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Kam et al.

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(54) **ORGANIC LIGHT EMITTING DISPLAY DEVICE**

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(30) **Foreign Application Priority Data**

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Oct. 30, 2013 (KR) 10-2013-0130280

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H01L 51/00 (2006.01)
H01L 27/32 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 51/5088*** (2013.01); ***H01L 51/5044*** (2013.01); *H01L 27/3209* (2013.01); *H01L 51/002* (2013.01)

(58) **Field of Classification Search**
CPC H01J 1/63; H01L 51/50
See application file for complete search history.

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(57) **ABSTRACT**

An organic light emitting display device includes first and second electrodes facing each other on a substrate, a charge generation layer formed between the first and second electrodes, a first light emitting stack formed between the charge generation layer and the first electrode, and a second light emitting stack formed between the charge generation layer and the second electrode, wherein a hole injection layer of a light emitting stack to realize blue color of the first and second light emitting stacks is formed by doping a host formed of hexaazatriphenylene (HAT-CN) with 0.5% to less than 10% of a dopant formed of a hole transporting material based on a volume of the hole injection layer.

4 Claims, 12 Drawing Sheets

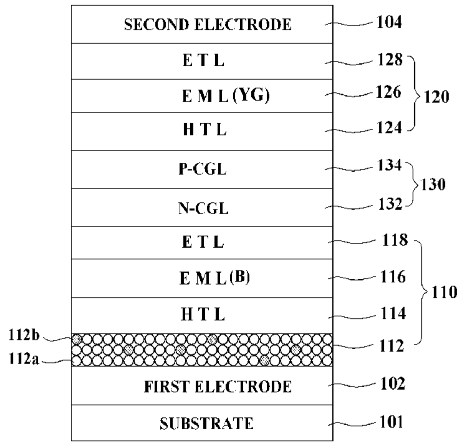
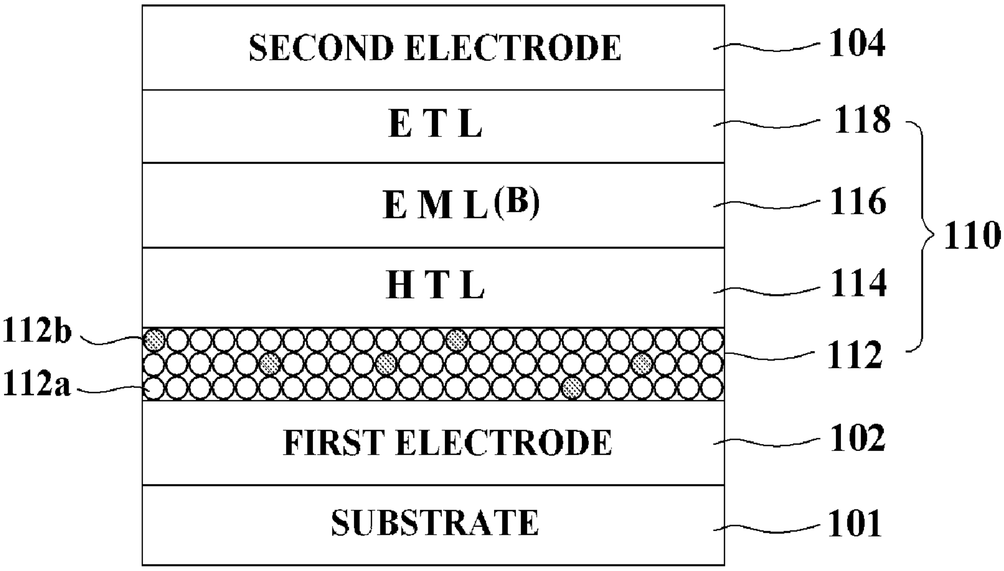


FIG.1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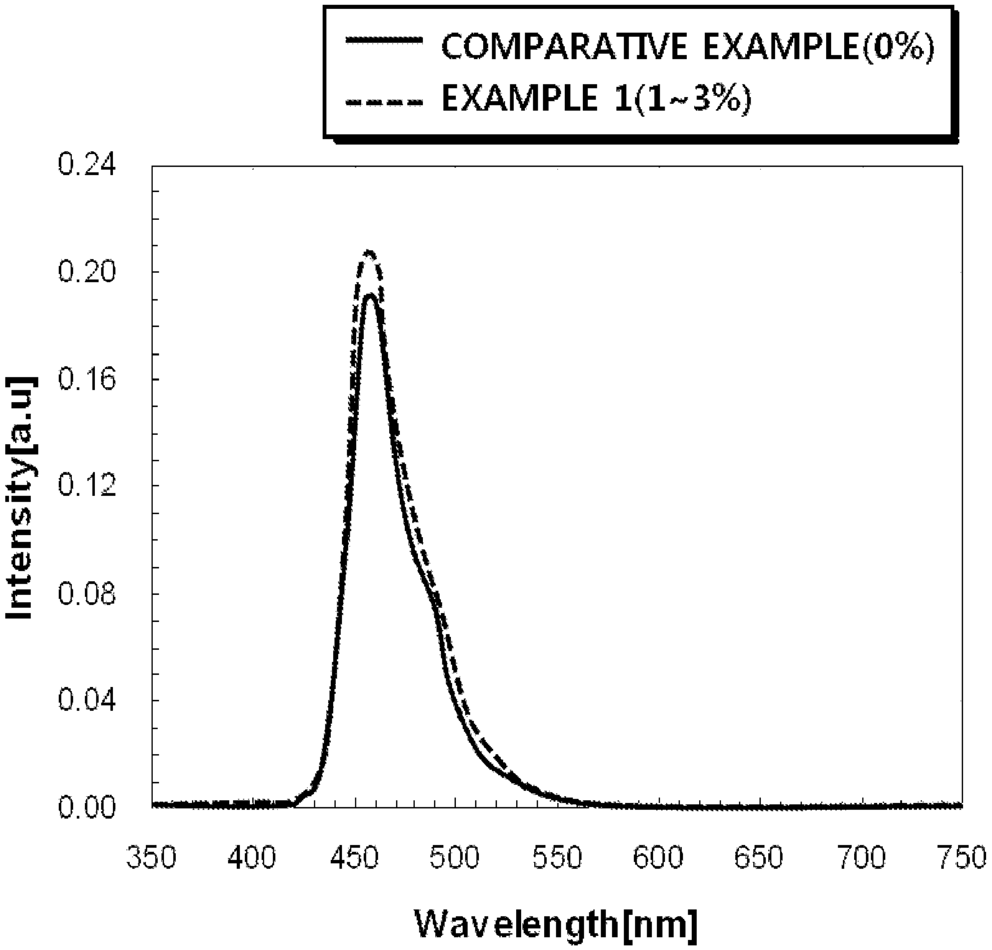
104
E T L
118
E M L(B)
116
110
H T L
114
112b
112
112a
FIRST ELECTRODE
102
SUBSTRATE
101

FIG.2A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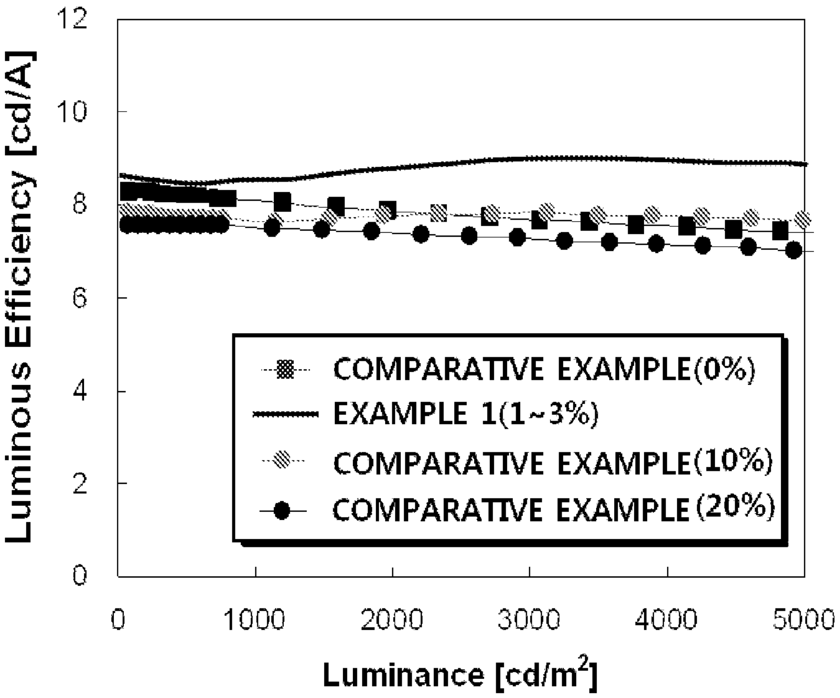
Wavelength[nm]

FIG.2B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8
6
4
2
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0
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4000
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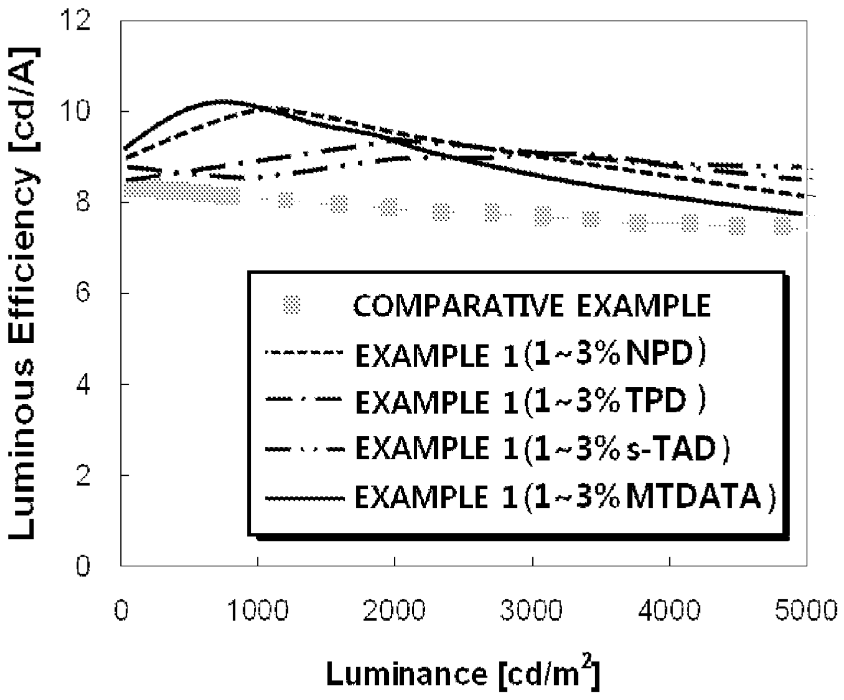
EXAMPLE 1(1~3%)
COMPARATIVE EXAMPLE(10%)
COMPARATIVE EXAMPLE (20%)

FIG.2C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2
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6
8
10
12
Luminance [cd/m2]
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1000
2000
3000
4000
5000
COMPARATIVE EXAMPLE
EXAMPLE 1(1~3% NPD)
EXAMPLE 1(1~3% TPD)
EXAMPLE 1(1~3% s-TAD)
EXAMPLE 1(1~3% MTDATA)

FIG.3

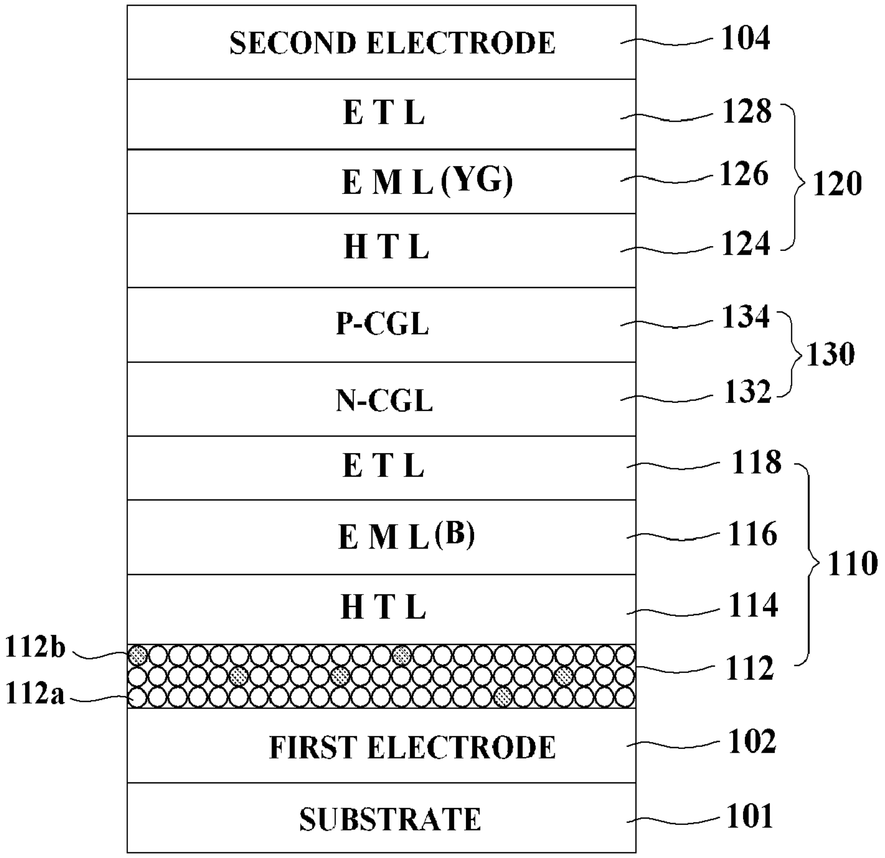
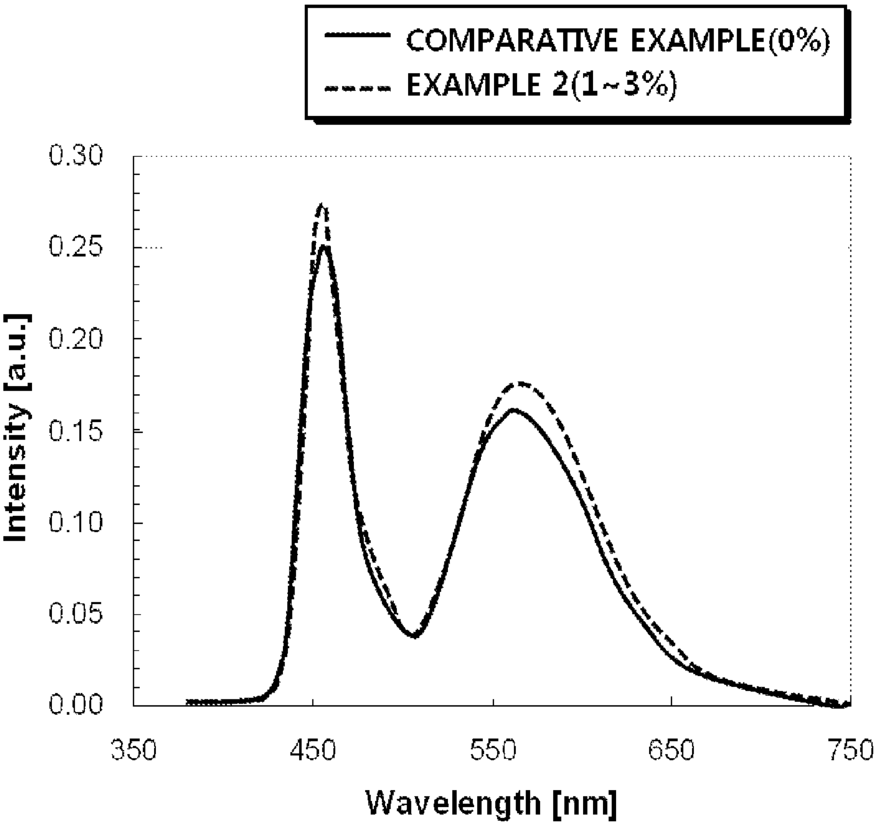

SECOND ELECTRODE
104
E T L
128
E M L (YG)
126
H T L
124
120
P-CGL
134
N-CGL
132
130
E T L
118
E M L (B)
116
H T L
114
110
112b
112a
112
FIRST ELECTRODE
102
SUBSTRATE
101

FIG.4A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EXAMPLE 2(1~3%)
Intensity [a.u.]
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0.25
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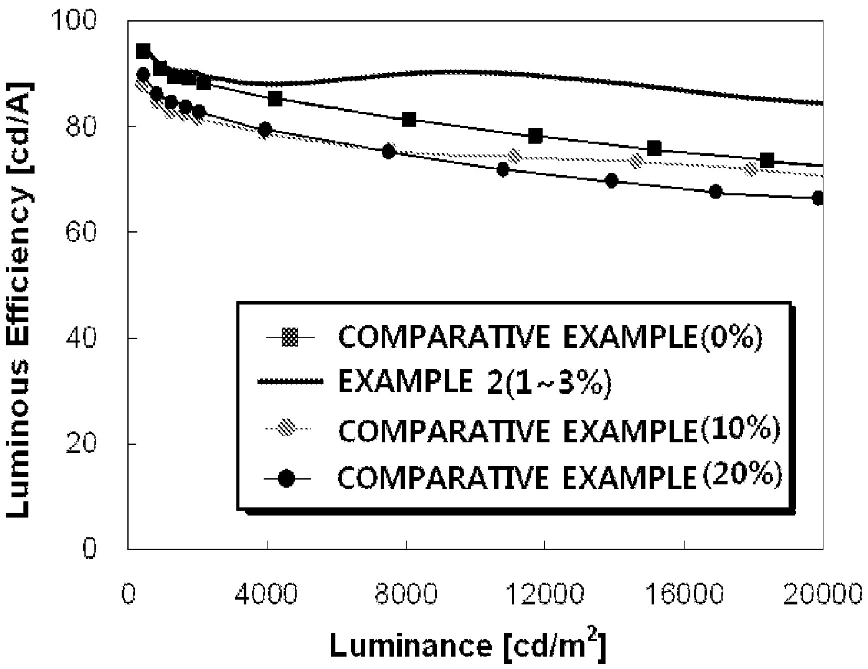
0.00
350
450
550
650
750
Wavelength [nm]

FIG.4B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80
60
40
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0
0
4000
8000
12000
16000
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Luminance [cd/m²]
COMPARATIVE EXAMPLE(0%)
EXAMPLE 2(1~3%)
COMPARATIVE EXAMPLE(10%)
COMPARATIVE EXAMPLE (20%)

FIG.4C

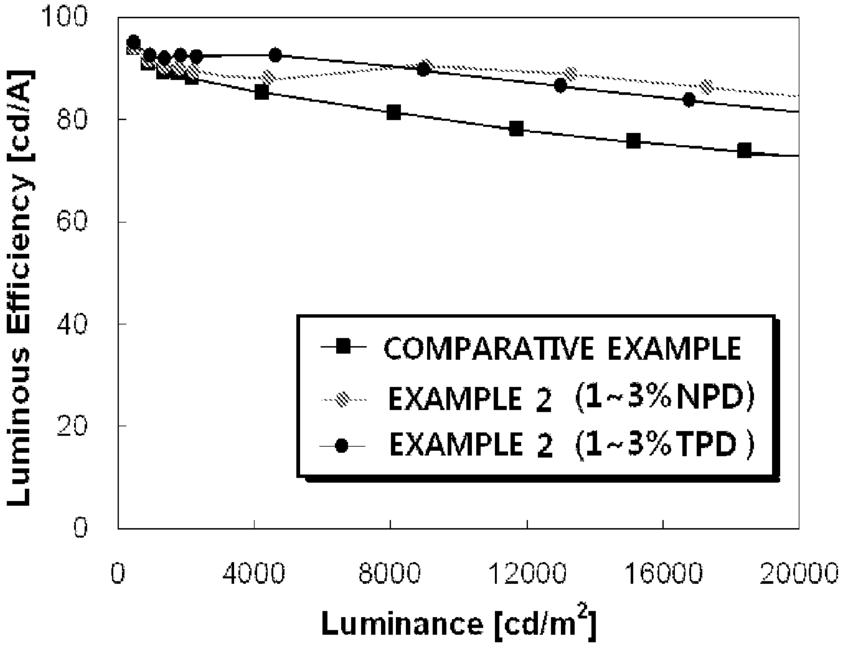

100
80
60
40
20
0
Luminous Efficiency [cd/A]
0
4000
8000
12000
16000
20000
Luminance [cd/m²]
COMPARATIVE EXAMPLE
EXAMPLE 2 (1~3%NPD)
EXAMPLE 2 (1~3%TPD)

FIG.5

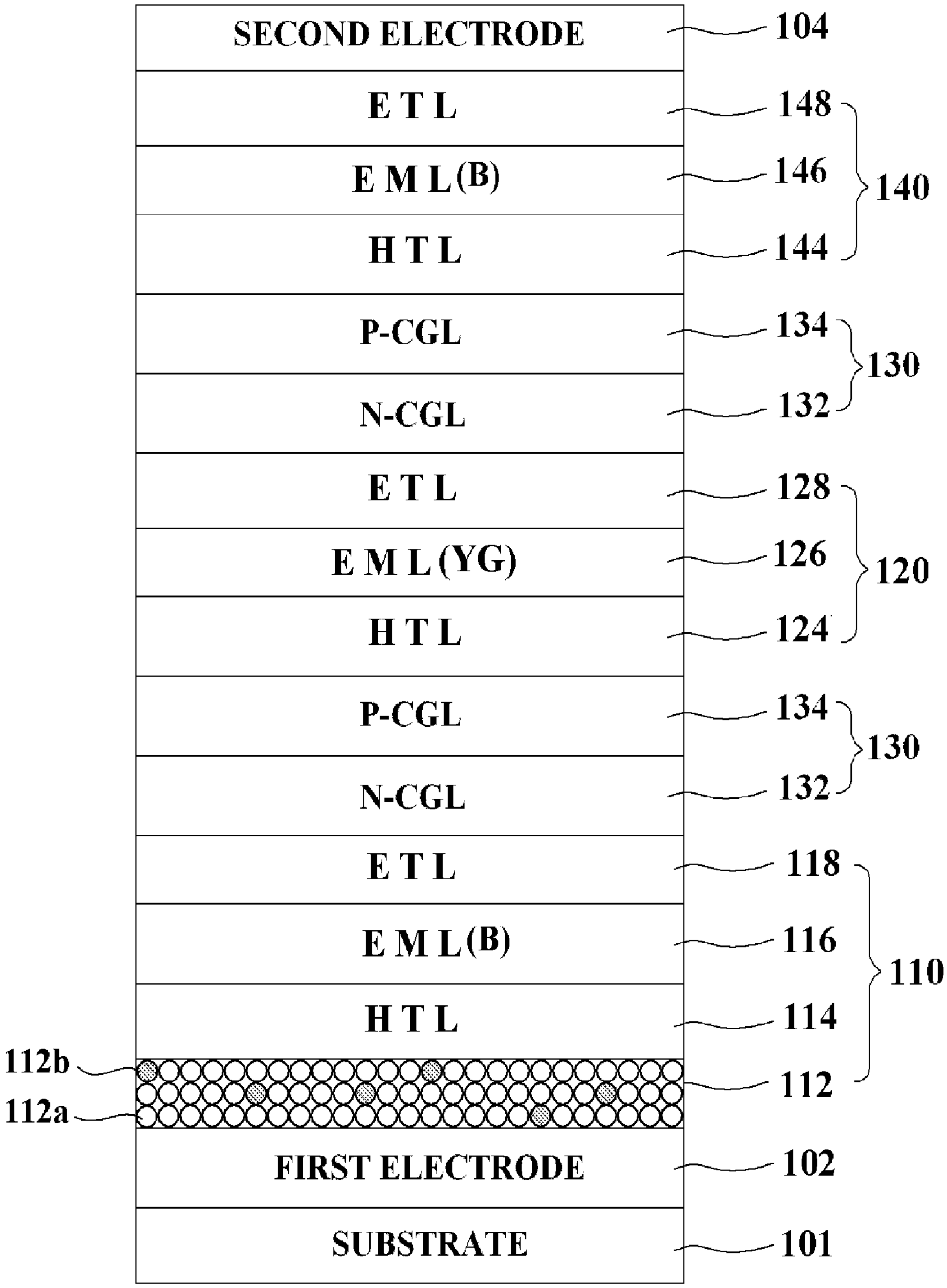

SECOND ELECTRODE
104
E T L
148
E M L(B)
146
H T L
144
140
P-CGL
134
N-CGL
132
130
E T L
128
E M L (YG)
126
H T L
124
120
P-CGL
134
N-CGL
132
130
E T L
118
E M L(B)
116
H T L
114
110
112b
112a
112
FIRST ELECTRODE
102
SUBSTRATE
101

FIG.6A

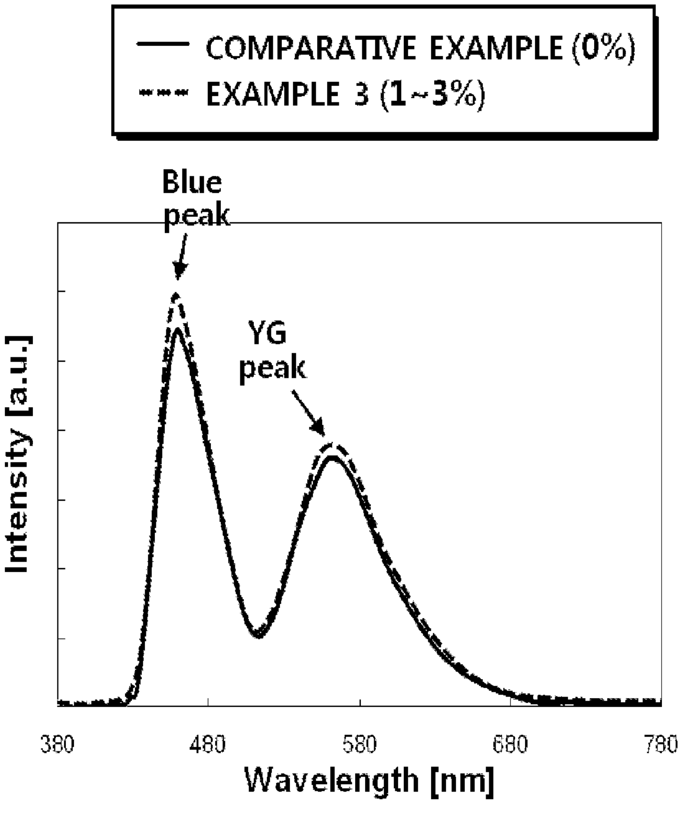
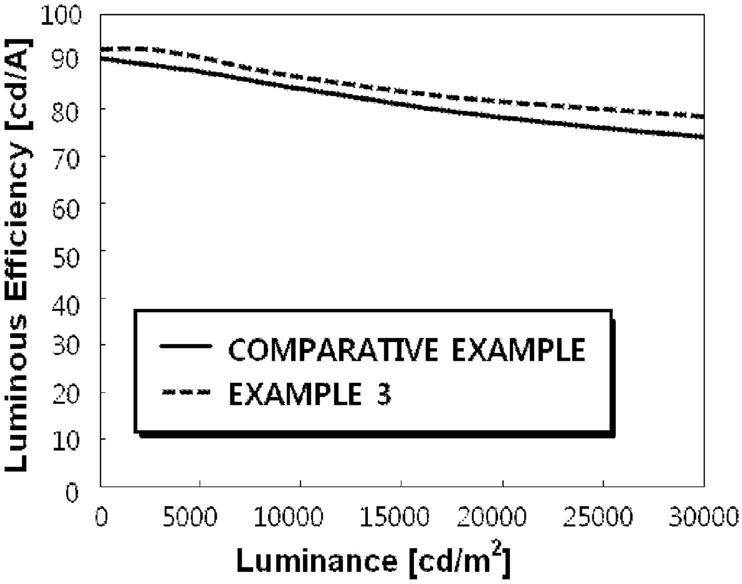

COMPARATIVE EXAMPLE (0%)
EXAMPLE 3 (1~3%)
Blue peak
YG peak
Intensity [a.u.]
380
480
580
680
780
Wavelength [nm]

FIG.6B


Luminous Efficiency [cd/A]
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90
80
70
60
50
40
30
20
10
0
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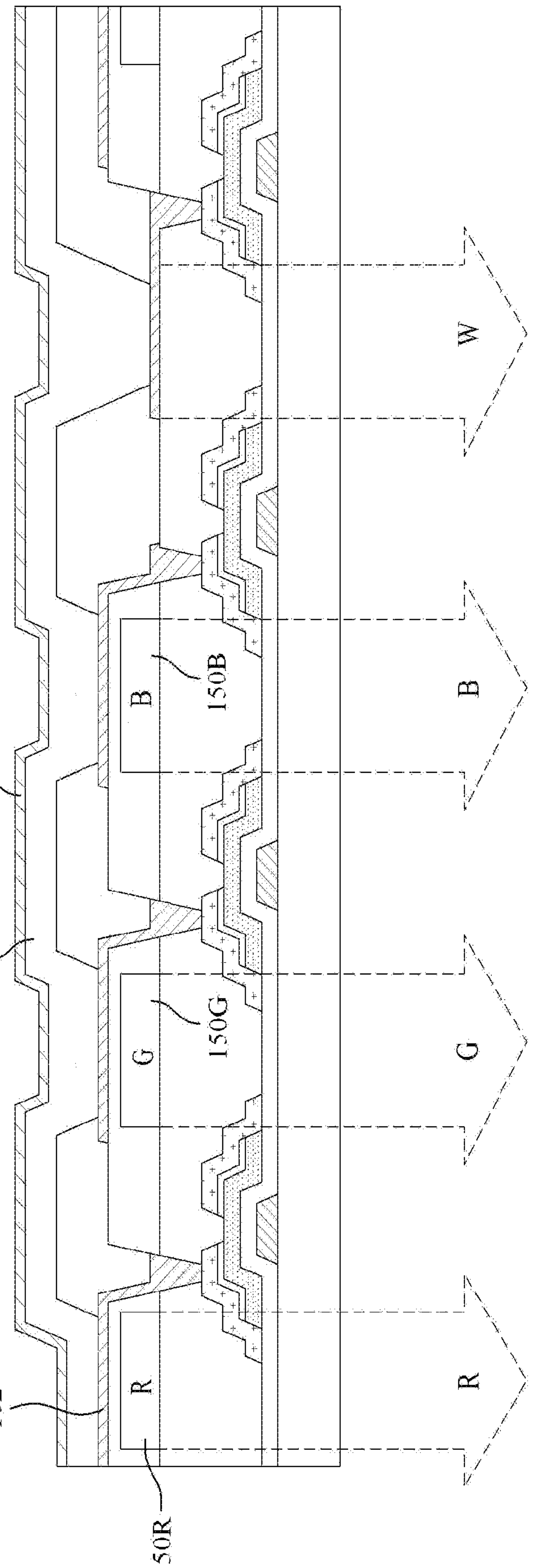
20000
25000
30000
Luminance [cd/m^2]
COMPARATIVE EXAMPLE
EXAMPLE 3

FIG.7



ORGANIC LIGHT EMITTING DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of Korean Patent Applications No. 10-2012-0155899, filed on Dec. 28, 2012 and No. 10-2013-0130280, filed on Oct. 30, 2013, which are hereby incorporated by reference herein, in their entireties.

BACKGROUND

1. Technical Field

The present disclosure relates to an organic light emitting display device with enhanced efficiency.

2. Discussion of the Related Art

In line with recent information era, the display field, which visually displays electrical information signals, has rapidly developed. To meet such development, various flat panel display devices with excellent performance, such as ultra-thin, lightweight, and low power consumption, have developed.

Examples of flat panel display devices include, without being limited to, a liquid crystal display (LCD) device, a plasma display panel (PDP) device, a field emission display (FED) device, and an organic light emitting device (OLED).

In particular, OLEDs, which are self-emissive devices, have faster response time, higher luminous efficiency, higher luminance and wider viewing angles than other flat panel display devices.

A conventional organic light emitting display device includes a blue emission layer formed of a fluorescent blue material to produce white light. In a fluorescent blue device including the blue emission layer formed of a fluorescent blue material, however, a roll-off phenomenon in which luminous efficiency according to luminance decreases as luminance increases occurs.

SUMMARY

Accordingly, the present disclosure is directed to an organic light emitting display device that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present disclosure is to provide an organic light emitting display device with enhanced efficiency.

Additional advantages, objects, and features of the disclosure will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the disclosure. The objectives and other advantages of the disclosure may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the disclosure, as embodied and broadly described herein, an organic light emitting display device includes first and second electrodes facing each other on a substrate, a charge generation layer formed between the first and second electrodes, a first light emitting stack formed between the charge generation layer and the first electrode, and a second light emitting stack formed between the charge generation layer and the second electrode, wherein a hole injection layer of a light emitting stack to realize blue color of the first and second light emitting stacks is formed by doping a host formed of hexaazatriphenylene (HAT-CN) with 0.5% to less than 10% of a dopant formed of a hole transporting material based on a volume of the hole injection layer.

The dopant may be formed of the same material as that of a hole transport layer of any one of the first and second light emitting stacks.

The first light emitting stack may include a fluorescent blue emission layer, and the second light emitting stack may include a phosphorescent yellow-green emission layer.

The organic light emitting display device may further include at least one third light emitting stack formed between the second light emitting stack and the second electrode.

The dopant may be formed of the same material as that of a hole transport layer of at least one of the first, second and third light emitting stacks.

The first and third light emitting stacks may include a fluorescent blue emission layer, and the second light emitting stack may include a phosphorescent yellow-green emission layer.

In another aspect of the present disclosure, an organic light emitting display device includes first and second electrodes facing each other on a substrate, a blue emission layer formed between the first and second electrodes, a hole injection layer and a hole transport layer, formed between the blue emission layer and the first electrode, and an electron transport layer formed between the blue emission layer and the second electrode, wherein the hole injection layer is formed by doping a host formed of hexaazatriphenylene (HAT-CN) with 0.5% to less than 10% of a dopant formed of a hole transporting material based on a volume of the hole injection layer.

The dopant may be formed of the same material as that of the hole transport layer.

The dopant may be formed of a material having higher hole mobility than electron mobility and a hole mobility of 5.0×10^{-5} Vs/cm^2 to 1.0×10^{-2} Vs/cm^2.

A doping rate of the dopant may be 1% to 5% based on the volume of the hole injection layer.

It is to be understood that both the foregoing general description and the following detailed description of the present disclosure are exemplary and explanatory and are intended to provide further explanation as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the disclosure. In the drawings:

FIG. **1** is a sectional view of a blue organic light emitting device according to a first embodiment of the present disclosure;

FIGS. **2**A to **2**C are graphs for explaining optical characteristics of an organic light emitting display device of Comparative Example and the blue organic light emitting display device according to the first embodiment of the present disclosure;

FIG. **3** is a sectional view of an organic light emitting display device according to a second embodiment of the present disclosure;

FIGS. **4**A to **4**C are graphs for explaining all-optical characteristics of an organic light emitting display device of

Comparative Example and the organic light emitting display device according to the second embodiment of the present disclosure;

FIG. **5** is a sectional view of an organic light emitting display device according to a third embodiment of the present disclosure including three light emitting stacks;

FIGS. **6**A and **6**B are graphs for explaining all-optical characteristics of an organic light emitting display device of Comparative Example and the organic light emitting display device according to the third embodiment of the present disclosure; and

FIG. **7** is a sectional view of an organic light emitting display device according to the present disclosure including color filters.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. **1** is a sectional view of a blue organic light emitting device according to a first embodiment of the present disclosure.

The blue organic light emitting device of FIG. **1** includes first and second electrodes **102** and **104** and an organic emission layer **110** formed between the first and second electrodes **102** and **104**.

Any one of the first and second electrodes **102** and **104** is formed as a transparent electrode or a semi-transparent electrode and the other thereof is formed as a reflective electrode. When the first electrode **102** is a semi-transparent electrode and the second electrode **104** is a reflective electrode, the organic light emitting display device is embodied as a bottom emission type that emits light in a bottom direction. When the second electrode **104** is a semi-transparent electrode and the first electrode **102** is a reflective electrode, the organic light emitting display device is embodied as a top emission type that emits light in a top direction. In the present disclosure, a case in which the first electrode **102** as an anode is formed as a reflective electrode and the second electrode **104** as a cathode is formed as a semi-transparent electrode will be described by way of example.

The first electrode **102** is formed as multiple layers including a metal layer formed of aluminum (Al) or an Al alloy (e.g., AlNd) and a transparent layer formed of indium tin oxide (ITO), indium zinc oxide (IZO), or the like and serves as a reflective electrode.

The second electrode **104** is formed as a single layer or multiple layers, and each layer constituting the second electrode **104** is formed of a metal, an inorganic material, a mixture of metals, a mixture of a metal and an inorganic material, or a mixture thereof. When each layer is formed of the mixture of a metal and an inorganic material, a mix ratio thereof is 10:1 to 1:10 and, when each layer is formed of the mixture of metals, a mix ratio thereof is 10:1 to 1:10. The metal constituting the second electrode **104** may be Ag, Mg, Yb, Li, or Ca, the inorganic material constituting the second electrode **104** may be Li_2O, CaO, LiF, or MgF_2, and the metal and the inorganic material facilitate migration of electrons and thus enable a large amount of electrons to be supplied to the organic emission layer **110**.

A hole injection layer (HIL) **112**, a hole transport layer (HTL) **114**, an emission layer (EML(B)) **116**, and an electron transport layer (ETL) **118** are sequentially formed between the first and second electrodes **102** and **104**.

The HIL **112** facilitates injection of holes from the first electrode **102**. The HTL **114** supplies the holes from the HIL **112** to the EML(B) **116**. The ETL **118** supplies electrons from the second electrode **104** to the EML(B) **116**.

The holes supplied via the HTL **114** and the electrons supplied via the ETL **118** are recombined in the EML(B) **116**, whereby light is emitted. In particular, the EML(B) **116** is formed of a fluorescent blue material and thus realizes blue color.

The HIL **112** of the organic light emitting display device according to the first embodiment of the present disclosure is formed by doping a host **112***a* with 0.5% to less than 10% of a dopant **112***b* based on a volume of the HIL **112** and has a thickness of about 7 nm or less. In this regard, the dopant **112***b* may be doped on the host **112***a* with a doping rate of 1 to 5% based on the volume of the HIL **112**. The host **112***a* is formed of hexaazatriphenylene (HAT-CN), and the dopant **112***b* is formed of a hole transporting material having higher hole mobility than electron mobility. In this regard, the hole transporting material may be a material having a hole mobility of 5.0×10^{-5} Vs/cm^2 to 1.0×10^{-2} Vs/cm^2. For example, the hole transporting material may be at least one of N,N-dinaphthyl-N,N'-diphenyl benzidine (NPD), N,N'-bis-(3-methylphenyl)-N,N'-bis-(phenyl)-benzidine (TPD), s-TAD, and 4,4',4"-Tris(N-3-methylphenyl-N-phenylamino)-triphenylamine (MTDATA), and a material for forming the HTL **114** may be used as the hole transporting material. Accordingly, the hole mobility of the HIL **112** is enhanced and thus hole injection characteristics at an interface between the HIL **112** and the HTL **114** are enhanced. As a result, a formation rate of excitons formed through combination between electrons and holes increases due to stable charge balance in the EML(B) **116** and, accordingly, luminous efficiency is enhanced.

FIGS. **2**A to **2**C are graphs for explaining optical characteristics of organic light emitting display devices of Comparative Example and Example 1.

In particular, as illustrated in FIG. **2**A, the organic light emitting display device of Example 1 including the HIL **112** doped with 1 to 3% of the dopant **112***b* has higher peak intensity than that of the organic light emitting display device of Comparative Example including an HIL that is undoped with a dopant and thus, as shown in Table 1 below, the organic light emitting display device of Example 1 has higher efficiency at 10 mA/cm^2, increased by 7% or greater, than that of the organic light emitting display device of Comparative Example.

TABLE 1

	10 mA/cm^2				
	Efficiency (Cd/A)	QE (%)	Color coordinate (CIEx)	Color coordinate (CIEy)	Roll off
Comparative Example	8.0	9.6	0.136	0.092	0.93
Example 1	8.6	10.3	0.137	0.092	1.05

In addition, as illustrated in FIG. **2**B, a blue light emitting device including the HIL **112** doped with 1 to 3% of the dopant **112***b* has increased luminous efficiency in the entire luminance region when compared to blue light emitting devices of Comparative Examples respectively including an undoped HIL, an HIL doped with 10% of a dopant, and an

HIL doped with 20% of a dopant. In addition, as shown in Table 1, the organic light emitting display device of Example 1 has a roll-off factor (a ratio of efficiency at a current density of 50 mA/cm^2 to efficiency at a current density of 10 mA/cm^2) of 1.05, which is higher than that of the organic light emitting display device of Comparative Example having a roll-off factor of 0.93. From the results, it can be confirmed that the blue organic light emitting device according to the first embodiment of the present disclosure undergoes reduced roll-off phenomenon in which efficiency is decreased in a high luminance region.

In particular, it can be confirmed that the blue light emitting device including the HIL **112** doped with 1 to 3% of the dopant **112***b* undergoes less roll-off phenomenon in which efficiency is decreased in a high luminance region than the blue light emitting devices respectively including the HIL doped with 10% of a dopant and the HIL doped with 20% of a dopant. Thus, in the blue light emitting device according to the first embodiment of the present disclosure, a doping rate of the dopant **112***b* of the HIL **112** may be 0.5% to less than 10% based on the volume of the HIL **112**.

In addition, as illustrated in FIG. **2**C, it can be confirmed that, even though different types of materials (e.g., NPD, TPD, s-TAD, and MTDATA) for forming the dopant **112***b* are used, the blue light emitting device of Example including the HIL **112** doped with 1 to 3% of the dopant **112***b* has enhanced luminous efficiency in the entire luminance region when compared to the blue light emitting device of Comparative Example. Although NPD, TPD, s-TAD, and MTDATA have been described as dopant materials by way of example, various other hole transporting materials may be used as dopant materials and the same effect may be obtained using the dopant materials.

FIG. **3** is a sectional view of an organic light emitting display device according to a second embodiment of the present disclosure.

The organic light emitting display device of FIG. **3** includes the same elements as those of the organic light emitting display device of FIG. **1**, except that the organic light emitting display device of FIG. **3** has a two-stack structure. Thus, a detailed description of the same elements will be omitted herein.

The organic light emitting display device of FIG. **3** includes the first and second electrodes **102** and **104** facing each other, first and second light emitting stacks **110** and **120** formed between the first and second electrodes **102** and **104**, and a charge generation layer (CGL) **130** disposed between the first and second light emitting stacks **110** and **120**. In the present embodiment, two light emitting stacks are used, but embodiments are not limited thereto. That is, at least three light emitting stacks may be formed.

The first light emitting stack **110** is formed between the first electrode **102** and the charge generation layer **130**. The first light emitting stack **110** includes the HIL **112**, a first HTL **114**, a first EML(B) **116**, and a first ETL **118** that are sequentially formed on the first electrode **102**.

The second light emitting stack **120** is formed between the second electrode **104** and the charge generation layer **130**. The second light emitting stack **120** includes a second HTL **124**, a second EML(YG) **126**, and a second ETL **128** that are sequentially formed on the charge generation layer **130**.

The first EML(B) **116** includes a fluorescent blue dopant and host to emit blue light, and the second EML(YG) **126** includes a phosphorescent yellow-green dopant and host to emit orange light. Accordingly, the blue light of the first EML(B) **116** and the orange light of the second EML(YG) **126** may be realized as white light through mixing. In addition, white light may be emitted using other fluorescent dopants and phosphorescent dopants.

The charge generation layer **130** is formed between the first and second light emitting stacks **110** and **120** and controls charge balance between the first and second light emitting stacks **110** and **120**. The charge generation layer **130** includes an N-type charge generation layer **132** and a P-type charge generation layer **134** that are sequentially stacked.

The N-type charge generation layer **132** injects electrons into the first light emitting stack **110**, and the P-type charge generation layer **134** injects holes into the second light emitting stack **120**.

The electrons transferred to the first light emitting stack **110** via the N-type charge generation layer **132** and holes transferred via the HIL **112** and the first HTL **114** are combined in the first EML(B) **116** of the first light emitting stack **110**, forming excitons and releasing energy, whereby visible light is emitted.

The holes transferred to the second light emitting stack **120** via the P-type charge generation layer **134** and electrons transferred via the second electrode **104** and the second ETL **128** are combined in the second EML(YG) **126** of the second light emitting stack **120**, forming excitons and releasing energy, whereby visible light is emitted.

In the organic light emitting display device according to the second embodiment of the present disclosure, the HIL **112** of the first light emitting stack **110** to emit blue light is formed by doping the host **112***a* with 0.5% to less than 10% of the dopant **112***b* based on a volume of the HIL **112** and has a thickness of about 7 nm or less. In this regard, the dopant **112***b* may be doped on the host **112***a* with a doping rate of 1 to 5% based on the volume of the HIL **112**. The host **112***a* is formed of hexaazatriphenylene (HAT-CN), and the dopant **112***b* is formed of a hole transporting material having higher hole mobility than electron mobility. In this regard, the hole transporting material may be a material having a hole mobility of 5.0×10^{-5} Vs/cm^2 to 1.0×10^{-2} Vs/cm^2. For example, the hole transporting material may be at least one of NPD, TPD, s-TAD, and MTDATA, and materials for forming the first and second HTLs **114** and **124** of the first and second light emitting stacks **110** and **120** may be used as the hole transporting material. Accordingly, the hole mobility of the HIL **112** of the first light emitting stack **110** is enhanced and thus hole injection characteristics at an interface between the HIL **112** and the first HTL **114** of the first light emitting stack **110** are enhanced. As a result, a formation rate of excitons formed through combination between electrons and holes increases due to charge balance in the first EML(B) **116** and, accordingly, luminous efficiency is enhanced.

FIGS. **4**A to **4**C are graphs for explaining all-optical characteristics of organic light emitting display devices of Comparative Example and Example 2.

In particular, as illustrated in FIG. **4**A, the organic light emitting display device of Example 2 including the HIL **112** of the first light emitting stack **110**, doped with 1 to 3% of the dopant **112***b*, has higher peak intensity (blue peak) of the first EML(B) **116** to realize blue color and higher peak intensity (YG peak) of the second EML(YG) **126** to realize orange color than those of the organic light emitting display device of Comparative Example including an HIL of a first light emitting stack, undoped with a dopant and thus, as shown in Table 2 below, the organic light emitting display device of Example 2 has higher efficiency at 10 mA/cm^2, increased by 6% or greater, than that of the organic light emitting display device of Comparative Example.

TABLE 2

	10 mA/cm^2				
	Efficiency (Cd/A)	QE (%)	Color coordinate (CIEx)	Color coordinate (CIEy)	Roll off
Comparative Example	81.1	32.0	0.317	0.339	0.81
Example 2	86.5	35.1	0.324	0.330	0.84

In addition, as illustrated in FIG. **4**B, the organic light emitting display device of Example 2 including the HIL **112** of the first light emitting stack **110**, doped with 1% to 3% of the dopant **112***b*, has higher luminous efficiency in the entire luminance region than that of organic light emitting display devices of Comparative Examples respectively including an HIL of a first light emitting stack, undoped with a dopant, an HIL of a first light emitting stack, doped with 10% of a dopant, and an HIL of a first light emitting stack, doped with 20% of a dopant. In addition, as shown in Table 2, the organic light emitting display device of Example 2 has a roll-off factor (a ratio of efficiency at a current density of 50 mA/cm^2 to efficiency at a current density of 10 mA/cm^2) of 0.84, which is higher than that of the organic light emitting display device of Comparative Example having a roll-off factor of 0.81. From the results, it can be confirmed that the organic light emitting display device having a multi-stack light emitting structure according to the second embodiment of the present disclosure undergoes reduced roll-off phenomenon in which efficiency is decreased in a high luminance region.

In particular, it can be confirmed that the organic light emitting display device of Example 2 including the HIL **112** of the first light emitting stack **110**, doped with 1% to 3% of the dopant **112***b*, undergoes less roll-off phenomenon in which efficiency is decreased in a high luminance region than the organic light emitting devices respectively including the HIL doped with 10% of a dopant and the HIL doped with 20% of a dopant. Thus, in the organic light emitting display device according to the second embodiment of the present disclosure, a doping rate of the dopant **112***b* of the HIL **112** of the first light emitting stack **110** may be 0.5% to less than 10%.

In addition, as illustrated in FIG. **4**C, it can be confirmed that, even though different types of materials (e.g., NPD and TPD) for forming the dopant **112***b* are used, the organic light emitting display device of Example 2 including the HIL **112** doped with 1% to 3% of the dopant **112***b* has enhanced luminous efficiency in the entire luminance region when compared to the organic light emitting display device of Comparative Example. Although NPD and TPD have been described as dopant materials by way of example, various other hole transporting materials may be used as dopant materials and the same effect may be obtained using the dopant materials.

In the second embodiment of the present disclosure, two light emitting stacks are used, but embodiments are not limited thereto. That is, at least three light emitting stacks may be formed. For example, as illustrated in FIG. **5**, three light emitting stacks, e.g., first, second and third light emitting stacks **110**, **120** and **140**, may be formed.

An organic light emitting display device illustrated in FIG. **5** includes the first and second electrodes **102** and **104** facing each other, the first, second and third light emitting stacks **110**, **120** and **140** formed between the first and second electrodes **102** and **104**, and charge generation layers **130** respectively disposed between the first and second light emitting stacks **110** and **120** and between the second and third light emitting stacks **120** and **140**.

The first light emitting stack **110** is formed between the first electrode **102** and the charge generation layer **130**. The first light emitting stack **110** includes the HIL **112**, the first HTL **114**, the first EML(B) **116**, and the first ETL **118** that are sequentially formed on the first electrode **102**.

The second light emitting stack **120** is formed between the first and third light emitting stacks **110** and **140**. The second light emitting stack **120** includes the second HTL **124**, the second EML(YG) **126**, and the second ETL **128** that are sequentially formed on the charge generation layer **130**.

The third light emitting stack **120** is formed between the second electrode **104** and the charge generation layer **130**. The third light emitting stack **120** includes a third HTL **144**, a third EML(B) **146**, and a third ETL **148** that are sequentially formed on the charge generation layer **130**.

The first and third EMLs(B) **116** and **146** include a fluorescent blue dopant and host to emit blue light, and the second EML(YG) **126** includes a phosphorescent yellow-green dopant and host to emit orange light. Accordingly, the blue light of the first and third EMLs(B) **116** and **146** and the orange light of the second EML(YG) **126** may be realized as white light through mixing. In particular, a structure of the organic light emitting display device according to a third embodiment of the present disclosure differs from that of the organic light emitting display device of FIG. **3** in that the organic light emitting display device according to the third embodiment further includes the third EML(B) **146** to realize blue color. In addition, white light may be realized using other fluorescent dopants and phosphorescent dopants.

The charge generation layers **130** are respectively formed between the first and second light emitting stacks **110** and **120** and between the second and third light emitting stacks **120** and **140** and control charge balance among the first, second and third light emitting stacks **110**, **120** and **140**. Each charge generation layer **130** includes an N-type charge generation layer **132** and a P-type charge generation layer **134** that are sequentially stacked.

The N-type charge generation layer **132** injects electrons into the first and second light emitting stacks **110** and **120**, and the P-type charge generation layer **134** injects holes into the second and third light emitting stacks **120** and **140**.

The electrons transferred to the first light emitting stack **110** via the N-type charge generation layer **132** and holes transferred via the HIL **112** and the first HTL **114** are combined in the first EML(B) **116** of the first light emitting stack **110**, forming excitons and releasing energy, whereby visible light is emitted.

The electrons transferred to the second light emitting stack **120** via the N-type charge generation layer **132** and holes transferred to the second light emitting stack **120** via the P-type charge generation layer **134** are combined in the second EML(YG) **126** of the second light emitting stack **120**, forming excitons and releasing energy, whereby visible light is emitted.

The holes transferred to the third light emitting stack **140** via the P-type charge generation layer **134** and electrons transferred via the second electrode **104** and the third ETL **148** are combined in the third EML(B) **146** of the third light emitting stack **140**, forming excitons and releasing energy, whereby visible light is emitted.

In the organic light emitting display device according to the third embodiment of the present disclosure, the HIL **112** of the first light emitting stack **110** to emit blue light is formed by doping the host **112***a* with the dopant **112***b* with a doping rate of 0.5% to less than 10% based on a volume of the HIL **112** and has a thickness of about 7 nm or less. In this regard, the dopant **112***b* may be doped on the host **112***a* in a doping rate of 1% to 5% based on the volume of the HIL **112**. The host **112***a* is formed of HAT-CN, and the dopant **112***b* is formed of a hole transporting material having higher hole mobility than electron mobility. In this regard, the hole transporting material may be a material having a hole mobility of 5.0×10^{-5} Vs/cm^2 to 1.0×10^{-2} Vs/cm^2. For example, the hole transporting material may be at least one of NPD, TPD, s-TAD, and MTDATA, and a material for forming at least one of the first, second and third HTLs **114**, **124** and **144** of the first, second and third light emitting stacks **110**, **120** and **140** may be used as the hole transporting material. Accordingly, the hole mobility of the HIL **112** of the first light emitting stack **110**, including a hole transporting material, is enhanced and thus hole injection characteristics at an interface between the HIL **112** and the first HTL **114** of the first light emitting stack **110** are enhanced. As a result, a formation rate of excitons formed through combination between electrons and holes increases due to charge balance in the first EML(B) **116** and, accordingly, luminous efficiency is enhanced.

FIGS. **6**A and **6**B are graphs for explaining all-optical characteristics of organic light emitting display devices of Comparative Example and Example 3.

In particular, as illustrated in FIG. **6**A, the organic light emitting display device of Example 3 including the HIL **112** of the first light emitting stack **110**, doped with the dopant **112***b*, has higher peak intensity (blue peak) of the first EML(B) **116** to realize blue color and higher peak intensity (YG peak) of the second EML(YG) **126** to realize orange color than those of the organic light emitting display device of Comparative Example including an HIL of a first light emitting stack, undoped with a dopant and thus, as shown in Table 3 below, the organic light emitting display device of Example 3 has higher efficiency at 10 mA/cm^2, increased by 2.9% or greater, than that of the organic light emitting display device of Comparative Example.

TABLE 3

	10 mA/cm^2	
	Efficiency (Cd/A)	Roll off
Comparative Example	84.9	0.85
Example 3	87.8	0.87

In addition, as illustrated in FIG. **6**B, the organic light emitting display device of Example 3 including the HIL **112** of the first light emitting stack **110**, doped with 1 to 3% of the dopant **112***b*, has higher luminous efficiency in the entire luminance region than that of the organic light emitting display device of Comparative Example including an HIL of a first light emitting stack, undoped with a dopant. In addition, the organic light emitting display device of Example 3 has a roll-off factor (a ratio of efficiency at a current density of 50 mA/cm^2 to efficiency at a current density of 10 mA/cm^2) of 0.87, which is higher than that of the organic light emitting display device of Comparative Example having a roll-off factor of 0.85. From the results, it can be confirmed that the organic light emitting display device having a multi-stack light emitting structure according to the third embodiment of the present disclosure undergoes reduced roll-off phenomenon in which efficiency is decreased in a high luminance region.

The organic light emitting display devices according to the present disclosure may be applied to a structure having red, green and blue color filters **150**R, **150**G and **150**B as illustrated in FIG. **7**. White light generated via the first and second light emitting stacks **110** and **120** illustrated in FIG. **3** or white light generated via the first, second and third light emitting stacks **110**, **120** and **140** illustrated in FIG. **5** is emitted as red light while passing through a sub-pixel region provided with the red color filter **150**R, is emitted as green light while passing through a sub-pixel region provided with the green color filter **150**G, is emitted as blue light while passing through a sub-pixel region provided with the blue color filter **150**B, and is emitted unchanged while passing through a sub-pixel region not provided with a color filter.

As is apparent from the foregoing description, in organic light emitting display devices according to the present disclosure, a hole injection layer is formed by doping a host formed of HAT-CN with a hole transporting material. Accordingly, hole mobility of the hole injection layer is enhanced and thus hole injection characteristics at an interface between the hole injection layer and a hole transport layer are enhanced. As a result, a formation rate of excitons formed through combination between electrons and holes increases due to stable charge balance in an emission layer and thus luminous efficiency may be enhanced and a roll-off phenomenon may also be reduced. In particular, when the organic light emitting display devices according to the present disclosure are applied to a large area display panel, power consumption may be reduced.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure without departing from the spirit or scope of the disclosure. Thus, it is intended that the present disclosure covers the modifications and variations of this disclosure provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An organic light emitting display device comprising:

a first electrode and a second electrode facing each other on a substrate; a blue emission layer formed between the first electrode and the second electrode; a hole injection layer and a hole transport layer, formed between the blue emission layer and the first electrode; and an electron transport layer formed between the blue emission layer and the second electrode, wherein the hole injection layer is formed by doping a host formed of HAT-CN with 1 vol. % to less than 3 vol. % of a dopant that is a hole transporting material based on a volume of the hole injection layer, wherein the dopant is formed of at least one of N,N-dinaphthyl-N,N'-diphenyl benzidine (NPD), N,N'-bis-(3-methylphenyl)-N,N'-bis-(phenyl)-benzidine (TPD), or s-TAD.

2. The organic light emitting display device according to claim **1**, wherein the dopant is a same material as that of the hole transport layer.

3. The organic light emitting display device according to claim **1**, wherein the dopant is a material having a hole mobility higher than an electron mobility, the hole mobility from 5.0×10^{-5} Vs/cm^2 to 1.0×10^{-2} Vs/cm^2.

4. The organic light emitting display device according to claim **1**, further comprising:

a first light emitting stack including the hole injection layer, the hole transport layer, the blue emission layer, and electron transport layer;

a second light emitting stack including a phosphorescent yellow-green emission layer between the first light emitting stack and the second electrode; and

a charge generation layer between the first and second light emitting stacks.

* * * * *

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摘要(译)

有机发光显示装置包括在基板上彼此面对的第一和第二电极，在第一和第二电极之间形成的电荷产生层，在电荷产生层和第一电极之间形成的第一发光叠层，以及第二光发光堆叠形成在电荷产生层和第二电极之间，其中通过掺杂由六氮杂苯并菲（HAT-CN）形成的主体形成用于实现第一和第二发光叠层的蓝色的发光叠层的空穴注入层。基于空穴注入层的体积，由空穴传输材料形成的掺杂剂的0.5%至小于10%。