carrier transporting function and light emitting function separately. The device is used in combination with compounds each having hole transporting property, electron transporting property, or light emitting property as appropriate, thereby allowing a substantial increase in freedom of choice in material to be used. Further, various compounds having different emission wavelengths can be used, thereby allowing an increase in variety of luminescent colors. Further, luminous efficiency may be enhanced by efficiently trapping each carrier or exciton in the light emitting layer **3** provided in the middle of the device.

FIG. **4** is a sectional view showing yet another example of the organic light emitting device according to the present invention. FIG. **4** has a structure similar to that shown in FIG. **3** except that a hole-injecting layer **7** is inserted into a side of the anode **2**. The structure is effective for improving adhesiveness between the anode **2** and the hole transport layer **5** or for improving hole-injecting property, which is effective in lowering a voltage to be applied to the device.

FIG. **5** is a sectional view showing still yet another example of the organic light emitting device according to the present invention. FIG. **5** has a structure similar to that shown in FIG. **3** except that a layer (a hole/exciton-blocking layer **8**) for blocking travel of a hole or exciton to a side of the cathode **4** is inserted between the light emitting layer **3** and the electron transport layer **6**. The structure uses a compound having an extremely high ionization potential in the hole/exciton-blocking layer **8** and is effective for enhancing luminous efficiency.

However, FIGS. **1** to **5** each show a basic device structure, and the structure of the organic light emitting device of the present invention is not limited to the structures shown in FIGS. **1** to **5**. For example, the organic light emitting device of the present invention may have any one of various layer structures including: a structure in which an insulating layer is provided at an interface between an electrode and an organic layer; a structure in which an adhesive layer or interference layer is provided; and a structure in which a hole transport layer is composed of two layers with different ionization potentials.

The organic light emitting device of the present invention may be used in any one of the modes shown in FIGS. **1** to **5**.

In particular, an organic layer using the fused heterocyclic aromatic compound of the present invention is useful as a light emitting layer, an electron transport layer, or a hole transport layer. In addition, a layer formed by a vacuum deposition method, a solution coating method, or the like is hardly crystallized and has excellent stability over time.

In the present invention, the fused heterocyclic compound is used particularly as a component of the light emitting layer.

However, a conventionally known additive compound such as a hole transporting compound of a low molecular weight compound or polymer compound, luminescent compound, or electron transporting compound can be used together as required.

Examples of the compounds will be shown below.

A preferred hole-injection transporting material has excellent mobility for facilitating injection of a hole from an anode and for transporting the injected hole to a light emitting layer. Examples of a low molecular weight material or polymer material having hole-injection transporting property include, but of course are not limited to, the following.

A triarylamine derivative, a phenylenediamine derivative, a triazole derivative, an oxadiazole derivative, an imidazole derivative, a pyrazoline derivative, a pyrazolone derivative, an oxazole derivative, a fluorenone derivative, a hydrazone derivative, a stilbene derivative, a phthalocyanine derivative, a porphyrin derivative, poly(vinylcarbazole), poly(silylene), poly(thiophene), and other conductive polymers.

Examples of a material which is mainly involved in a light emitting function to be used in the organic light emitting device of the present invention include, but are not limited to, the following.

A fused aromatic ring compound such as a naphthalene derivative, a phenanthrene derivative, a fluorene derivative, a pyrene derivative, a tetracene derivative, a coronene derivative, a chrysene derivative, a perylene derivative, a 9,10-diphenylanthracene derivative, or rubrene; a quinacridone derivative; an acridone derivative; a coumarin derivative; a pyran derivative; Nile red; a pyrazine derivative; a benzoimidazole derivative; a benzothiazole derivative; a benzoxazole derivative; a stilbene derivative; an organometallic complex such as: an organic aluminum complex such as tris(8-quinolinolato)aluminum; or an organic beryllium complex; and a polymer derivative such as a poly(phenylenevinylene)derivative, a poly(fluorene) derivative, a poly(phenylene) derivative, a poly(thienylenevinylene)derivative, or a poly(acetylene) derivative.

The electron-injection transporting material may be arbitrarily selected from materials which facilitate injection of an electron from a cathode and which have a function of transporting the injected electron into a light emitting layer. The material is selected in consideration of, for example, the balance with the mobility of a carrier of the hole transport material. Examples of a material having electron-injection transporting property include, but of course are not limited to, the following.

An oxadiazole derivative, an oxazole derivative, a thiazole derivative, a thiadiazole derivative, a pyrazine derivative, a triazole derivative, a triazine derivative, a perylene derivative, a quinoline derivative, a quinoxaline derivative, a fluorenone derivative, an anthrone derivative, a phenanthroline derivative, and an organometallic complex.

In the organic light emitting device according to the present invention, a layer containing the compound of the present invention and a layer containing other organic compounds are each formed by the following method. A thin film is generally formed by a vacuum deposition method, an ionized evaporation method, sputtering, plasma, or a known coating method (such as a spin coating, dipping, casting, LB, or inkjet method) in which a compound is dissolved in an appropriate solvent. In film formation by a coating method, in particular, a film may be formed by using a compound in combination with an appropriate binder resin.

The binder resin may be selected from a wide variety of binder resins. Examples of the binder resin include, but of course not limited to, the following.

A polyvinyl carbazole resin, a polycarbonate resin, a polyester resin, a polyarylate resin, a polystyrene resin, an ABS resin, a polybutadiene resin, a polyurethane resin, an acrylic resin, a methacrylic resin, a butyral resin, a polyvinyl acetal resin, a polyamide resin, a polyimide resin, a polyethylene resin, a polyethersulfone resin, a diallyl phthalate resin, a phenol resin, an epoxy resin, a silicone resin, a polysulfone resin, and a urea resin.

These resins may be used alone or in a mixture of two or more kinds thereof as a homopolymer or copolymer. Further, an additive such as a known plasticizer, antioxidant, or ultraviolet absorber may be used in combination as required.

An anode material preferably has as large a work function as possible, and examples thereof include: a metal element such as gold, platinum, silver, copper, nickel, palladium, cobalt, selenium, vanadium, or tungsten; an alloy thereof; and a metal oxide such as tin oxide, zinc oxide, indium oxide, indium tin oxide (ITO), or indium zinc oxide. Further, a conductive polymer such as polyaniline, polypyrrole, polythiophene, or polyphenylene sulfide may also be used. Each of those electrode materials may be used alone, or two or more kinds thereof may be used in combination. Further, the anode may have a single layer structure or a multilayer structure.

Meanwhile, a cathode material preferably has a small work function, and examples thereof include: a metal element such as lithium, sodium, potassium, calcium, magnesium, aluminum, indium, ruthenium, titanium, manganese, yttrium, silver, lead, tin, or chromium; and an alloy thereof such as a lithium-indium alloy, a sodium-potassium alloy, a magnesium-silver alloy, an aluminum-lithium alloy, an aluminum-magnesium alloy, or a magnesium-indium alloy. A metal oxide such as indium tin oxide (ITO) may also be used. Each of those electrode materials may be used alone, or two or more kinds thereof may be used in combination. Further, the cathode may have a single layer structure or a multilayer structure.

The substrate to be used in the present invention is not particularly limited, but examples thereof include: an opaque substrate such as a metallic substrate or a ceramics substrate; and a transparent substrate such as a glass substrate, a quartz substrate, or a plastic sheet substrate. In addition, a color filter film, a fluorescent color converting filter film, a dielectric reflection film, or the like may be used in the substrate for controlling luminescent color.

Further, a protective layer or a sealing layer may be formed on the produced device to prevent contact between the device and oxygen, moisture, or the like. Examples of the protective layer include: a diamond thin film; a film formed of an inorganic material such as metal oxide or metal nitride; a polymer film formed of a fluorine resin, polyparaxylene, polyethylene, a silicone resin, or a polystyrene resin; and a photo-curable resin. Further, the device itself may be covered with glass, a gas impermeable film, a metal, or the like and packaged with an appropriate sealing resin.

A thin film transistor (TFT) may be produced on a substrate, and then the device of the present invention may be produced to be connected to TFT.

Regarding the emission direction of a device, the device may have a bottom emission structure (structure in which light is emitted from a substrate side) or a top emission structure (structure in which light is emitted from an opposite side of the substrate).

EXAMPLES

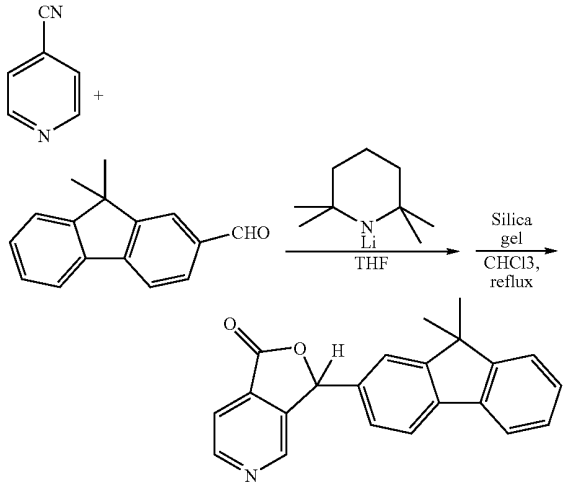
Hereinafter, the present invention will be described more specifically by way of examples, but the present invention is not limited to the examples.

Example 1

Method of Producing Exemplified Compound No. 1308

Exemplified Compound 1308 of the present invention can be produced by, for example, such method as described below.

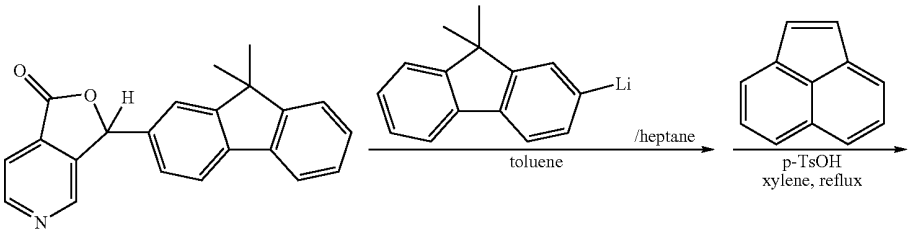
(1) Synthesis of Intermediate Compound 1: 3-(9,9-dimethyl-9H-fluore-2-yl)-furo[3,4-c]-pyridine-1-(3H)-one



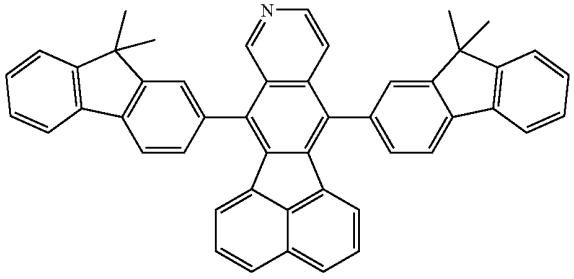
Intermediate Compound 1

Under a nitrogen atmosphere, 4.35 g (30.8 mmol) of 2,2,6,6-tetramethylpiperidine was dissolved in tetrahydrofuran (60 ml) as a solvent, and the solution was cooled to −30° C. After that, 17.5 mL (1.6-mol/L solution, 28.0 mmol) of normal butyllithium was slowly dropped to the solution. After the dropping, the mixture was heated to 0° C., and was stirred for 15 minutes. After that, the mixture was cooled to −70° C. A solution (30 ml) of 1.46 g (14.0 mmol) of isonicotinonitrile in tetrahydrofuran was dropped over 15 minutes to the mixture at −70° C. After the mixture had been stirred at −70° C. for an additional 30 minutes, a solution (15 ml) of 6.24 g (28.1 mmol) of 9,9-dimethyl-9H-fluorene-2-carbaldehyde in tetrahydrofuran was dropped over 10 minutes to the mixture. After having been stirred at −70° C. for an additional 30 minutes, the mixture was slowly heated to 0° C., and water was added to the mixture to stop the reaction. Chloroform was added to the mixture to separate an organic layer, and the layer was washed with water four times. After that, the solvent was removed by distillation, and chloroform (50 ml) and 10 g of silica gel were added to the resultant residue. The mixture was stirred under heat and reflux for 3 hours. After the mixture had been cooled to room temperature, the solvent was removed by distillation again. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=2:1), whereby 2.41 g of Intermediate Compound 1 was obtained.

(2) Synthesis of Exemplified Compound 1308



Intermediate Compound 1



Exemplified Compound 1308

Under a nitrogen atmosphere, 2.94 g (9.19 mmol) of 2-iodo-9,9-dimethyl-9H-fluorene was dissolved in heptane (88 mL), and the solution was cooled to −30° C. After that, 5.7 mL (1.6-mol/L solution, 9.12 mmol) of normal butyllithium was slowly dropped to the solution. After having been stirred at −30° C. for 30 minutes, the mixture was heated to 0° C., and was stirred for 10 minutes. After that, the mixture was cooled to −50° C. A solution (90 mL) of Intermediate Compound 1 (1.48 g, 4.52 mmol) in toluene was dropped to the mixture at −50° C., and the whole was slowly heated to 0° C. After water had been added to the resultant at 0° C. to stop the reaction, 5 mL of acetic acid was added to the resultant. Toluene was added to the resultant to separate an organic layer, and the layer was washed with water twice. After that, the solvent was removed by distillation. Xylene (45 mL) was added to the resultant residue, and then 1.39 g (9.13 mmol) of acenaphthylene and 1.75 g (9.20 mmol) of p-toluenesulfonic monohydrate were added to the residue. Then, the mixture was stirred under heat and reflux for 8 hours. After the mixture had been cooled to room temperature, water was added to the mixture to stop the reaction. Sodium carbonate was added to the mixture, and the whole was repeatedly extracted with chloroform twice, whereby an organic layer was separated. After the organic layer had been washed with water twice, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene: ethyl acetate=30:1), whereby 0.38 g of Exemplified Compound 1308 was obtained.

A mass spectrometer manufactured by Waters Corporation was used to identify 636.3 as the M^+ of the compound.

Further, NMR measurement identified the structure of the compound (FIG. **6**).

The PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1308 in toluene was measured. As a result, a blue light emission spectrum having a light emission peak at 435 nm, a half width of 62 nm, and an excellent color purity was shown (FIG. **13**).

The following exemplified compound can be synthesized in the same manner as in Example 1 except that the following compound is used instead of 2-iodo-9,9-dimethyl-9H-fluorene in Example 1.

(Exemplified Compound No. 1404): 1-bromo-pyrene

Further, the following exemplified compounds can be synthesized in the same manner as in Example 1 except that the following respective compounds are used instead of 2-iodo-9,9-dimethyl-9H-fluorene and 9,9-dimethyl-9H-fluorene-2-carbaldehyde in Example 1.

(Exemplified Compound No. 1410): 1-bromo-pyrene, pyrene-1-carbaldehyde

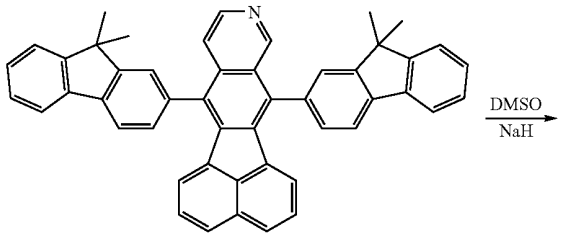
(Exemplified Compound No. 1425): 3-bromo-fluoranthene, fluoranthene-3-carbaldehyde

(Exemplified Compound No. 1322): 4-bromo-2-tert-butyl-9,9-dimethyl-9H-fluorene, 2-tert-butyl-9,9-dimethyl-9H-fluorene-4-carbaldehyde

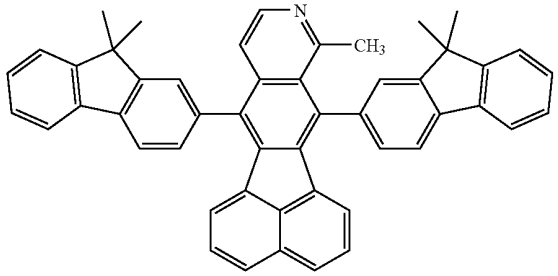
Further, Exemplified Compound No. 2511 can be synthesized in the same manner as in Example 1 except that picolinic acid is used instead of isonicotinonitrile in Example 1.

Example 2

Method of Producing Exemplified Compound No. 1309



Exemplified Compound 1308



Exemplified Compound 1309

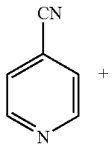
Exemplified Compound No. 1309 can be synthesized by using Exemplified Compound No. 1308 as a starting material in accordance with a method described in J. Org. Chem. 31, 248 (1966). A specific method for the synthesis will be described below.

Under a nitrogen atmosphere, a suspension of sodium hydride in dimethyl sulfoxide is heated to 70° C., and a solution of Exemplified Compound No. 1308 in dimethyl sulfoxide is dropped to the suspension of sodium hydride. After having been stirred at 70° C. for 4 hours, the mixture is cooled to room temperature, and water is added to the mixture to stop the reaction. The mixture is repeatedly extracted with chloroform twice, whereby an organic layer is separated. The solvent is removed by distillation. The resultant residue is purified by silica gel column chromatography (toluene/ethyl acetate-based), whereby Exemplified Compound 1309 can be obtained.

Example 3

Method of Producing Exemplified Compound No. 1303

(1) Synthesis of Intermediate Compound 3: 3-phenylfuro[3,4-c]-pyridine-1-(3H)-one



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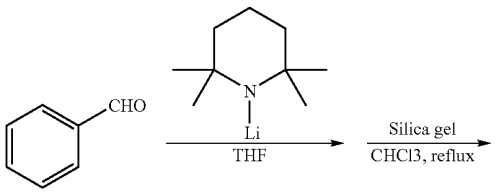
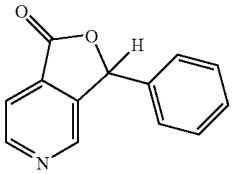
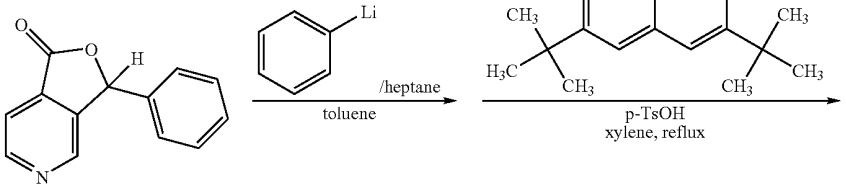




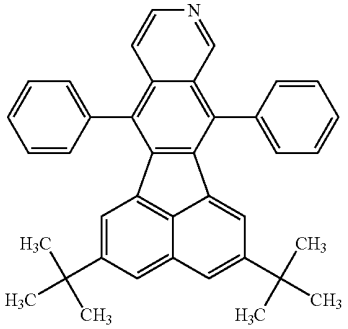
Intermediate Compound 3

Under a nitrogen atmosphere, 14.35 g (105.5 mmol) of 2,2,6,6-tetramethylpiperidine was dissolved in tetrahydrofuran (200 ml) as a solvent, and the solution was cooled to −30° C. After that, 60 mL (1.6-mol/L solution, 96.1 mmol) of normal butyllithium was slowly dropped to the solution. After the dropping, the mixture was heated to 0° C., and was stirred for 15 minutes. After that, the mixture was cooled to −70° C. A solution (100 ml) of 5.00 g (48.0 mmol) of isonicotinonitrile in tetrahydrofuran was dropped over 15 minutes to the mixture at −70° C. After the mixture had been stirred at −70° C. for an additional 30 minutes, a solution (50 ml) of 10.2 g (96.1 mmol) of benzaldehyde in tetrahydrofuran was dropped over 5 minutes to the mixture. After having been stirred at −70° C. for an additional 30 minutes, the mixture was slowly heated to 0° C., and water was added to the mixture to stop the reaction. Chloroform was added to the mixture to separate an organic layer, and the layer was washed with water four times. After that, the solvent was removed by distillation, and chloroform (50 ml) and 35 g of silica gel were added to the resultant residue. The mixture was stirred under heat and reflux for 6 hours, and then stirred under heat and reflux for 3 hours with addition of acetic acid. After the mixture had been cooled to room temperature, the solvent was removed by distillation again. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=8:1), whereby 2.06 g of Intermediate Compound 3 were obtained.

(2) Synthesis of Exemplified Compound 1303



Intermediate Compound 3



Exemplified Compound 1303

Under a nitrogen atmosphere, 6.3 mL (1.04-mol/L solution, 6.55 mmol) of phenyllithium was dropped to 30 mL of heptane, and the solution was cooled to −50° C. A solution (55 mL) of Intermediate Compound 3 (1.00 g, 4.73 mmol) in toluene was dropped to the mixture at −50° C., and the whole was slowly heated to 0° C. Water was added to the resultant at 0° C. to stop the reaction, and then 5 mL of acetic acid was added to the resultant. The resultant solid product was filtrated and washed with heptane.

Subsequently, the resultant solid product was dissolved in 30 mL of xylene. 2.70 g (14.19 mmol) of p-toluenesulfonic monohydrate and 3.11 g (11.76 mmol) of 4,7-di-t-butylacenaphthylene were added to the solution, and the whole was stirred under heat and reflux for 26 hours. After the resultant had been cooled to room temperature, water was added to the resultant to stop the reaction. Sodium carbonate was added to the resultant, and the whole was repeatedly extracted with chloroform twice, whereby an organic layer was separated. After the organic layer had been washed with water twice, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=20:1), whereby 0.37 g of Exemplified Compound 1303 was obtained.

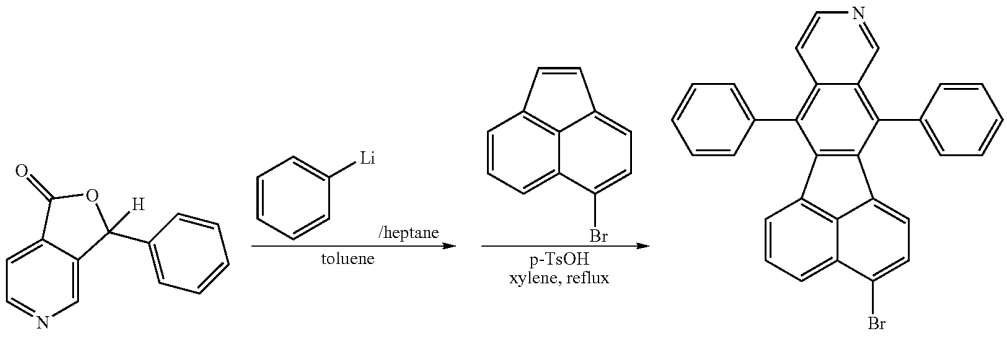
It should be noted that NMR measurement identified the structure of the compound (FIG. **7**).

The PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1303 in toluene was measured. As a result, a blue light emission spectrum having a light emission peak at 422 nm, a half width of 58 nm, and an excellent color purity was shown (FIG. **14**).

Example 4

Method of Producing Exemplified Compound No. 1536

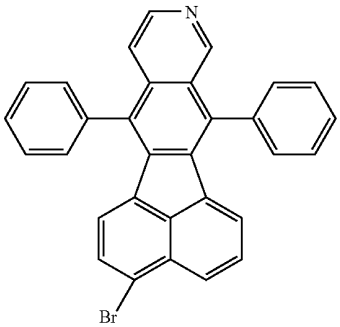
(1) Synthesis of Intermediate Compound 4: 4-bromo-7,12-diphenylacenaphtho[1,2-g]isoquinoline and Intermediate Compound 5: 3-bromo-7,12-diphenylacenaphtho[1,2-g]isoquinoline



Intermediate Compound 3

Intermediate Compound 4

+



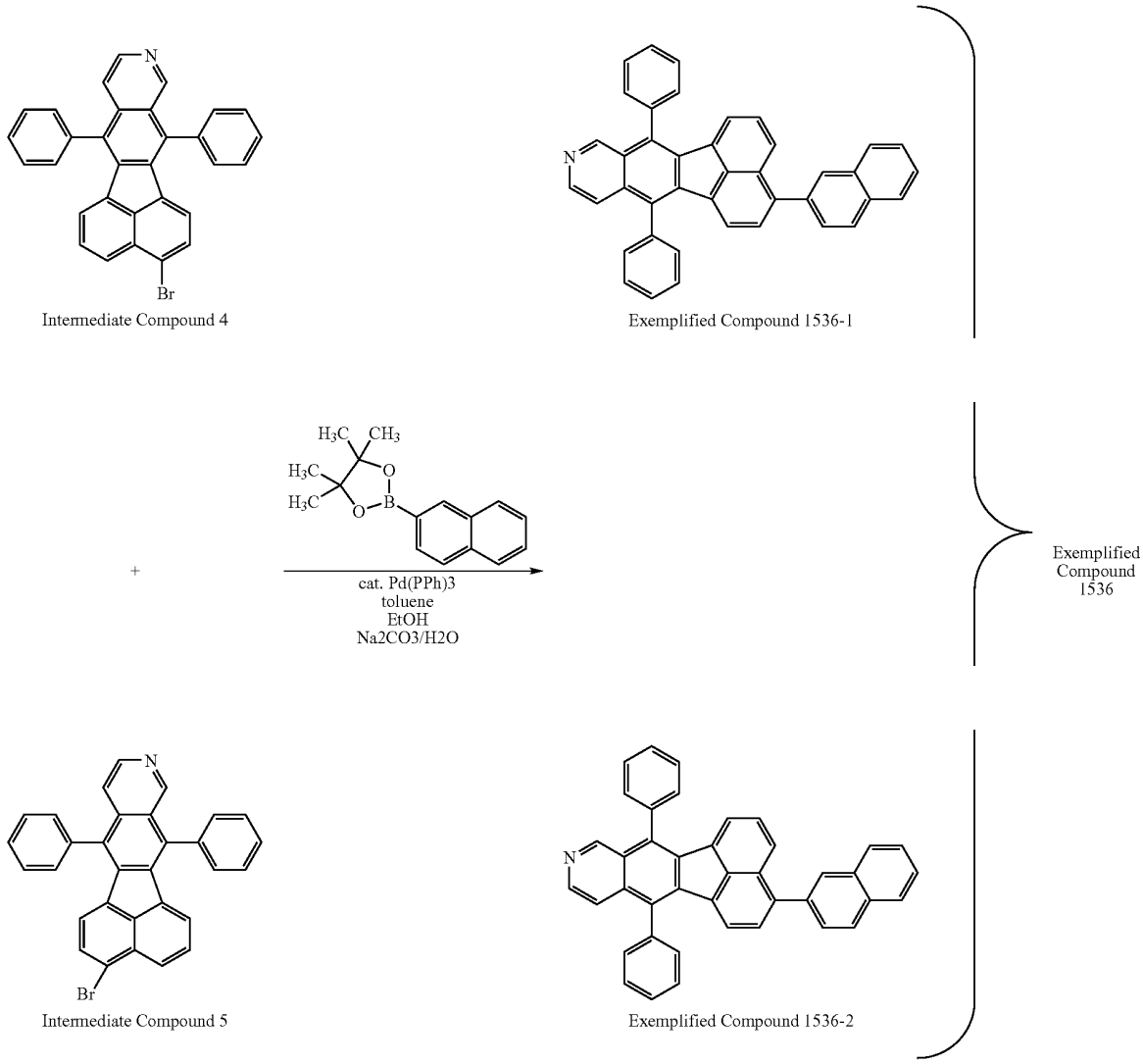
Intermediate Compound 5

Under a nitrogen atmosphere, 6.3 mL (1.04-mol/L solution, 6.55 mmol) of phenyllithium was dropped to 30 mL of heptane, and the solution was cooled to −50° C. A solution (55 mL) of Intermediate Compound 3 (0.925 g, 4.52 mmol) in toluene was dropped to the mixture at −50° C., and the whole was slowly heated to 0° C. Water was added to the resultant at 0° C. to stop the reaction, and then 5 mL of acetic acid was added to the resultant. The resultant solid product was filtrated and washed with heptane.

Subsequently, the resultant solid product was dissolved in 90 mL of xylene. 4.83 g (25.39 mmol) of p-toluenesulfonic monohydrate and 2.55 g (11.04 mmol) of 5-bromoacenaphthylene were added to the solution, and the whole was stirred under heat and reflux for 30 hours. After the resultant had been cooled to room temperature, water was added to the resultant to stop the reaction. Sodium carbonate was added to the resultant, and the whole was repeatedly extracted with chloroform twice, whereby an organic layer was separated. After the organic layer had been washed with water twice, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=20:1), whereby 0.43 g of the mixture of Intermediate Compounds 4 and 5 (Intermediate Compound 4 Intermediate Compound 5=1:1) was obtained.

It should be noted that NMR measurement identified the structure of the compound (FIG. **8**).

(2) Synthesis of Exemplified Compound No. 1536



Under a nitrogen atmosphere, 0.30 g (0.62 mmol) of the mixture of Intermediate Compounds 4 and 5, 0.11 g (0.62 mmol) of 4,4,5,5-tetramethyl-2-(naphthalen-2-yl)-1,3,2-dioxaborolane, and 0.04 g (0.03 mmol) of tetrakistriphenylphosphinepalladium were suspended in the mixed solvent of 15 mL of toluene, 8 mL of ethanol, and 6 mL of a 10% aqueous solution of sodium carbonate. The resultant solution was stirred under heat and reflux for 1 hour, and the disappearance of Intermediate Compounds 4 and 5 was observed. After that, the resultant was cooled to room temperature, and water was added to the resultant to stop the reaction. An organic layer was separated, and was then washed with water twice. After that, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=10:1), whereby 0.192 g of the mixture of Exemplified Compounds 1536 containing Exemplified Compounds 1536-1 and 1536-2 at a composition ratio of 1:1 was obtained.

Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) identified 531.9 as the M^+ of the compound.

Further, NMR measurement identified the structure of the compound (FIG. **9**).

The PL spectrum of a solution (1.0×10^{-5} mol/t) of Exemplified Compound 1536 in toluene was measured. As a result, a blue light emission spectrum having a light emission peak at 439 nm, a half width of 59 nm, and an excellent color purity was shown (FIG. **15**).

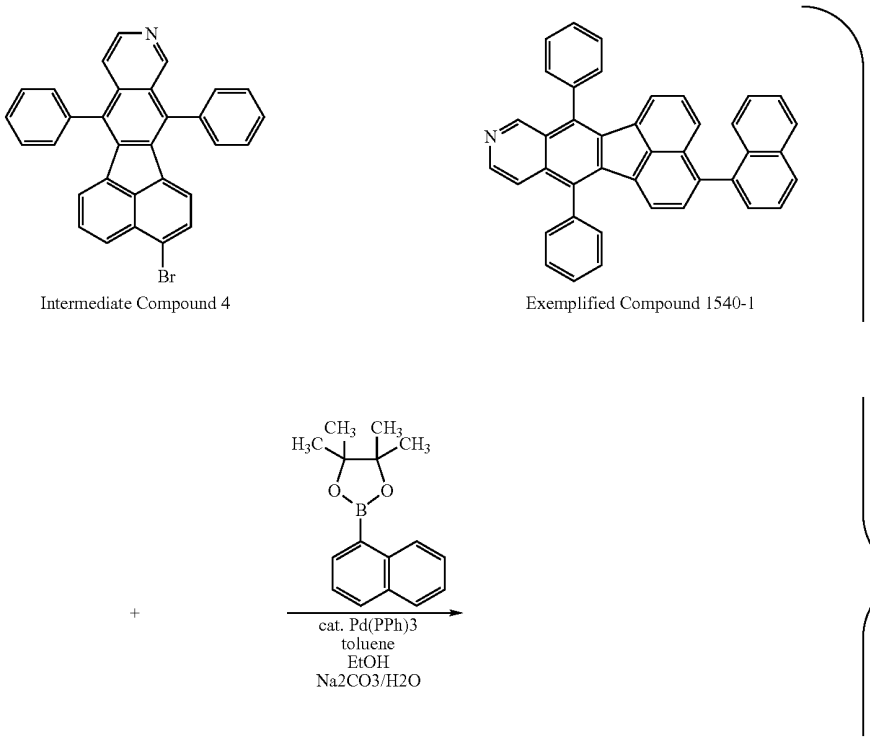
In addition, Exemplified Compound 2611 can be synthesized in the same manner as in Example 4 except that: picolinic acid is used instead of isonicotinonitrile in Example 4; and 2-(7,12-diphenylbenzo[k]-fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane is used instead of 4,4,5,5-tetramethyl-2-(naphthalen-2-yl)-1,3,2-dioxaborolane in Example 4.

In addition, Exemplified Compound No. 3101 can be synthesized in the same manner as in Example 4 except that: pyrimidine-4-carboxylic acid is used instead of isonicotinonitrile in Example 4; and 2-(fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane is used instead of 4,4,5,5-tetramethyl-2-(naphthalen-2-yl)-1,3,2-dioxaborolane in Example 4.

In addition, Exemplified Compound 3109 can be synthesized in the same manner as in Example 4 except that: pyrimidine-4-carboxylic acid is used instead of isonicotinonitrile in Example 4; and 2-(7,12-diphenylbenzo[k]-fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane is used instead of 4,4,5,5-tetramethyl-2-(naphthalen-2-yl)-1,3,2-dioxaborolane in Example 4.

Example 5

Method of Producing Exemplified Compound No. 1540



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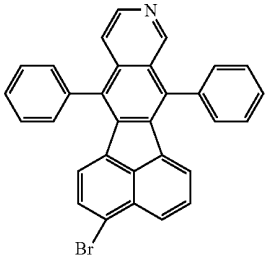
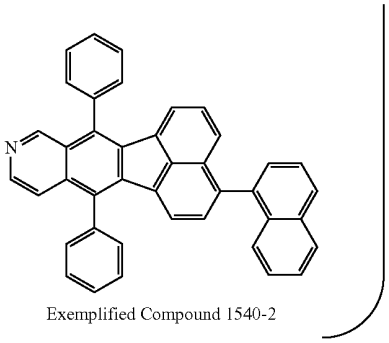


Intermediate Compound 5



Exemplified Compound 1540-2

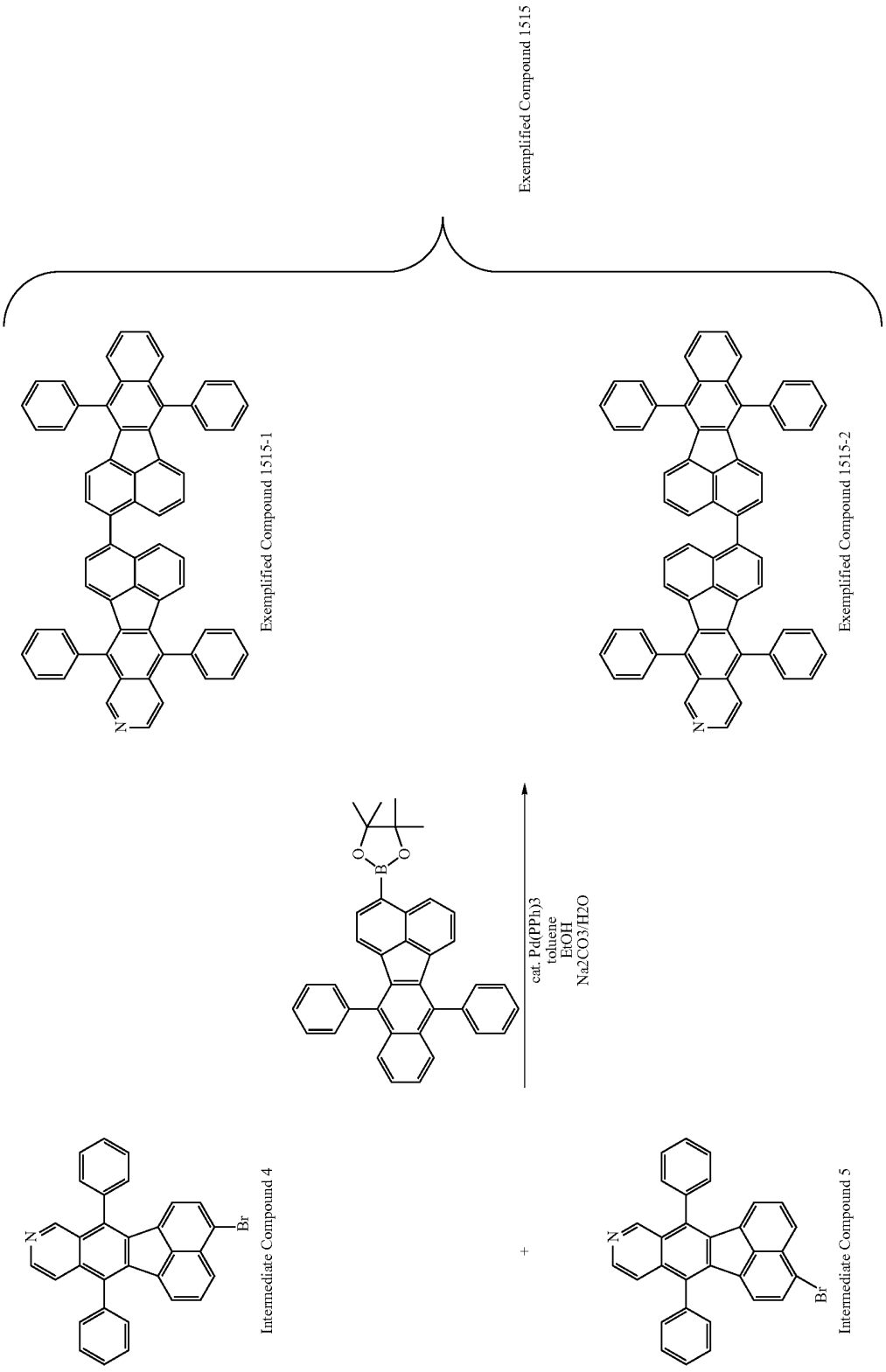
Under a nitrogen atmosphere, 0.50 g (1.03 mmol) of the mixture of Intermediate Compounds 4 and 5, 0.19 g (1.10 mmol) of 4,4,5,5-tetramethyl-2-(naphthalen-1-yl)-1,3,2-dioxaborolane, and 0.06 g (0.05 mmol) of tetrakistriphenylphosphinepalladium were suspended in a mixed solvent of 25 mL of toluene, 13 mL of ethanol, and 10 mL of a 10% aqueous solution of sodium carbonate. The resultant solution was stirred under heat and reflux for 2 hours, and the disappearance of Intermediate Compounds 4 and 5 was observed. After that, the resultant was cooled to room temperature, and water was added to the resultant to stop the reaction. An organic layer was separated, and was then washed with water twice. After that, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=10:1), whereby 0.476 g of the mixture of Exemplified Compounds 1540 containing Exemplified Compounds 1540-1 and 1540-2 at a composition ratio of 1:1 was obtained.

NMR measurement identified the structure of the compound (FIG. **10**).

The PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1540 in toluene was measured. As a result, a blue light emission spectrum having a light emission peak at 434 nm, a half width of 62 nm, and an excellent color purity was shown (FIG. **16**).

Example 6

Method of Producing Exemplified Compound No. 1515


Exemplified Compound 1515
Exemplified Compound 1515-1
Exemplified Compound 1515-2
cat. Pd(PPh)3
toluene
EtOH
Na2CO3/H2O
Intermediate Compound 4
Intermediate Compound 5
Br
Br
N
N
O
O
B

Under a nitrogen atmosphere, 0.30 g (0.62 mmol) of the mixture of Intermediate Compounds 4 and 5, 0.34 g (0.64 mmol) of 2-(7,12-diphenylbenzo[k]-fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane, and 0.04 g (0.03 mmol) of tetrakistriphenylphosphinepalladium were suspended in a mixed solvent of 15 mL of toluene, 8 mL of ethanol, and 6 mL of a 10% aqueous solution of sodium carbonate. The resultant solution was stirred under heat and reflux for 2 hours, and the disappearance of Intermediate Compounds 4 and 5 was observed. After that, the resultant was cooled to room temperature, and water was added to the resultant to stop the reaction. An organic layer was separated, and was then washed with water twice. After that, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene:ethyl acetate=10:1), whereby 0.372 g of the mixture of Exemplified Compounds 1515 containing Exemplified Compounds 1515-1 and 1515-2 at a composition ratio of 1:1 was obtained.

Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) identified 807.85 as the M^+ of the compound.

Further, NMR measurement identified the structure of the compound (FIG. **11**).

The PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1515 in toluene was measured. As a result, a blue light emission spectrum having a light emission peak at 461 nm, a half width of 58 nm, and an excellent color purity was shown (FIG. **17**).

In addition, each of the following exemplified compounds can be synthesized in the same manner as in Example 6 except that any one of the following compounds is used instead of 2-(7,12-diphenylbenzo[k]-fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane in Example 6.

(Exemplified Compound 1501): 2-(fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane

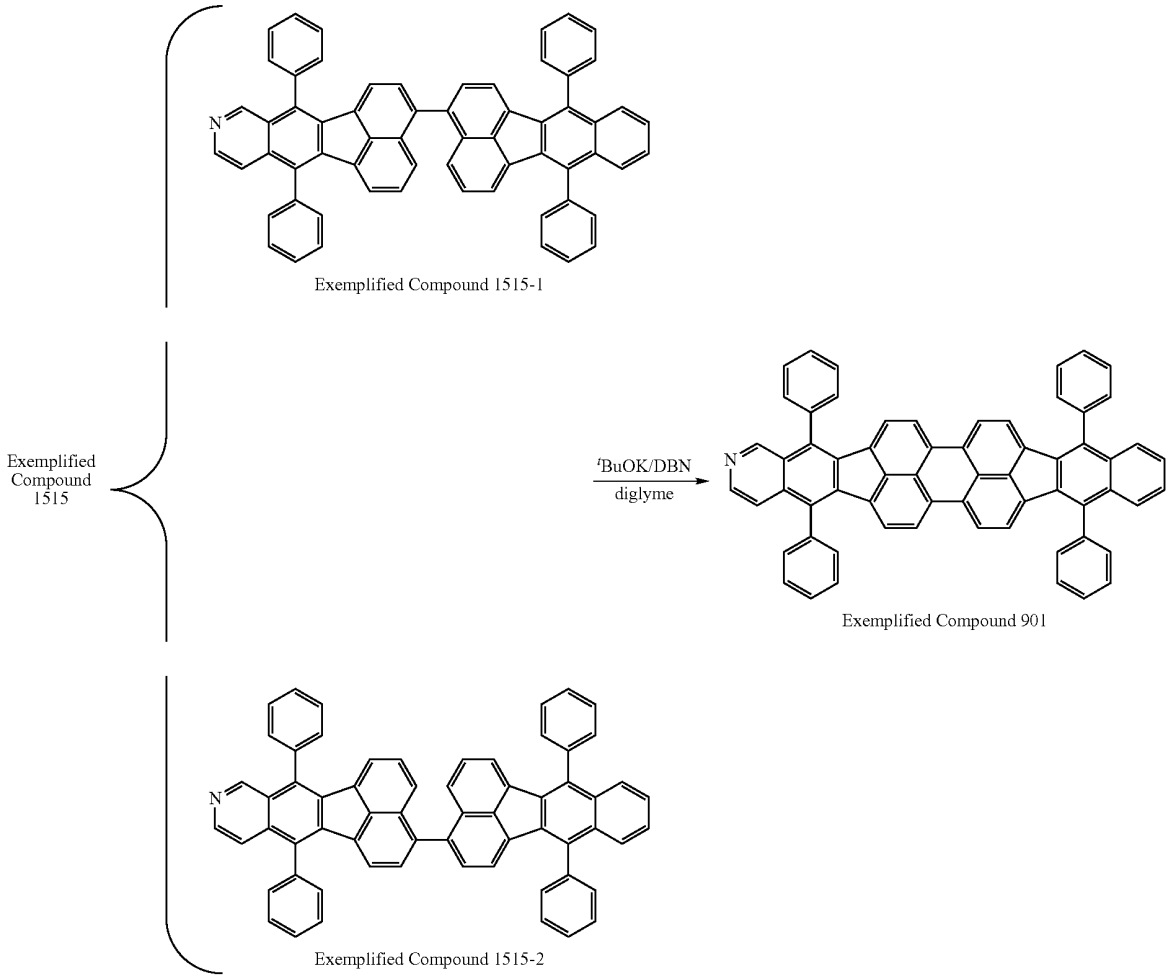
(Exemplified Compound 1529): 7,12-diphenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolane-2-yl)-acenaphtho[1,2-g]isoquinoline

(Exemplified Compound 1534): 4,4,5,5-tetramethyl-2-(pyren-1-yl)-1,3,2-dioxaborolane)

(Exemplified Compound 1517): 2-(7,12-bis(2,7-di-tert-butyl-9,9-dimethyl-9H-fluoren-4-yl)benzo[k]fluoranthen-3-yl)-4,4,5,5,tetramethyl-1,3,2-dioxaborolane

Example 7

Method of Producing Exemplified Compound No. 1901



In accordance with a method described in J. Org. Chem. 66, 94 (2001), under a nitrogen atmosphere, 3.03 g (27 mmol) of t-butoxypotassium and 4.47 g (36 mmol) of DBN were added to 9 mL of diglyme, and the whole was stirred under heat and reflux for 1 hour. After that, 0.13 g (1.23 mmol) of Exemplified Compound 1515 was added in one stroke to the resultant, and the whole was stirred under heat and reflux for an additional 2 hours. After having been cooled to room temperature, the resultant was cooled in an ice bath to 5° C., and then water and chloroform were sequentially added to the resultant. An organic layer was separated, and was then washed with a saturated aqueous solution of ammonium chloride twice. After that, the organic layer was additionally washed with water twice, and the solvent was removed by distillation. The resultant residue was purified by alumina column chromatography (toluene ethyl acetate=5:1), whereby 0.80 g of Exemplified Compound 1901 was obtained.

Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) identified 805.31 as the M^+ of the compound.

Further, NMR measurement identified the structure of the compound (FIG. **12**).

The PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1901 in toluene was measured. As a result, a red light emission spectrum having a light emission peak at 597 nm, a half width of 21 nm, and an excellent color purity was shown (FIG. **8**).

In addition, the following exemplified compounds can be synthesized in the same manner as in Example 7 except that any one of the following compounds is used instead of Exemplified Compound 1515 in Example 7.

(Exemplified Compound 1701): Exemplified Compound 1501

(Exemplified Compound 1927): Exemplified Compound 1517

(Exemplified Compound 2301): Exemplified Compound 1529

(Exemplified Compound 2321): Exemplified Compound 1308

(Exemplified Compound 2701): Exemplified Compound 2601

(Exemplified Compound 2801): Exemplified Compound 2611

(Exemplified Compound 2919): Exemplified Compound 2511

(Exemplified Compound 3201): Exemplified Compound 3101

(Exemplified Compound 3301): Exemplified Compound 3109

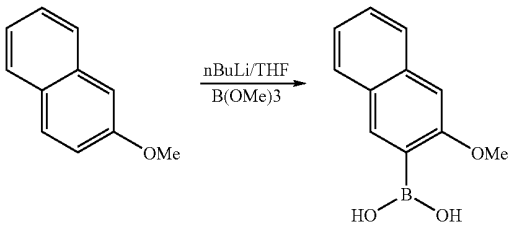
(Exemplified Compound 3413): Exemplified Compound 3008

Example 8

Method of Producing Exemplified Compound No. 3512

Exemplified Compound 3512 of the present invention can be produced by, for example, such method as described below.

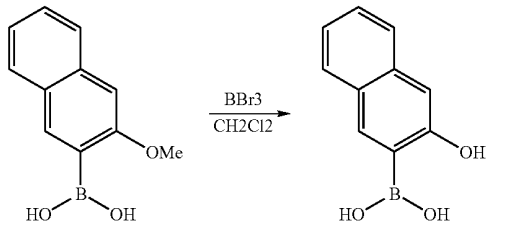
(1) Synthesis of Intermediate Compound 6: 3-methoxynaphthalen-2-ylboronic acid



Intermediate Compound 6

Under a nitrogen atmosphere, 15.0 g (94.9 mmol) of 2-methoxynaphthalene was dissolved in tetrahydrofuran (300 ml), and the solution was cooled to 0° C. After that, 238 mL (1.6-mol/L solution, 190 mmol) of normal butyllithium were slowly dropped to the solution. After the dropping, the mixture was stirred at 0° C. for 2 hours. After that, the mixture was cooled to −10° C., and 33 mL (340 mmol) of trimethyl borate was dropped over 10 minutes to the mixture. The resultant was heated to room temperature, and was stirred overnight. After that, 0.2N hydrochloric acid was added to the resultant to stop the reaction. Chloroform was added to the resultant to separate an organic layer, and the layer was washed with a saturated aqueous solution of ammonium chloride once and with water four times. After that, the solvent was removed by distillation, and heptane and toluene were added to the resultant residue to purify the residue by recrystallization, whereby 4.81 g of Intermediate Compound 6 were obtained.

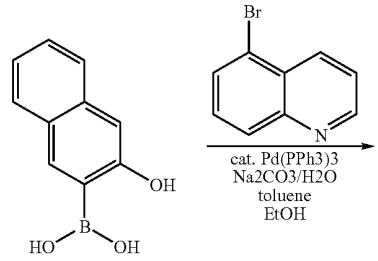
(2) Synthesis of Intermediate Compound 7: 3-hydroxynaphthalen-2-ylboronic acid



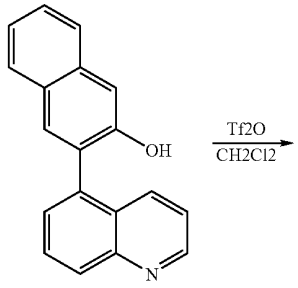
Intermediate Compound 6 Intermediate Compound 7

Under a nitrogen atmosphere, 4.81 g (23.8 mmol) of Intermediate Compound 6 were dissolved in methylene chloride (96 ml), and the solution was cooled to 0° C. After that, 71 mL of a solution of tribromoborate in methylene chloride (1.0-mol/L solution, 71 mmol) were dropped over 15 minutes to the solution. After the dropping, the mixture was heated to room temperature, and was stirred for 5 hours. After that, the reaction solution was transferred to water so that the reaction was stopped. Chloroform was added to the resultant to separate an organic layer, and the layer was washed with water three times. After that, the solvent was removed by distillation, and methanol and heptane were added to the resultant residue to precipitate a crystal. After that, the crystal was filtrated, whereby 3.96 g of Intermediate Compound 7 were obtained.

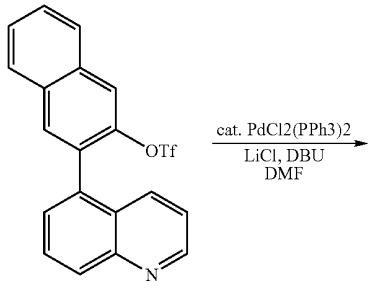
(3) Synthesis route from Intermediate Compound 7 to Exemplified Compound 3512



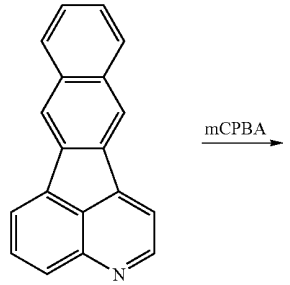
Intermediate Compound 7



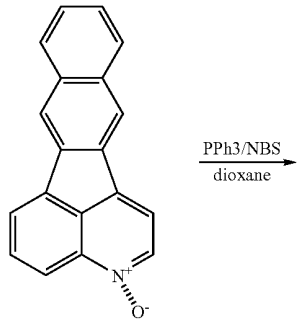
Intermediate Compound 8



Intermediate Compound 9



Intermediate Compound 10



Intermediate Compound 11

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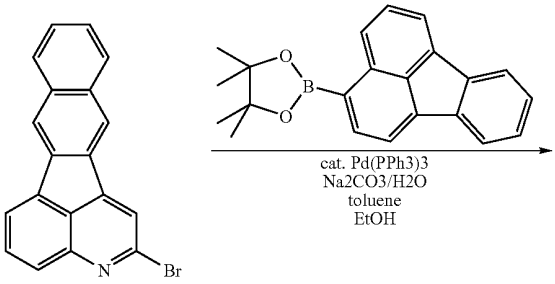
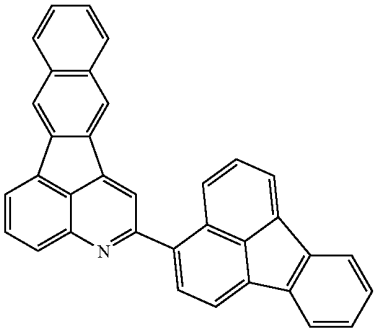


Intermediate Compound 12



Exemplified Compound 3512

Exemplified Compound 3512 can be synthesized by using Intermediate Compound 7 as a starting material by the above synthesis route through six steps of reactions.

In addition, Exemplified Compound No. 3509 can be synthesized in the same manner as in Example 8 except that 4,4,5,5-tetramethyl-2-(pyren-1-yl)-1,3,2-dioxaborolane is used instead of 2-(fluoranthen-3-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane in Example 8.

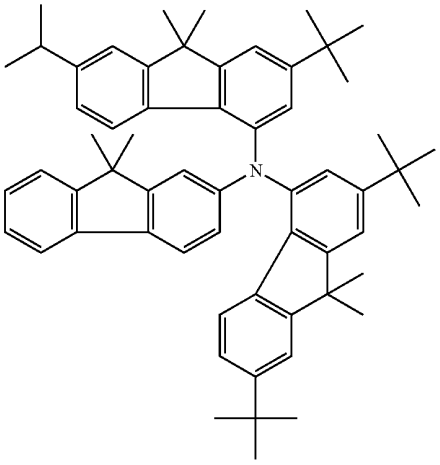
Example 9

An organic light emitting device having a structure shown in FIG. **3** was produced by the following method.

Indium tin oxide (ITO) was formed into a film having a thickness of 120 nm by a sputtering method on a glass substrate as the substrate **1** so as to serve as the anode **2**, and the resultant was used as a transparent, conductive supporting substrate. The substrate was subjected to ultrasonic cleaning with acetone and isopropyl alcohol (IPA) sequentially. Next, the substrate was washed with pure water and dried. Further, the substrate was subjected to UV/ozone cleaning, and the resultant was used as a transparent, conductive supporting substrate.

A chloroform solution having a concentration of 0.1 wt % was prepared by using Compound 13 represented by the following structural formula as a hole transporting material.

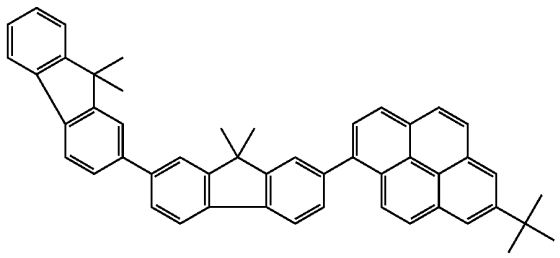
Compound 13



The solution was dropped onto the above ITO electrode, and the whole was subjected to spin coating initially at 500 RPM for 10 seconds and then at 1,000 RPM for 40 seconds, whereby a film was formed. After that, the resultant was dried in a vacuum oven at 80° C. for 10 minutes so that the solvent in the thin film was completely removed. As a result, the hole transporting layer **5** was formed.

Next, Exemplified Compound 1308 shown above and Compound 14 having a structure represented by the following structural formula were co-deposited from the vapor at a weight ratio of 5:95 onto the hole transporting layer **5**, whereby the light emitting layer **3** having a thickness of 30 nm was provided. The layer was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.1 nm/sec or more to 0.2 nm/sec or less.

Compound 14



Further, 2,9-bis[2-(9,9-dimethylfluorenyl)]-1,10-phenanthroline was formed into a film having a thickness of 30 nm by a vacuum vapor deposition method to serve as the electron transporting layer **6**. The layer was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.1 nm/sec or more to 0.2 nm/sec or less.

Next, lithium fluoride (LiF) was formed into a film having a thickness of 0.5 nm by a vacuum vapor deposition method on the foregoing organic layer. Further, an aluminum film having a thickness of 100 nm was provided by a vacuum vapor deposition method to serve as an electron injecting electrode (cathode **4**), whereby an organic light emitting device was produced. The lithium fluoride film was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.01 nm/sec. The aluminum film was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.5 nm/sec or more to 1.0 nm/sec or less.

The resultant organic EL device was covered with a protective glass plate in a dry air atmosphere and sealed with an acrylic resin-based adhesive in order that the device might not deteriorate owing to the adsorption of moisture.

A voltage of 4 V was applied to the device thus obtained with the ITO electrode (anode **2**) defined as a positive electrode and the Al electrode (cathode **4**) defined as a negative electrode. As a result, the device was observed to emit blue light with a luminous efficiency of 2.0 lm/W. In addition, the device was observed to emit blue light having CIE chromaticity coordinates (x, y) of (0.15, 0.10) and a good color purity.

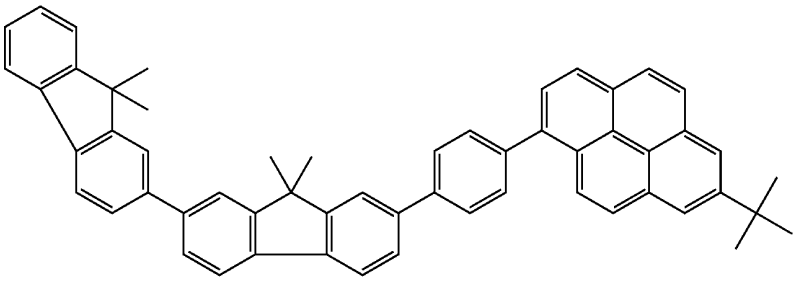
Further, a voltage was applied to the device for 100 hours under a nitrogen atmosphere with a current density kept at 30 mA/cm^2. As a result, the initial luminance of the device, that is, 690 cd/m^2 reduced to 563 cd/m^2 in 100 hours. This means that luminance deterioration was small.

It should be noted that the energy gap of each of Exemplified Compound 1308 and Compound 14 was determined by optical absorption measurement with a UV measuring device U-3010 manufactured by Hitachi, Ltd. A dilute solution of Exemplified Compound 1308 showed an optical absorption end at 426 nm. The energy gap of the compound was calculated to be 2.91 eV from the foregoing. A spin-coated film of Compound 14 showed an optical absorption end at 417 nm. The energy gap of the compound was calculated to be 2.97 eV from the foregoing.

Example 10

A device was produced in the same manner as in Example 9 except that Compound 15 having a structure represented by the following formula was used instead of Compound 14 in Example 9.

Compound 15



The device of this example was observed to emit blue light with a luminous efficiency of 2.2 lm/W at an applied voltage of 4 V. In addition, the device was observed to emit blue light having CIE chromaticity coordinates (x, y) of (0.15, 0.10) and a good color purity.

Further, a voltage was applied to the device for 100 hours under a nitrogen atmosphere with a current density kept at 30 mA/cm^2. As a result, the initial luminance of the device, that is, 931 cd/m^2 reduced to 690 cd/m^2 in 100 hours. This means that luminance deterioration was small.

It should be noted that the energy gap of Compound 15 was determined by optical absorption measurement with a UV measuring device U-3010 manufactured by Hitachi, Ltd. A spin-coated film of Compound 15 showed an optical absorption end at 405 nm. The energy gap of the compound was calculated to be 3.06 eV from the foregoing.

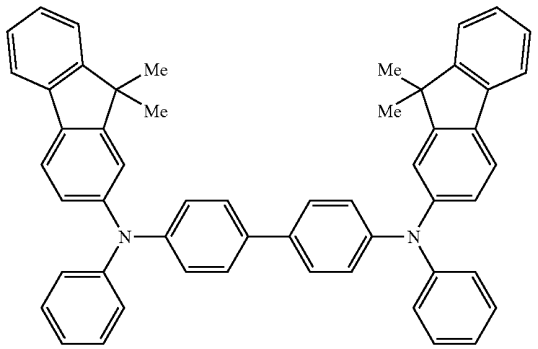
Example 11

An organic light emitting device having a structure shown in FIG. **4** was produced by the following method.

Indium tin oxide (ITO) was formed into a film having a thickness of 120 nm by a sputtering method on a glass substrate as the substrate **1** so as to serve as the anode **2**, and the resultant was used as a transparent, conductive supporting substrate. The substrate was subjected to ultrasonic cleaning with acetone and isopropyl alcohol (IPA) sequentially. Next, the substrate was washed with pure-water and dried. Further, the substrate was subjected to UV/ozone cleaning, and the resultant was used as a transparent, conductive supporting substrate.

A chloroform solution having a concentration of 0.1 wt % was prepared by using Compound 16 represented by the following structural formula as a hole transporting material.

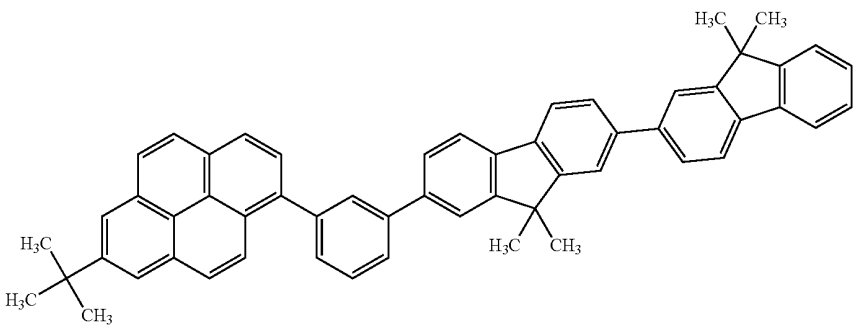
Compound 16



The solution was dropped onto the above ITO electrode, and the whole was subjected to spin coating initially at 500 RPM for 10 seconds and then at 1,000 RPM for 40 seconds, whereby a film was formed. After that, the resultant was dried in a vacuum oven at 80° C. for 10 minutes so that the solvent in the thin film was completely removed. As a result, the hole injecting layer **7** was formed. Next, Compound 13 shown above was formed into a film having a thickness of 15 nm by a vacuum vapor deposition method on the hole injecting layer **7** so as to serve as the hole transporting layer **5**.

Exemplified Compound 1303 and Compound 17 having a structural represented by the following structure formula were co-deposited from the vapor at a weight ratio of 5:95 onto the hole transporting layer **5**, whereby the light emitting layer **3** having a thickness of 30 nm was provided. The layer was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.1 nm/sec or more to 0.2 nm/sec or less.

Compound 17



Further, 2,9-bis[2-(9,9'-dimethylfluorenyl)]-1,10-phenanthroline was formed into a film having a thickness of 30 nm by a vacuum vapor deposition method to serve as the electron transporting layer **6**. The layer was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.1 nm/sec to 0.2 nm/sec.

Next, lithium fluoride (LiF) was formed into a film having a thickness of 0.5 nm by a vacuum vapor deposition method on the foregoing organic layer. Further, an aluminum film having a thickness of 100 nm was provided by a vacuum vapor deposition method to serve as an electron injecting electrode (cathode **4**), whereby an organic light emitting device was produced. The lithium fluoride film was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.01 nm/sec. The aluminum film was formed under conditions including a degree of vacuum at the time of the deposition of 1.0×10^{-4} Pa and a deposition rate of 0.5 nm/sec to 1.0 nm/sec.

The resultant organic EL device was covered with a protective glass plate in a dry air atmosphere and sealed with an acrylic resin-based adhesive in order that the device might not deteriorate owing to the adsorption of moisture.

A voltage of 4.9 V was applied to the device thus obtained with the ITO electrode (anode **2**) defined as a positive electrode and the Al electrode (cathode **4**) defined as a negative electrode. As a result, the device was observed to emit blue light with a luminous efficiency of 1.39 lm/W. In addition, the device was observed to emit blue light having CIE chromaticity coordinates (x, y) of (0.15, 0.08) and a good color purity.

It should be noted that the energy gap of each of Exemplified Compound 1303 and Compound 17 was determined by optical absorption measurement with a UV measuring device U-3010 manufactured by Hitachi, Ltd. A dilute solution of Exemplified Compound 1303 showed an optical absorption end of the dilute solution at 419 nm. The energy gap of the compound was calculated to be 2.96 eV from the foregoing. A spin-coated film of Compound 17 showed an optical absorption end at 390 nm. The energy gap of the compound was calculated to be 3.18 eV from the foregoing.

Example 12

A device was produced in the same manner as in Example 11 except that: Compound 14 shown above was used instead of Compound 17 in Example 11; and Exemplified Compound 1536 was used instead of Exemplified Compound 1303 in Example 11. The device of this example was observed to emit blue light with a luminous efficiency of 2.65 lm/W at an applied voltage of 4.7 V. In addition, the device was observed to emit blue light having CIE chromaticity coordinates (x, y) of (0.14, 0.13) and a good color purity.

Further, a voltage was applied to the device for 100 hours under a nitrogen atmosphere with a current density kept at 30 mA/cm^2. As a result, the initial luminance of the device, that is, 1178 cd/m^2 reduced to 1021 cd/m^2 in 100 hours. This means that luminance deterioration was small.

It should be noted that the energy gap of Exemplified Compound 1536 was determined by optical absorption measurement with a UV measuring device U-3010 manufactured by Hitachi, Ltd. A spin-coated film of Exemplified Compound 1536 showed an optical absorption end of the dilute solution at 438 nm. The energy gap of the compound was calculated to be 2.83 eV from the foregoing.

Example 13

A device was produced in the same manner as in Example 11 except that: Compound 14 shown above was used instead of Compound 17 in Example 11; Exemplified Compound 1515 was used instead of Exemplified Compound 1303 in Example 11; and Compound 14 and Exemplified Compound 1515 were co-deposited from the vapor at a weight ratio of 2:98.

The device of this example was observed to emit blue light with a luminous efficiency of 5.03 lm/W at an applied voltage of 4.4 V. In addition, the device was observed to emit blue light having CIE chromaticity coordinates (x, y) of (0.14, 0.21) and a good color purity.

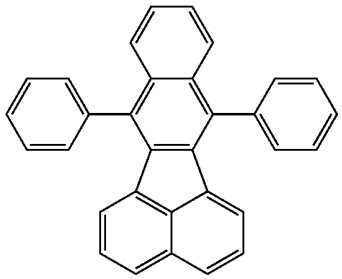
Further, a voltage was applied to the device for 100 hours under a nitrogen atmosphere with a current density kept at 30 mA/cm^2. As a result, the initial luminance of the device, that is, 2118 cd/m^2 reduced to 2031 cd/m^2 in 100 hours. This means that luminance deterioration was small.

It should be noted that the energy gap of Exemplified Compound 1515 was determined by optical absorption measurement with a UV measuring device U-3010 manufactured by Hitachi, Ltd. A spin-coated film of Exemplified Compound 1515 showed an optical absorption end of the dilute solution at 454 nm. The energy gap of the compound was calculated to be 2.73 eV from the foregoing.

COMPARATIVE EXAMPLE 1

A device was produced in the same manner as in Example 10 except that Compound 18 having a structure represented by the following formula was used instead of Exemplified Compound 1308 in Example 10.

Compound 18



The device of this example was observed to emit light with a luminous efficiency of 1.9 lm/W at an applied voltage of 4 V.

Further, a voltage was applied to the device for 20 hours under a nitrogen atmosphere with a current density kept at 30 mA/cm^2. As a result, the initial luminance of the device, that is, 840 cd/m^2 reduced to 406 cd/m^2, which was half or less as high as the initial luminance, in 20 hours.

Example 14

The results of the measurement of the oxidation-reduction potential of each of the following compounds by a cyclic voltammetry method are shown in the following table.

Guest used in the light emitting layer of Example 10 (Exemplified Compound 1308)

Guest used in the light emitting layer of Comparative Example 1 (Compound 18)

Host commonly used in the light emitting layers of Example 10 and Comparative Example 1 (Compound 15)

It should be noted that the measurement was performed in a solution of each of the compounds in N,N-dimethylforma-

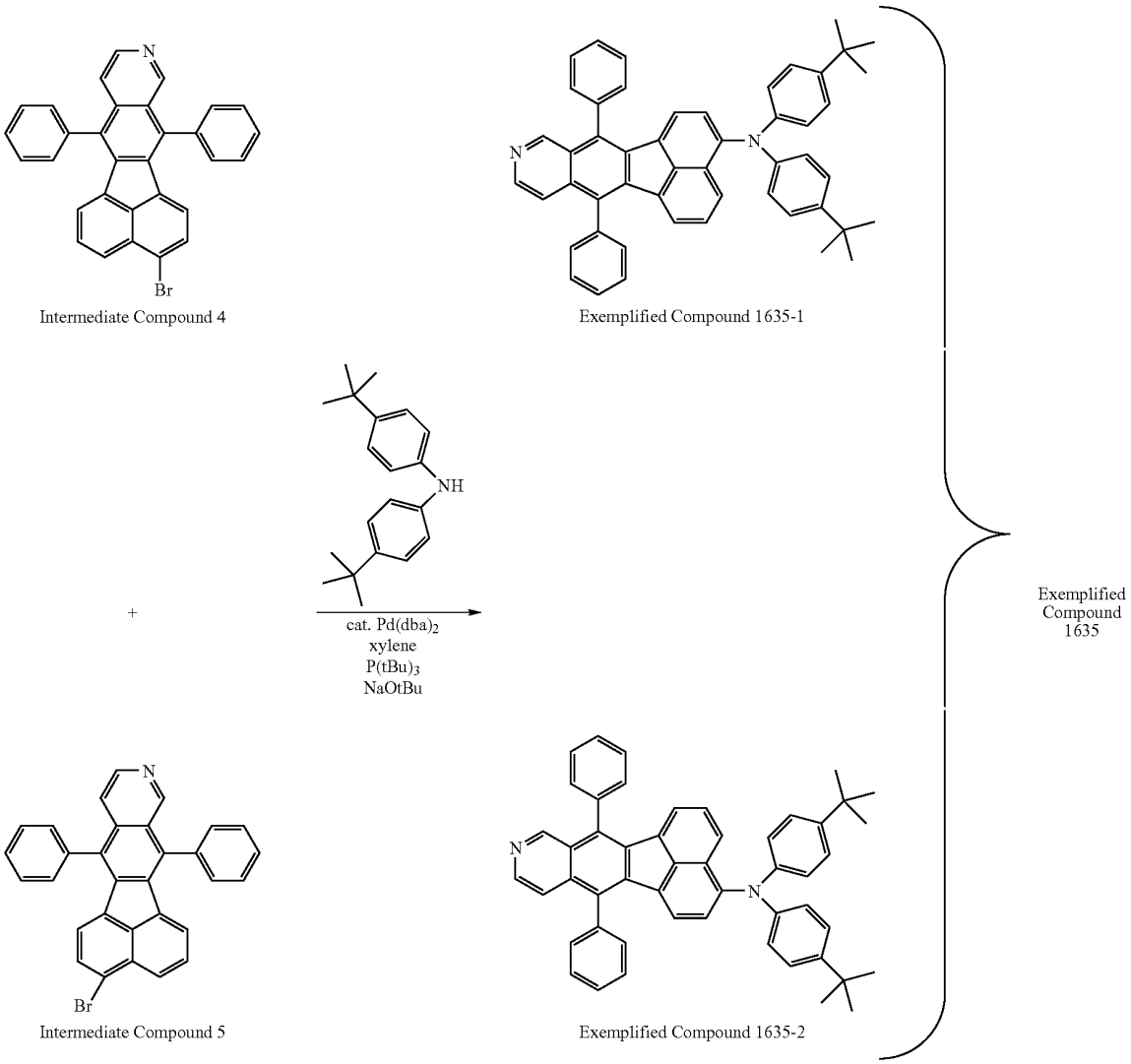
mide having a concentration of 1×10^{-4} mol/L or more to 1×10^{-6} mol/L or less under the following conditions.
Supporting electrolyte: 0.1-mol/L tetrabutyl ammonium perchlorate
Temperature: 25° C.
Reference electrode: $Ag/AgNO_3$
Counter electrode: platinum electrode
Working electrode: glassic carbon

Compound	E_{red}/VvsAg/Ag$^+$	Relative durable time
Exemplified Compound 1308	−2.03	1
Compound 18	−2.17	0.06
Compound 15	−2.37	

The results of Table 1, and the results of Example 10 and Comparative Example 1 show that a difference in reduction potential between a host material and a guest material to be used in the light emitting layer of an organic electroluminescence device is related to a reduction in deterioration of the device due to energization. That is, Exemplified Compound 1308 as a guest used in a light emitting layer has a reduction potential of −2.03 V, which is higher than the reduction potential of Compound 18, that is, −2.17 V. In addition, Exemplified Compound 1308 is a material having an electron affinity larger than that of Compound 18 and excellent in durability because a difference in reduction potential between the common host used in light emitting layers and Exemplified Compound 1308 is as large as 0.34 V. It has been found that when Compound 15 is used as a host material, high luminance can be maintained for a long time period, and the deterioration of a light emitting device using the compound due to energization at a constant current can be reduced by combining Exemplified Compound 1308 as a guest material having a reduction potential higher than that of the host material by 0.3 V or more with the host material in the light emitting layer of the device.

Example 15

Method of Producing Exemplified Compound No. 1635



Under a nitrogen atmosphere, 0.192 g (2.0 mmol) of t-butoxysodium, 0.48 g (1.0 mmol) of the mixture of Intermediate Compounds 4 and 5, 0.44 g (1.50 mmol) of di-4-t-butylphenylamine, 0.10 g of bisdibenzylidene acetone palladium, and 0.050 g of tri-t-butylphosphine were suspended in 100 mL of xylene. The resultant solution was stirred under heat and reflux for 5 hours, and the disappearance of Intermediate Compounds 4 and 5 was observed. After that, the resultant was cooled to room temperature, and water was added to the resultant to stop the reaction. An organic layer was separated, and was then washed with water twice. After that, the solvent was removed by distillation. The resultant residue was purified by silica gel column chromatography (toluene:heptane=1:1), whereby 0.483 g of the mixture of Exemplified Compounds 1653 containing Exemplified Compounds 1653-1 and 1653-2 at a composition ratio of 1:1 was obtained.

Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) identified 684 as the M^+ of the compound.

Further, NMR measurement identified the structure of the compound (FIG. **19**).

The PL spectrum of a solution (1.0×10^{-5} mol/L) of Exemplified Compound 1653 in toluene was measured. As a result, a green light emission spectrum having a light emission peak at 529 nm, a half width of 66.3 nm, and an excellent color purity was shown.

In addition, the following exemplified compounds can be synthesized in the same manner as in Example 15 except that the following compounds is used instead of di-4-t-butylphenylamine in Example 15. (Di-4-methylphenylamine): Exemplified Compound 1636 (Carbazole): Exemplified Compound 1625

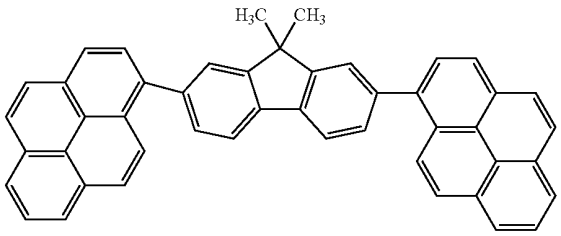
Example 16

A device was produced in the same manner as in Example 11 except that: Compound 19 shown below was used instead of Compound 17 in Example 11; Exemplified Compound 1635 was used instead of Exemplified Compound 1303 in Example 11; and Compound 19 and Exemplified Compound 1635 were co-deposited from the vapor at a weight ratio of 5:95.

The device of this example was observed to emit green light with a luminous efficiency of 8.74 μm/W at an applied voltage of 4.3 V. In addition, the device was observed to emit green light having CIE chromaticity coordinates (x, y) of (0.39, 0.59) and a good color purity.

Further, a voltage was applied to the device for 100 hours under an atmospheric condition with a current density kept at 165 mA/cm^2. As a result, the initial luminance of the device, that is, 15,700 cd/m^2 reduced to 12,420 cd/m^2 in 100 hours. This means that luminance deterioration was small.

Compound 19



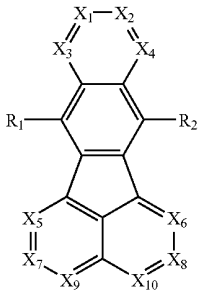
While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions

This application claims the benefit of Japanese Patent Application No. 2006-213063, filed Aug. 4, 2006 and 2007-118218, filed Apr. 27, 2007, which are incorporated by reference herein in their entirety.

The invention claimed is:

1. A fused heterocyclic compound represented by the following general formula [1]:

[1]



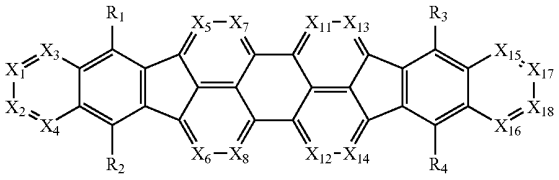
wherein:

X_1 represents a nitrogen atom, X_2 to X_8 each represent CH, one of X_9 and X_{10} represents CH and the other represents a carbon atom having a substituent R, R represents a substituted or unsubstituted arylamino group or a substituted or unsubstituted fused polycyclic aromatic group having two rings or more to five rings or less; and

R_1 and R_2 each represent a phenyl group.

2. A fused heterocyclic compound represented by the following general formula [5]:

[5]



wherein:

X_1 represents a nitrogen atom, X_2 to X_8 and X_{11} to X_{16} each represent CH, X_{17} and X_{18} each represent CH, or one of X_{17} and X_{18} represents CH, the other represents a nitrogen atom; and

R_1 and R_2 represent a phenyl group, and R_3 and R_4 each represent a substituted or unsubstituted aryl group.

3. An organic light emitting device comprising:

a pair of electrodes constituted of an anode and a cathode at least one of which is formed of a transparent or semi-transparent electrode material; and

a layer containing an organic compound, the layer being interposed between the pair of electrodes,

wherein the layer containing an organic compound contains the fused heterocyclic compound according to claim **1**.

4. An organic light emitting device according to claim 3, wherein the layer containing the fused heterocyclic compound comprises at least two kinds of compounds of a host and a guest.

5. An organic light emitting device according to claim 4, wherein the guest comprises the fused heterocyclic compound, and the host comprises a compound having an energy gap larger than an energy gap of the fused heterocyclic compound.

6. An organic light emitting device according to claim 5, wherein the guest has a reduction potential higher than that of the host by 0.3 V or more.

7. An organic light emitting device according to claim 3, wherein the layer containing the fused heterocyclic compound comprises at least one layer having a light emitting region.

8. An organic light emitting device according to claim 7, wherein the at least one layer having the light emitting region comprises a light emitting layer.

9. An organic light emitting device comprising:

a pair of electrodes constituted of an anode and a cathode at least one of which is formed of a transparent or semi-transparent electrode material; and

a layer containing an organic compound, the layer being interposed between the pair of electrodes,

wherein the layer containing an organic compound contains the fused heterocyclic compound according to claim 2.

10. An organic light emitting device according to claim 9, wherein the layer containing the fused heterocyclic compound comprises at least two kinds of compounds of a host and a guest.

11. An organic light emitting device according to claim 10, wherein the guest comprises the fused heterocyclic compound, and the host comprises a compound having an energy gap larger than an energy gap of the fused heterocyclic compound.

12. An organic light emitting device according to claim 11, wherein the guest has a reduction potential higher than that of the host by 0.3 V or more.

13. An organic light emitting device according to claim 9, wherein the layer containing the fused heterocyclic compound comprises at least one layer having a light emitting region.

14. An organic light emitting device according to claim 13, wherein the at least one layer having the light emitting region comprises a light emitting layer.

* * * * *

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摘要(译)

为了提供具有极好纯度的发光色调并且输出具有高亮度和长寿命且高效率的光的有机发光器件的材料，本发明涉及具有至少一个部分结构的稠合杂环化合物。通过以下通式[1]。