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(54) **WHITE LIGHT EMITTING ORGANIC ELECTROLUMINESCENT DEVICE AND ORGANIC ELECTROLUMINESCENT DISPLAY HAVING THE SAME**

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(57) **ABSTRACT**

A white light emitting organic electroluminescent device and organic electroluminescent display having the same are provided. The organic electroluminescent device includes a first electrode, a second electrode, and an emission layer interposed between the first and second electrodes and having a fluorescence layer and a phosphorescence layer. Thereby, it is possible to obtain the white light emitting organic electroluminescent device having luminance yield improved.

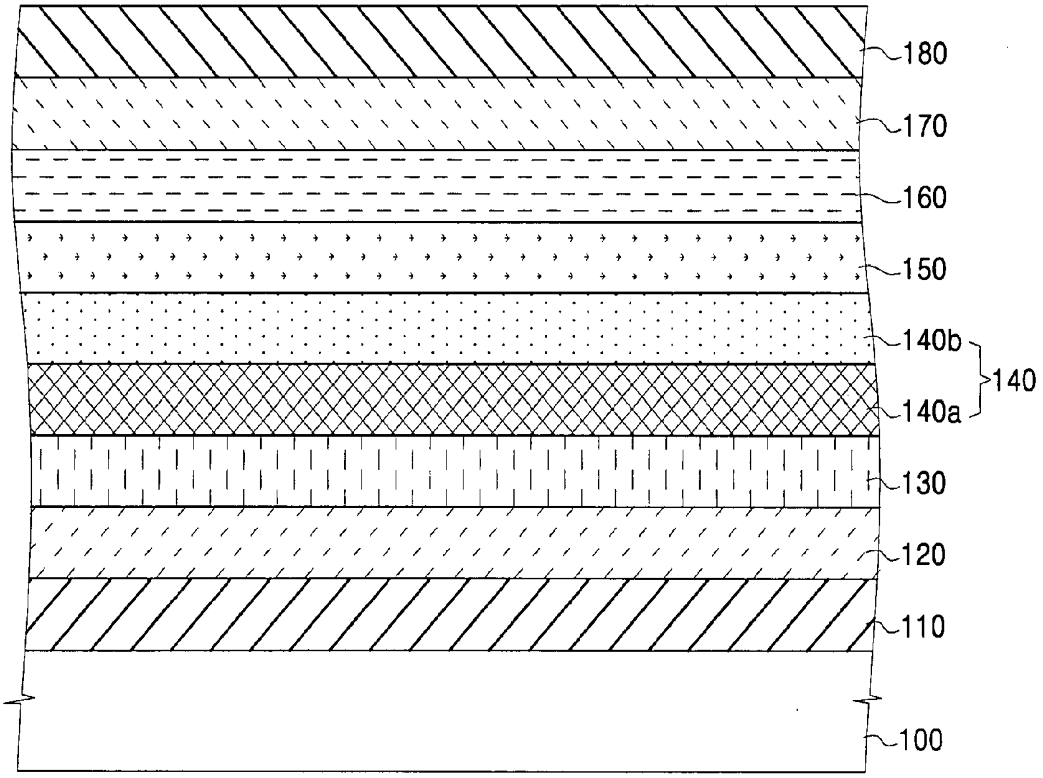


FIG. 1

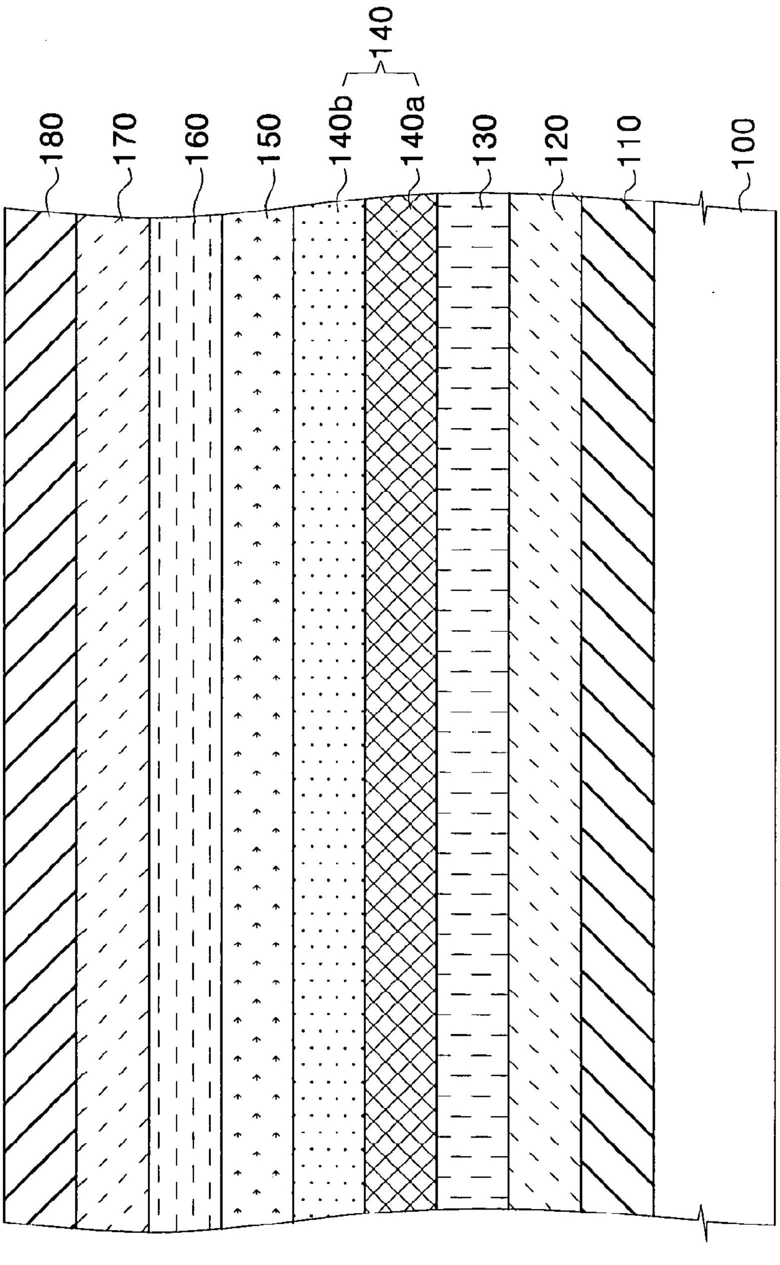


FIG. 2

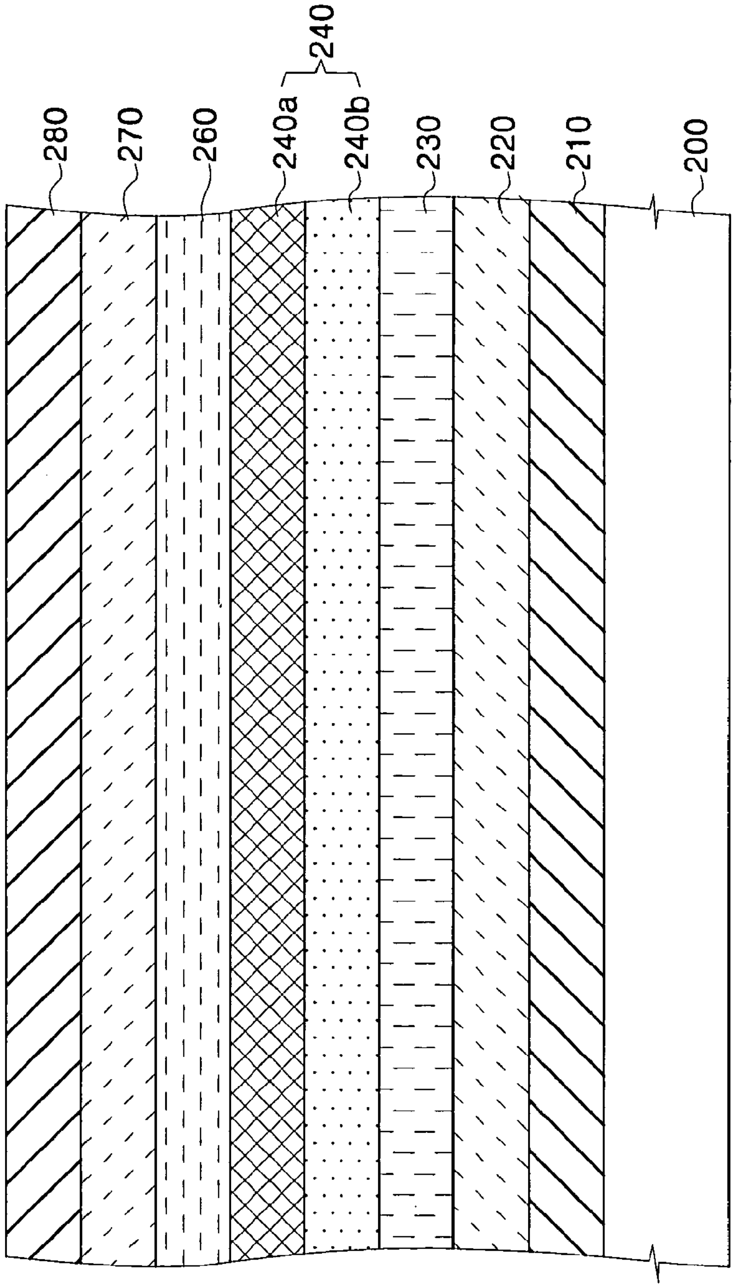
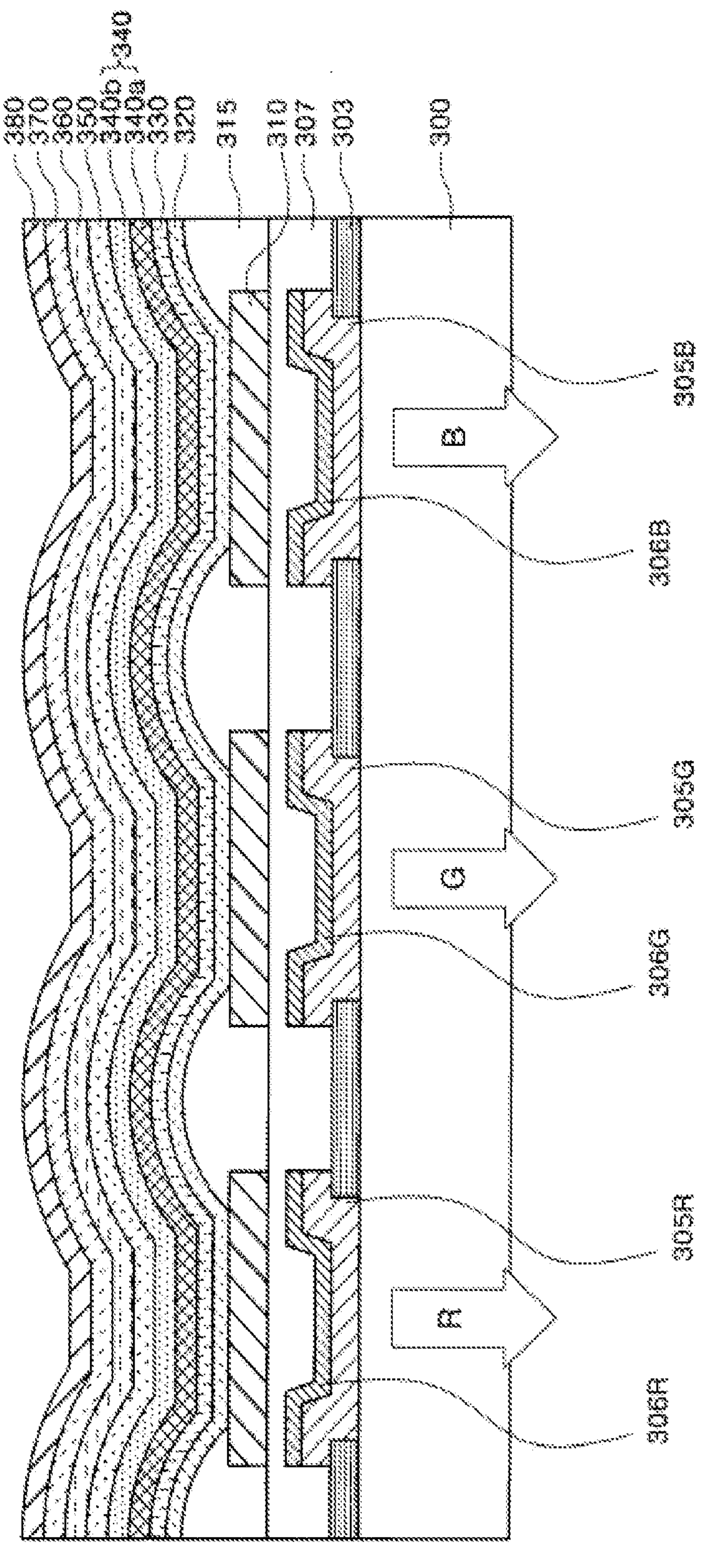


FIG. 3


380
370
360
350
340b
340a
340
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320
315
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307
303
300
305B
B
306B
305G
G
306G
305R
R
306R

WHITE LIGHT EMITTING ORGANIC ELECTROLUMINESCENT DEVICE AND ORGANIC ELECTROLUMINESCENT DISPLAY HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 11/019,461, filed on Dec. 23, 2004, and claims priority to and the benefit of Korean Patent Application No. 10-2004-0002454, filed on Jan. 13, 2004, which are all hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an organic electroluminescent device and, more particularly, to an organic electroluminescent device emitting white light.

[0004] 2. Description of the Related Art

[0005] An organic electroluminescent device emitting white light has a variety of applications for a paper thin light source, a backlight of a liquid crystal display, a full color display employing a color filter, and so forth.

[0006] This white light emitting organic electroluminescent device has been disclosed in U.S. Pat. No. 6,627,333. According to U.S. Pat. No. 6,627,333, the organic electroluminescent device is composed of a first electrode, a hole injection layer, a hole transport layer, an emission layer, an electron transport layer, an electron injection layer, and a second electrode. The emission layer is doped with a compound emitting blue fluorescent light, and the hole transport layer and/or the electron transport layer which come(s) into contact with the emission layer are/is doped with a compound emitting yellow fluorescent light. However, according to U.S. Pat. No. 6,627,333, the organic electroluminescent device shows a low luminance yield of 3 to 5 cd/A or so.

SUMMARY OF THE INVENTION

[0007] The present invention, therefore, solves aforementioned problems associated with the conventional art by providing an organic electroluminescent device having luminance yield improved.

[0008] In an exemplary embodiment according to the present invention, an organic electroluminescent device emitting white light includes a first electrode, a second electrode, and an emission layer interposed between the first and second electrodes and having a fluorescence layer and a phosphorescence layer.

[0009] In another exemplary embodiment according to the present invention, an organic electroluminescent display includes: first and second electrodes, at least one of which is a transparent electrode; an emission layer interposed between the first and second electrodes and having a fluorescence layer and a phosphorescence layer to emit white light on driving; and a color filter layer located on a path through which light extracted outside from the emission layer passes.

[0010] In the organic electroluminescent device or the organic electroluminescent display, the fluorescence layer, preferably, is the emission layer emitting light in the blue range. In this case, the fluorescence layer may include one selected from a group consisting of distyrylarylene (DSA), a DSA derivative, distyrylbenzene (DSB), a DSB derivative, 4,4'-bis(2,2'-diphenyl vinyl)-1,1'-biphenyl (DPVBi), a DPVBi derivative, spiro-DPVBi, spiro-sexyphenyl (spiro-6P), 9,10-bis[(2'7"-t-butyl)-9',9"-spirobifluorenyl]anthracene (TBSA), 2,5-bis{4-[bis-(9,9-dimethyl-2-fluorenyl) amino]phenyl}thiophene (BFA-1T), and N-arylbenzimidazoles (TPBI). In addition, preferably, the fluorescence layer further includes one dopant material selected from a group consisting of a styrylamine, a phenylene, and a distyrylbiphenyl.

[0011] In the organic electroluminescent device or the organic electroluminescent display, the phosphorescence layer may be the emission layer emitting light in the orange-red range. In this case, the phosphorescence layer may include one, as a host material, selected from a group consisting of an arylamine, a carbazole, and a spiro. The host material may include one selected from a group consisting of 4,4-N,N dicarbazole-biphenyl (CBP), a CBP derivative, N,N-dicarbazolyl-3,5-benzene (mCP) and a mCP derivative. The phosphorescence layer may include a phosphorescent organic metal complex having one central metal selected from a group consisting of Ir, Pt, Tb and Eu, as a dopant material. The dopant material may include one phosphorescent organic metal complex selected from a group consisting of PQIr(acac), PQ$_2$Ir(acac) (iridium(III)bis(2-phenylquinolyl-N,C2')acetylacetonate), PIQIr(acac), PtOEP (2,3,7,8,12,13,17,18-octaethyl-21H,23H-porphine platinum), bis(2-(2'-benzo[4,5-a]thienyl)pyridinato-N,C2')iridium(acetylacetonate) (Btp$_2$Ir), and Tris[1-phenylisoquinolinato-C2,N]iridium(III) (Ir(piq)$_3$).

[0012] Most preferably, the fluorescence layer is the emission layer emitting light in the blue range, and the phosphorescence layer is the emission layer emitting light in the orange-red range.

[0013] The organic electroluminescent device or the organic electroluminescent display may further include at least one selected from a group consisting of a hole injection layer, a hole transport layer, an electron injection layer, an electron transport layer and a hole blocking layer.

[0014] In the organic electroluminescent device or the organic electroluminescent display, the first electrode may be an anode, the fluorescence layer may be located on the first electrode, and the phosphorescence layer may be located on the fluorescence layer. In this case, the organic electroluminescent device may further include a hole blocking layer located on the phosphorescence layer. At this time, the fluorescence layer, preferably, has a thickness of 50 to 200 Å, and the phosphorescence layer, preferably, has a thickness of 50 to 300 Å.

[0015] Alternatively, the first electrode may be an anode, the phosphorescence layer may be located on the first electrode, and the fluorescence layer may be located on the phosphorescence layer. At this time, the phosphorescence layer, preferably, has a thickness of 50 to 200 Å, and the fluorescence layer, preferably, has a thickness of 50 to 300 Å.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above and other features and advantages of the present invention will become more apparent to those of ordinary skill in the art by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

[0017] FIG. **1** is a cross-sectional view for illustrating an organic electroluminescent device and method of fabricating the same in accordance with a first embodiment of the present invention;

[0018] FIG. **2** is a cross-sectional view for illustrating an organic electroluminescent device and method of fabricating the same in accordance with a second embodiment of the present invention; and

[0019] FIG. **3** is a cross-sectional view showing a full-color organic electroluminescent display and method of fabricating the same in accordance with a third embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Hereinafter, the present invention will now be described in more detail with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those ordinarily skilled in the art. In the drawings, like numbers refer to like elements throughout the specification.

[0021] FIG. **1** is a cross-sectional view for explaining an organic electroluminescent device and a method of fabricating the same in accordance with a first embodiment of the present invention.

[0022] Referring to FIG. **1**, a first electrode **110** is formed on a substrate **100**. The first electrode **110** may be formed of a transparent electrode or a reflective electrode. When the first electrode **110** is formed of the transparent electrode, it is formed of ITO (indium tin oxide) or IZO (indium zinc oxide). When the first electrode **110** is formed of the reflective electrode, it is formed of Ag, Al, Mi, Pt, Pd, or their alloys. Thereby, the first electrode **110** may be formed as an anode.

[0023] A hole injection layer (HIL) **120** as an electric charge injection layer, and a hole transport layer (HTL) **130** as an electric charge transport layer may be sequentially formed on the first electrode **110**. Alternatively, any one of the hole injection layer **120** and the hole transport layer **130** may not be formed. The hole injection layer **120** is a layer for facilitating to inject holes into an emission layer which will be formed in the subsequent process, which may be formed of a low molecular weight material such as CuPc, TNATA, TCTA, TDAPB or TDATA, or a polymer material (high molecular material) such as PANI or PEDOT. Further, the hole transport layer **130** is a layer for facilitating to transport holes to an emission layer which will be formed in the subsequent process, which may be formed of a low molecular weight material such as α-NPB, TPD, s-TAD or MTADATA, or a polymer material such as PVK.

[0024] A fluorescence layer **140***a* is formed on the hole transport layer **130**. The fluorescence layer **140***a* is preferably formed of an emission layer that emits light belonging to a blue range. The blue light may have a wavelength of 440 to 500 nm. In this case, the fluorescence layer **140***a* may be formed to contain one selected from a group consisting of DSA (distyrylarylene), a DSA derivative, DSB (distyrylbenzene), a DSB derivative, DPVBi (4,4'-bis(2,2'-diphenyl vinyl)-1,1'-biphenyl), a DPVBi derivative, spiro-DPVBi, spiro-sexyphenyl(spiro-6P), 9,10-bis[(2"7"-t-butyl)-9',9"-spirobifluorenyl]anthracene (TBSA), 2,5-bis{4-[bis-(9,9-dimethyl-2-fluorenyl)amino]phenyl}thiophene (BFA-1T), and N-arylbenzimidazole (TPBI). Furthermore, the fluorescence layer **140***a* may be formed to further contain one selected from a group consisting of a styrylamine, a phenylene, and a DSBP (distyrylbiphenyl), as a dopant material.

[0025] A phosphorescence layer **140***b* is formed on the fluorescence layer **140***a*. The phosphorescence layer **140***b* is preferably formed of an emission layer that emits light belonging to an orange-red range. The orange-red light may have a wavelength of 560 to 620 nm. In this case, the phosphorescence layer **140***b* may contain one selected from a group consisting of an arylamine, a carbazole, and a spiro group. The host material may include on selected from a group consisting of 4,4-N,N dicarbazole-byphenyl (CBP), a (CBP) derivative, N,N-dicarbazolyl-3,5-benzene (mCP), and an mCP derivative. In addition, the phosphorescence layer **140***b* may include a phosphorescent organic metal complex having one central metal selected from a group consisting of Ir, Pt, Tb, and Eu, as a dopant material. The dopant material may contain one, as a phosphorescent organic metal complex, selected from a group consisting of PQIr(acac), PQ_2Ir (acac), PIQIr(acac), PtOEP, Btp_2Ir, and $Ir(piq)_3$.

[0026] Most preferably, the fluorescence layer **140***a* is formed as an emission layer emitting blue light, and the phosphorescence layer **140***b* in formed as an emission layer emitting orange-red light. Alternatively, the fluorescence layer **140***a* may be formed as an emission layer emitting orange-red light, and the phosphorescence layer **140***b* may be formed as an emission layer emitting blue light.

[0027] The fluorescence layer **140***a* and the phosphorescence layer **140***b* serve as an emission layer (EML) **140**. Thereby, in the process of driving the organic electroluminescent device, the emission layer **140** may emit white light.

[0028] Meanwhile, the fluorescence layer **140***a* neighboring the first electrode **110** or the anode, preferably, has a thickness of 50 to 200 Å, and the phosphorescence layer **140***b*, preferably, has a thickness of 50 to 300 Å. Thereby, in the process of driving the organic electroluminescent device, a width of an emission region formed within the emission layer **140** may be increased.

[0029] A hole blocking layer (HBL) **150** may be formed on the phosphorescence layer **140***b*. The hole blocking layer **150** serves to suppress excitons generated from the phosphorescence layer **140***b* from diffusing in the process of driving the organic electroluminescent device. The hole blocking layer **150** may be formed of Balq, BCP, CF-X, TAZ, or spiro-TAZ.

[0030] Subsequently, an electron transport layer (ETL) **160***a* s an electric charge transport layer and electron injection layer (EIL) **170** as an electric charge injection layer may be sequentially formed on the hole blocking layer **150**. Anyone of the electron transport layer **160** and the electron injection layer **170** may not be formed. The electron transport layer **160** is a layer for facilitating to transport electrons to the emission layer **140**, and may be formed, for example, either of a polymer material such as PBD, TAZ, or spiro-PBD, or of a low molecular weight material such as Alq3, BAlq or SAlq. The electron injection layer **170** is a layer for facilitating to inject electrons into the emission layer **140**, and may be formed, for example, of Alq3, LiF, a Ga complex, or PBD.

[0031] Next, a second electrode **180** may be formed on the electron injection layer **170**. The second electrode **180** is formed of Mg, Ca, Al, Ag, Ba, or their alloys. Further, the second electrode **180** is formed to be thin enough to penetrate light in the case of a transparent electrode, and to be thick in the case of a relative electrode. Thereby, the second electrode

180 may be formed as a cathode. Any of of the first and second electrodes **110** and **180** is formed of the transparent electrode that light can penetrate.

[0032] Alternatively, the first electrode **110** may be formed as a cathode, and the second electrode **180** may be formed as an anode. In this case, the organic electroluminescent device may be formed to have a structure where the first electrode **110**, the electron injection layer **170**, the electron transport layer **160**, the hole blocking layer **150**, the phosphorescence layer **140***b*, the fluorescence layer **140***a*, the hole transport layer **130**, the hole injection layer **120**, and the second electrode **180** are sequentially stacked on the substrate **100**.

[0033] FIG. **2** is a cross-sectional view for illustrating an organic electroluminescent device and method of fabricating the same in accordance with a second embodiment of the present invention. The organic electroluminescent device according to the second embodiment has an emission layer that is different from that according to the first embodiment.

[0034] Referring to FIG. **2**, a first electrode **210** is formed on a substrate **200**. The first electrode **210** may be formed of a transparent electrode or a reflective electrode. When the first electrode **210** is a transparent electrode, it is formed of ITO or IZO. When the first electrode **210** is a reflective electrode, it is formed of Ag, Al, Ni, Pt, Pd, or their alloys. Thereby, the first electrode **210** may be formed as an anode.

[0035] A hole injection layer (HIL) **220** as an electric charge injection layer, and a hole transport layer (HTL) **230** as an electric charge transport layer may be sequentially formed on the first electrode **210**. Alternatively, any one of the hole injection layer **220** and the hole transport layer **230** may not be formed. The hole injection layer **220** is a layer for injecting electric charges into an emission layer which will be formed in the subsequent process, which may be formed of a low molecular weight material such as CuPc, TNATA, TCTA, TDAPB, or TDATA, or a polymer material such as PANI or PEDOT. Further, the hole transport layer **230** is a layer for transporting electric charges to an emission layer which will be formed in the subsequent process, which may be formed of a low molecular weight material such as α-NPB, TPD, s-TAD, or MTADATA, or a polymer material such as PVK.

[0036] A phosphorescence layer **240***b* is formed on the hole transport layer **230**. The phosphorescence layer **240***b* is preferably formed of an emission layer that emits light belonging to an orange-red range. The orange-red light may have a wavelength of 560 to 620 nm. In this case, the phosphorescence layer **240***b* may contain one selected from a group consisting of arylamines, carbaxoles, and spiros, which are host materials. The host material may include on selected from a group consisting of 4,4-N,N dicarbazole-byphenyl (CBP), (CBP) derivative, N,N-dicarbazolyl-3,5-benzene (mCP) and mCP derivative. In addition, the phosphorescence layer **240***b* may include a phosphorescent organic metal complex having one central metal selected from a group consisting of Ir, Pt, Tb, and Eu, as a dopant material. The dopant material may contain one, as a phosphorescent organic metal complex, selected from a group consisting of PQIr(acac), PQ_2Ir (acac), PIQIr(acac), PtOEP, Btp_2Ir, and $Ir(piq)_3$.

[0037] A fluorescence layer **240***a* is formed on the phosphorescence layer **240***b*. The fluorescence layer **240***a* is preferably formed of an emission layer that emits light belonging to a blue range. The blue light may have a wavelength of 440 to 500 nm. In this case, the fluorescence layer **240***a* may be formed to contain one selected from a group consisting of DSA, DSA derivative, DSB, DSB derivative, DPVBi, DPVBi derivative, spiro-DPVBi, spiro-6P, TBSA, BFA-1T and TPBI. Furthermore, the fluorescence layer **240***a* may be formed to further contain one selected from a group consisting of styrylamines, phenylenes, and DSBPs (distyrylbiphenyls), as a dopant material.

[0038] Both the phosphorescence layer **240***b* and the fluorescence layer **240***a* constitute the emission layer **240**. Thereby, in the process of driving the organic electroluminescent device, the emission layer **240** may emit white light.

[0039] Most preferably, the phosphorescence layer **240***b* is formed as an emission layer emitting orange-red light, and the fluorescence layer **240***a* is formed as an emission layer emitting blue light. Alternatively, the phosphorescence layer **240***b* may be formed as an emission layer emitting blue light, and the fluorescence layer **240***a* may be formed as an emission layer emitting orange-red light.

[0040] Meanwhile, the phosphorescence layer **240***b* neighboring the first electrode **210** or the anode, preferably, has a thickness of 50 to 200 Å, and the fluorescence layer **240***a*, preferably, has a thickness of 50 to 300 Å. Thereby, in the process of driving the organic electroluminescent device, an emission region formed within the emission layer **240** may be increased in width.

[0041] The fluorescence layer **240***a* may serve as a hole blocking layer with respect to the phosphorescence layer **240***b*. Alternatively, the hole blocking layer (not shown) may be separately formed on the fluorescence layer **240***a*. The hole blocking layer serves to suppress excitons generated from the phosphorescence layer **240***b* from diffusing in the process of driving the organic electroluminescent device. When the hole blocking layer is separately formed, it may be formed of BAlq, BCP, CF-X, TAZ, or spiro-TAZ.

[0042] Subsequently, an electron transport layer **260** as an electric charge transport layer and an electron injection layer **270** may be formed on the hole blocking layer or on the fluorescence layer **240***a* when the hole blocking layer is not formed. Alternatively, one or both of the electron transport layer **260** and the electron injection layer **270** may be omitted. The electron transport layer **260** is a layer for transporting electrons to the emission layer **240**, and may be formed, for example, either of a polymer material such as PBD, TAZ, or spiro-PBD, or of a low molecular weight material such as Alq3, Balq, or SAlq. The electron injection layer **270** is a layer for injecting electrons into the emission layer **240**, and may be formed, for example, or Alq3, LiF, Ga complex, or PBD.

[0043] Next, a second electrode **280** may be formed on the electron injection layer **270**. The second electrode **280** is formed on Mg, Ca, Al, Ag, Ba, or their alloys. Further, the second electrode **280** is formed to be thin enough for light to penetrate when being a transparent electrode, and to be thick when being a reflective electrode. Thereby, the second electrode **280** may be formed as a cathode. However, any one of the first and second electrodes **210** and **280** is formed of a transparent electrode light can penetrate.

[0044] Alternatively, the first electrode **210** may be formed as a cathode, and the second electrode **280** may be formed as an anode. In this case, the organic electroluminescent device may be formed to have a structure where the first electrode **210**, the electron injection layer **270**, the electron transport layer **260**, the fluorescence layer **240***a*, the phosphorescence layer **240***b*, the hole transport layer **230**, the hole injection layer **220** and the second electrode **280** are sequentially stacked on the substrate **200**.

[0045] FIG. **3** is a cross-sectional view showing a full-color organic electroluminescent display and method of fabricating the same in accordance with a third embodiment of the present invention.

[0046] Referring to FIG. **3**, there is provided a substrate **300**. The substrate **300** may be provided with a transparent substrate that light can penetrate. Black matrixes **303** that are spaced apart from each other are formed on the substrate **300**. The black matrixes **303** serve to absorb external light and scattered light. A red color filter layer **305**R, a green color filter layer **305**G and a blue color filter layer **305**B are each formed between the black matrixes **303**.

[0047] Each color filter layer may contain a pigment and a polymeric binder. The red color filter layer **305**R, the green color filter layer **305**G, and the blue color filter layer **305**B have characteristics that selectively allow penetration of light emitted from an emission layer, which will be formed in the subsequent process, more specifically, a wavelength in the red range, a wavelength in the green range, and a wavelength in the blue range, respectively. To this end, the red, green, and blue color filter layers **305**R, **305**G, and **305**B contain pigments having different properties from each other.

[0048] A red color conversion layer **306**R, a green color conversion layer **306**G, and a blue color conversion layer **306**B are formed on the red, green, and blue color filter layers **305**R, **305**G, and **305**B, respectively. Alternatively, these color conversion layers may not be formed. The color conversion layers may contain a fluorescent material and a polymer binder. The fluorescent material is excited by light incident from the emission layer and then transitioned to a ground state, thereby emitting light having a wavelength longer than the incident light. Thus, the red, green, and blue color conversion layers **306**R, **306**G, and **306**B contain fluorescent materials having different properties from each other.

[0049] An overcoating layer **307** is formed on the substrate on which the red, green and blue color conversion layers **306**R, **306**G and **306**B have been formed. The overcoating layer **307** is formed of a transparent layer, and serves not only to protect the red, green and blue color filter layers **305**R, **305**G, and **305**B and the red, green and blue color conversion layers **306**R, **306**G, and **306**B from a physical damage, but also to release a step generated by formation of the red, green and blue color filter layers **305**R, **305**G, and **305**B and the red, green and blue color conversion layers **306**R, **306**G, and **306**B. First electrodes **310** are formed on the overcoating layer **307**, so as to correspond to the red, green and blue color filter layers **305**R, **305**G and **305**B, respectively. The first electrodes **310** may be formed of transparent electrodes.

[0050] A pixel defining layer **315** having an opening that partially exposes a surface of each of the first electrodes **310** may be formed on the substrate **300** on which the first electrodes **310** have been formed. The pixel defining layer **315** is formed, for example, of an acryl-based organic layer. Next, a fluorescence layer **340***a* and a phosphorescence layer **340***b* are sequentially formed on the entire surface of the substrate including the exposed first electrodes **310**. The fluorescence layer **340***a* and the phosphorescence layer **340***b* constitute an emission layer **340**. A hole injection layer **320** and/or a hole transport layer **330** may be further formed on the exposed first electrodes **310** before the fluorescence layer **340***a* is formed. A hole blocking layer **350** may be formed on the phosphorescence layer **340***b*. Subsequently, an electron transport layer **360** and/or an electron injection layer **370** may be formed on the hole blocking layer **350**. Next, a second electrode **380** running across the first electrodes **310** is formed on the electron injection layer **370**. A detailed description about the first electrodes **310**, the hole injection layer **320**, the hole transport layer **330**, the fluorescence layer **340***a*, the phosphorescence layer **340***b*, the hole blocking layer **350**, the electron transport layer **360**, and the electron injection layer **370** will make reference to the first embodiment.

[0051] Alternatively, the emission layer **340** may be formed as in the organic electroluminescent device according to the foregoing second embodiment.

[0052] When the organic electroluminescent display is driven, the emission layer **340** emits white light. The white light emitted from the emission layer **340** is extracted outside through the first electrodes **310** as transparent electrodes and the substrate **300** as a transparent substrate. At this time, the red, green and blue color filter layers **305**R, **305**G and **305**B are located on a path through which the light extracted outside from the emission layer **340** passes. Therefore, while the organic electroluminescent display is driven, the white light emitted from the emission layer **340** passes through each of the red, green and blue color filter layers **305**R, **305**G, and **305**B to be extracted outside, so that it is possible to realize full colors of red (R), green (G), and blue (B).

[0053] While the embodiments have described the organic electroluminescent display where the color filter layers are located under the emission layer **340**, i.e., a bottom emission organic electroluminescent display by way of an example, it may be understood to those skilled in the art that the present invention may be applied to a top emission organic electroluminescent display or a double-sided emission organic electroluminescent display.

[0054] Hereinafter, examples are presented in order to help illustrate the present invention. However, the following examples are only intended to help illustrate, and not to restrict, the present invention.

FABRICATION EXAMPLE

[0055] Fabrication of White Light Emitting Organic Electroluminescent Device

[0056] A first electrode having an area of 2 mm×2 mm was formed of ITO on a substrate. The substrate was subjected to ultrasonic cleaning and UV-03 cleaning. A hole injection layer was formed by vacuum depositing TDATA (4,4'4"-tris (N,N-diphenyl-anino)triphenylamine) to a thickness of 600 Å on the first electrode cleaned with UV-03. A hole transport layer was formed by vacuum depositing α-NPB (N,N'-bis (naphthalene-1-yl)-N,N'bis(phenyl)benzidine; HOMO (highest occupied molecular orbital) 5.4 eV, LUMO (lowest unoccupied molecular orbital) 1.9 eV) to a thickness of 300 Å on the hole injection layer. A fluorescence layer emitting blue light was formed by doping 4,4'-bis[2,2'-di(4dialkylaminophenyl)vinyl]-1,1'-biphenyl into DPVBi at 1.5 wt % and vacuum depositing the doped material to a thickness of 60 Å on the hole transport layer. A phosphorescence layer emitting orange-red light was formed by doping $PQ_2Ir(acac)$ (iridium (III) bis(2-phenylquinolylN,C2')acetylacetonate) into CBP (available from UDC company) at 7 wt %, and vacuum depositing the doped material to a thickness of 250 Å on the fluorescence layer. A hole blocking layer, an electron transport layer and an electron injection layer were sequentially formed on the phosphorescence layer by vacuum depositing BAlq to a thickness of 50 Å, by vacuum depositing Alq3 to a thickness of 300 Å, and by vacuum depositing LiF to a thickness of 20 Å, respectively. A second electrode was formed by vacuum depositing aluminum (Al) on the electron injection layer to a thickness of 3000 Å.

COMPARATIVE EXAMPLE

[0057] Fabrication of White Light Emitting Organic Electroluminescent Device

[0058] A first electrode having an area of 2 mm×2 mm was formed of ITO on a substrate. The substrate was subjected to ultrasonic cleaning and UV-03 cleaning. A hole injection layer was formed by vacuum depositing TDATA to a thickness of 600 Å on the first electrode cleaned with UV-03. A hole transport layer was formed by vacuum depositing α-NPB to a thickness of 300 Å on the hole injection layer. A first fluorescence layer emitting blue light was formed by doping 4,4'-bis[2,2'-di(4-dialkylaminophenyl)vinyl]-1,1'-biphenyl into DPVBi at 1.5 wt % and vacuum depositing the doped material to a thickness of 60 Å on the hole transport layer. A second fluorescence layer emitting orange-red light was formed by doping IDEMITSUP1 (available from Idemitsu Company) into DPVBi at 3 wt % and vacuum depositing the doped material to a thickness of 250 Å on the first fluorescence layer. A hole blocking layer, an electron transport layer and electron injection layer were sequentially formed on the second fluorescence layer by vacuum depositing BAlq to a thickness of 50 Å, by vacuum depositing Alq3 to a thickness of 300 Å, and by vacuum depositing LiF to a thickness of 20 Å, respectively. A second electrode was formed by vacuum depositing aluminum (Al) to a thickness of 3000 Å on the electron injection layer.

[0059] The following Table 1 shows luminance yield of the white light emitting organic electroluminescent devices fabricated according to the Fabrication Example and the Comparative Example.

TABLE 1

	Reference Voltage (V, @ 500 cd/m^2)	Luminance yield (cd/A)
Fabrication Example	7.5	12.5
Comparative Example	6.0	9.4

[0060] Referring to Table 1, it may be seen that the luminance yield of the organic electroluminescent device according to Fabrication Example is improved compared to that of the organic electroluminescent device according to Comparative Example.

[0061] According to exemplary embodiments of the present invention as set forth above, it is possible to obtain a white light emitting organic electroluminescent device having an improved luminance yield by including an emission layer having a fluorescence layer and a phosphorescence layer.

[0062] Although the present invention has been described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that a variety of modifications and variations may be made to the present invention without departing from the spirit or scope of the present invention defined in the appended claims, and their equivalents.

What is claimed is:

1. An organic electroluminescent device emitting white light, comprising:

a first electrode;

a second electrode; and

an emission layer interposed between the first and second electrodes and comprising a fluorescence layer and a phosphorescence layer.

2. The organic electroluminescent device as claimed in claim **1**, wherein the fluorescence layer emits light in a blue range.

3. The organic electroluminescent device as claimed in claim **2**, wherein the fluorescence layer comprises one selected from the group consisting of distyrylarylene (DSA), a DSA derivative, distyrylbenzene (DSB), a DSB derivative, 4,4'-bis(2,2'-diphenyl vinyl)-1,1'-biphenyl (DPVBi), a DPVBi derivative, spiro-DPVBi, spiro-sexyphenyl (spiro-6P), 9,10-bis[(2"7"-t-butyl)-9',9"-spirobifluorenyl]anthracene (TBSA), 2,5-bis{4-[bis-(9,9-dimethyl-2-fluorenyl) amino]phenyl}thiophene (BFA-1T), and N-arylbenzimidazoles (TPBI).

4. The organic electroluminescent device as claimed in claim **3**, wherein the fluorescence layer further comprises a dopant material selected from the group consisting of a styrylamine, a phenylene, and a distyrylbiphenyl.

5. The organic electroluminescent device as claimed in claim **1**, wherein the phosphorescence layer emits light in an orange-red range.

6. The organic electroluminescent device as claimed in claim **5**, wherein the phosphorescence layer comprises a host material selected from the group consisting of an arylamine, a carbazole, and a spiro.

7. The organic electroluminescent device as claimed in claim **6**, wherein the host material comprises one selected from the group consisting of 4,4-N,N dicarbazole-biphenyl (CBP), a CBP derivative, N,N-dicarbazolyl-3,5-benzene (mCP), and an mCP derivative.

8. The organic electroluminescent device as claimed in claim **5**, wherein the phosphorescence layer comprises a phosphorescent organic metal complex comprising a central metal selected from the group consisting of Ir, Pt, Tb, and Eu, as a dopant material.

9. The organic electroluminescent device as claimed in claim **8**, wherein the dopant material comprises a phosphorescent organic metal complex selected from the group consisting of PQIr (tris(1-phenylquinoline)iridium), PQIr(acac) (bis(1-phenylquinoline)acetylacetonate iridium), PQ$_2$Ir (acac) (iridium III) bis(2-phenylquinolyl-N,C2')acetylacetonate), PIQIr(acac) (bis(1-phenylisoquinoline)acetylacetonate iridium), PtOEP(octaethylporphyrin platinum), Btp$_2$Ir bis(2-(2'-benzo[4,5-a]thienyl)pyridinato-N,C2')iridium (acetylacetonate), and Ir(piq)$_3$(tris[1-phenylisoquinolinato-C2,N]iridium(III)).

10. The organic electroluminescent device as claimed in claim **1**, wherein:

the fluorescence layer emits light in a blue range; and

the phosphorescence layer emits an orange-red range.

11. The organic electroluminescent device as claimed in claim **11**, further comprising at least one selected from the group consisting of a hole injection layer, a hole transport layer, an electron injection layer, an electron transport layer, and a hole blocking layer.

12. The organic electroluminescent device as claimed in claim **1**, wherein:

the first electrode is an anode;

the fluorescence layer is disposed on the first electrode; and

the phosphorescence layer is disposed on the fluorescence layer.

13. The organic electroluminescent device as claimed in claim **12**, further comprising a hole blocking layer disposed on the phosphorescence layer.

14. The organic electroluminescent device as claimed in claim **12**, wherein the fluorescence layer has a thickness in a range of 50 to 200 Å.

15. The organic electroluminescent device as claimed in claim **12**, wherein the phosphorescence layer has a thickness in a range of 50 to 300 Å.

16. The organic electroluminescent device as claimed in claim **1**, wherein:

the first electrode is an anode;

the phosphorescence layer is disposed on the first electrode; and

the fluorescence layer is disposed on the phosphorescence layer.

17. The organic electroluminescent device as claimed in claim **16**, wherein the phosphorescence layer has a thickness in a range of 50 to 200 Å.

18. The organic electroluminescent device as claimed in claim **16**, wherein the fluorescence layer has a thickness in a range of 50 to 300 Å.

19. An organic electroluminescent display comprising:

first and second electrodes, at least one of the first and second electrodes being a transparent electrode;

an emission layer interposed between the first and second electrodes and configured to emit white light, the emission layer comprising a fluorescence layer and a phosphorescence layer; and

a color filter layer disposed to receive the light emitted from the emission layer.

20. The organic electroluminescent display as claimed in claim **19**, wherein the fluorescence layer emits light in a blue range.

21. The organic electroluminescent display as claimed in claim **20**, wherein the fluorescence layer comprises:

one selected from the group consisting of distyrylarylene (DSA), a DSA derivative, distyrylbenzene (DSB), a DSB derivative, 4,4'-bis(2,2'-diphenyl vinyl)-1,1'-biphenyl (DPVBi), a DPVBi derivative, spiro-DPVBi, spiro-sexyphenyl (spiro-6P), 9,10-bis[(2"7"-t-butyl)-9',9"-spirobifluorenyl]anthracene (TBSA), 2,5-bis{4-[bis-(9,9-dimethyl-2-fluorenyl)amino]phenyl}thiophene (BFA-1T), and N-arylbenzimidazoles (TPBI); and

a dopant material selected from the group consisting of a styrylamine, a phenylene, and a distyrylbiphenyl.

22. The organic electroluminescent display as claimed in claim **19**, wherein the phosphorescence layer emits light in an orange-red range.

23. The organic electroluminescent display as claimed in claim **22**, wherein the phosphorescence layer comprises:

a host material selected from the group consisting of 4,4-N,N dicarbazole-biphenyl (CBP), a CBP derivative, N,N-dicarbazolyl-3,5-benzene (mCP), and an mCP derivative; and

a dopant material selected from the group consisting of PQIr (tris(1-phenylquinoline)iridium), PQIr(acac) (bis(1-phenylquinoline)acetylacetonate iridium), PQ$_2$Ir(acac) (iridium(III) bis(2-phenylquinolyl-N,C2')acetylacetonate), PIQIr(acac) (bis(1-phenylisoquinoline) acetylacetonate iridium), PtOEP(octaethylporphyrin platinum), Btp$_2$Ir bis(2-(2'-benzo[4,5-a]thienyl)pyridinato-N,C2')iridium(acetylacetonate), and Ir(piq)$_3$(tris[1-phenylisoquinolinato-C2,N]iridium(III)).

24. The organic electroluminescent display as claimed in claim **19**, wherein:

the fluorescence layer emits light in a blue range; and

the phosphorescence layer emits light in an orange-red range,

25. The organic electroluminescent display as claimed in claim **19**, further comprising at least one selected from the group consisting of a hole injection layer, a hole transport layer, an electron injection layer, an electron transport layer, and a hole blocking layer.

26. The organic electroluminescent display as claimed in claim **19**, wherein:

the first electrode is an anode;

the fluorescence layer is disposed on the first electrode; and

the phosphorescence layer is disposed on the fluorescence layer.

27. The organic electroluminescent display as claimed in claim **26**, further comprising a hole blocking layer disposed on the phosphorescence layer.

28. The organic electroluminescent display as claimed in claim **19**, wherein:

the first electrode is an anode;

the phosphorescence layer is disposed on the first electrode; and

the fluorescence layer is disposed on the phosphorescence layer.

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专利名称(译)	发白光的有机电致发光器件和具有该器件的有机电致发光显示器		
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摘要(译)

提供了一种发白光的有机电致发光器件和具有该器件的有机电致发光显示器。有机电致发光器件包括第一电极，第二电极和插入在第一和第二电极之间并具有荧光层和磷光层的发光层。由此，可以获得具有改善的亮度产率的白光发射有机电致发光器件。