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(54) **Organic light emitting diode display device and method of fabricating the same**

Organische LED-Anzeigevorrichtung und Verfahren zu ihrer Herstellung

Dispositif d'affichage à diode électroluminescente organique et son procédé de fabrication

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(73) Proprietor: **Samsung Display Co., Ltd.**
Gyeonggi-do (KR)

(72) Inventors:
- **Sung, Yeun-Joo**
  Suwon-si
  Gyeonggi-do (KR)
- **Kho, Sam-Il**
  Suwon-si
  Gyeonggi-do (KR)
- **Yoo, Byeong-Wook**
  Suwon-si
  Gyeonggi-do (KR)

(74) Representative: **Mounteney, Simon James**
Marks & Clerk LLP
90 Long Acre
London
WC2E 9RA (GB)

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an organic light emitting diode (OLED) display device and a method of fabricating the same.

2. Description of the Related Art

[0002] Generally, an organic light emitting diode (OLED) display device is an emitting display device, in which an electron and a hole are respectively inserted from an electron injecting electrode (cathode) and a hole injecting electrode (anode) into an emission layer, and the injected electron and hole are combined to thereby create an exciton, which emits light when transitioning from an excited state to a ground state.

[0003] Unlike a conventional liquid crystal thin film display device, a separate light source is not required due to the above structure, and this results in reduced size and weight of a device.

[0004] Generally, an OLED display device includes a substrate, a lower electrode disposed on the substrate, an organic layer including an emission layer disposed on the lower electrode, and an upper electrode disposed on the organic layer. The organic layer may further include a hole injection layer (HIL), a hole transport layer (HTL), and an electron blocking layer (EBL) between the lower electrode and the emission layer, and a hole blocking layer (HBL), an electron transport layer (ETL), and an electron injection layer (EIL) between the emission layer and the upper electrode.

[0005] An OLED display device may be classified as a bottom-emitting type or a top-emitting type depending on an emission direction of light generated from the emission layer. In the bottom-emitting type, light is emitted towards the substrate, an upper electrode is formed of a reflective electrode, and a lower electrode is formed of a transparent electrode. Here, when the OLED display device adopts an active matrix type, in which a thin film transistor is formed, light cannot pass through a region where the thin film transistor is formed, and thus an area through which light can pass is reduced. In contrast, in the top-emitting type, an upper electrode is formed of a semi-transmissive metal layer, and a lower electrode is formed of a transparent electrode including a reflective layer, so that light is emitted towards a direction opposite to a substrate, and an area through which light passes is larger than that of the bottom-emitting type.

[0006] In a conventional top-emitting OLED display device, an upper electrode is formed of a transparent conductive material such as Indium Tin Oxide (ITO) or Indium Zinc Oxide (IZO) or a very thin metal layer such as magnesium-silver (MgAg) so that light passes through the upper electrode.

[0007] However, when the upper electrode is formed of the transparent conductive material such as ITO or IZO, the upper electrode may have a high transmittance, but it is not appropriate due to a high work function when an upper electrode is a cathode. Also, when the upper electrode is formed of the semi-transmissive metal layer such as MgAg, the semi-transmissive metal layer should be formed thin in order to enhance transmittance, so it has a problem of an increased resistance value. US2004/0157167 discloses a process for manufacturing organic EL devices where the cathodes are deposited using liquid phase processes. WO99/54943 discloses electroluminescent devices where the cathode is prepared by vapor deposition or sputtering of an alloy of magnesium and second metal and the cathode comprises a film of ytterbium. US2005/0084994 discloses a method for producing a light emitting device comprising layers of silicon oxide with varying densities

SUMMARY OF THE INVENTION

[0008] The present invention provides an improved organic light emitting diode (OLED) display device.

[0009] According to a first aspect of the present invention, there is provided an organic light emitting diode (OLED) display device as set out in Claim 1. Preferred features of this aspect of the invention are set out in Claims 2 to 11.

[0010] According to a second aspect of the present invention, there is provided a method of making an organic light emitting diode (OLED) display device as set out in Claim 12. Preferred features of this aspect of the invention are set out in Claims 13 to 14.

[0011] In an embodiment of the present invention, an OLED display device includes: a substrate; a first electrode disposed on the substrate; an organic layer including an emission layer, the organic layer formed on the first electrode; and a second electrode being a cathode and including an ytterbium (Yb) layer formed on the organic layer and a silver (Ag) formed on the ytterbium layer, the second electrode having a thickness of 90Å to 120Å and wherein the Yb layer is formed to a thickness of 20 Å to 30 Å, and the Ag layer is formed to a thickness of 70 Å to 90 Å.

[0012] In an embodiment of a method of manufacturing an OLED display device, a method of fabricating an OLED display device includes: providing a substrate; forming a first electrode on the substrate; forming an organic layer including an emission layer on the first electrode; and forming a second electrode comprising an Yb layer formed on the organic layer and a Ag layer formed on the Yb layer, wherein the second electrode is a cathode and is formed to a thickness of 90Å to 120, wherein the Yb layer of the second electrode is formed to a thickness of 20 Å to 30 Å, and the Ag layer is formed to a thickness of 70 Å to 90 Å.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A more complete appreciation of the invention, and many of the attendant advantages thereof, will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference symbols indicate the same or similar components, wherein:

FIG. 1 is a cross-sectional view of an organic light emitting diode (OLED) display device according to a first embodiment of the present invention;
FIG. 2 is a cross-sectional view of an OLED display device according to a second embodiment of the present invention;
FIGS. 3 and 4 are graphs showing a change in transmittance according to a thickness of ytterbium (Yb) and silver (Ag) according to experimental examples; and
FIG. 5 is a graph showing a change in transmittance according to a thickness of magnesium-silver (MgAg) according to comparative examples.

DETAILED DESCRIPTION OF THE INVENTION

[0014] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. In the drawings, the thicknesses of layers and regions are exaggerated for clarity. The same reference numerals are used to denote the same elements.

[0015] FIG. 1 is a cross-sectional view of a top-emitting organic light emitting diode (OLED) display device according to a first embodiment of the present invention.

[0016] Referring to FIG. 1, a first electrode 110 is formed on a substrate 100. The substrate 100 may include at least one thin film transistor (not shown) in contact with the first electrode 110.

[0017] The first electrode 110 is a reflective anode electrode. In this case, the reflective anode electrode includes a reflective layer formed of silver (Ag), aluminum (Al), chrome (Cr), molybdenum (Mo), tungsten (W), titanium (Ti), gold (Au), palladium (Pd) or an alloy thereof, and a transparent electrode material such as Indium Tin Oxide (ITO), Indium Zinc Oxide (IZO) or Zinc Oxide (ZnO) which is stacked on the reflective layer. The formation of the first electrode 110 may be performed by a sputtering method, a vapor phase deposition method, an ion beam deposition method, an electron beam deposition method or a laser ablation method.

[0018] An organic layer 120 including an emission layer is formed on the first electrode 110. The emission layer may be a white light emission layer or a blue light emission layer, and the white light emission layer may be a single layer or a multilayer.

[0019] When the white light emission layer is a single layer, the single layer may be formed of plural light emitting materials to emit white light. For example, the single layer may be obtained by mixing a red light emitting material, a green light emitting, and a blue light emitting material. The red light emitting material may be formed of one of polythiophene (PT) and a derivative thereof which are polymers. The green light emitting material is formed of a small molecular material such as 8-hydroquinoline aluminum (Alq_3), bis(benzoquinolinolato)beryllium complex ($BeBq_2$) or tris(4-methyl-8-quinolinolato)aluminum (Almq), or a polymer such as poly(p-phenylenevinylene)(PPV) or a derivative thereof. The blue light emitting material is formed of a small molecular material such as bis[2-(2-hydroxyphenyl)benzoxazolate]zinc (ZnPBO), bis(8-hydroxyquinolato)-(4-phenylphenolato)aluminum (Balq), 4,4'-bis(2,2-diphenyl-vinyl)-biphenyl (DPVBi) or OXA-D, or a polymer such as polyphenylene (PPP) or a derivative thereof.

[0020] When the white light emission layer is a multilayer, it may be formed of double layers emitting light of different wavelength regions. One of the double layers may be an emission layer emitting light of an orange-red region and the other may be an emission layer emitting light of a blue region. The emission layer emitting light of an orange-red region may be a phosphorescent emission layer, and the emission layer emitting light of a blue region may be a fluorescent emission layer. The phosphorescent emission layer has much better emission characteristics than the fluorescent layer emitting light of the same wavelength region, and the fluorescent emission layer has much better life span characteristics than the phosphorescent emission layer. Therefore, when a white light emission layer is formed by stacking the phosphorescent emission layer emitting light of an orange-red region and the fluorescent emission layer emitting light of a blue light region, its emission efficiency and life span characteristics may be excellent. Also, the emission layer that is a double-layer may be formed of a polymer, a small molecular material or a combination thereof.

[0021] When the white light emission layer has a three-layer structure, it may be a layer in which red, green, and blue light emission layers are stacked, and the stacking sequence is not particularly defined.

[0022] The red light emission layer may be formed of a small molecular material such as Alq_3 (a host)/DCJTB (4-(dicyanomethylene)-2-1-propyl-6-(1,1,7,7-tetramethyljulolidyl-9-phenyl)- -4H-pyran; a fluorescent dopant), Alq_3 (a host)/DCM (4-dicyanomethylene-2-methyl-6-(p-dimethylamino-styryl)-4H-pyran; a fluorescent dopant) or CBP (4,4'-N,N'-dicarbazole-biphenyl; a host)/PtOEP (2,3,7,8,12,13,17,18-octaethyl-21 H,23H-phorpine platinum(II); a phosphorescent organic metal complex), or a polymer such as a polyfluorene (PFO)-based polymer or a poly(phenylene vinylene) (PPV)-based polymer.

[0023] The green light emission layer may be formed of a small molecular material such as Alq_3, Alq_3 (a host)/C545t (a dopant) or CBP (a host)/IrPPY (tris(2-phenylpyridine)-iridium; a phosphorescent organic material complex), or a polymer such as a PFO-based polymer or a PPV-based polymer.

[0024] The blue light emission layer may be formed of a small molecular material such as 4,4'-bis(2,2-diphenylvinyl)-biphenyl (DPVBi), spiro-DPVBi, spiro-6P, distyrylbenzene (DSB) or distyrylarylene (DSA), or a polymer such as a PFO-based polymer or a PPV-based polymer.

[0025] Also, the organic layer 120 may further include at least one layer selected from the group consisting of a hole injection layer (HIL), a hole transport layer (HTL), an electron blocking layer (EBL), a hole blocking layer (HBL), an electron injection layer (EIL), and an electron transport layer (ETL).

[0026] The HIL serves to facilitate injection of a hole into an organic emission layer to thereby increase the life span of a device. The HIL may be formed of an aryl amine compound and/or a starburst-type amine. More specifically, the HIL may be formed of at least one of 4,4',4"-tris[(3-methylphenyl(phenyl)amino)]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDATB), phthalocyanine copper (CuPc), etc.

[0027] The HTL may be formed of an arylene diamine derivative, a starburst-type compound, a biphenyl diamine derivative having a spiro radical, a ladder-type compound, or so forth. More specifically, the HTL may be formed of N,N-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine (TPD) or 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (α-NPB).

[0028] The EBL acts to prevent an exciton generated in the emission layer in the process of driving an OLED display device from being diffused. The EBL may be formed of bis(8-hydroxyquinolato)-(4-phenylphenolato)aluminum (Balq), 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP), CF-X, 3-phenyl-4-(1'-naphthyl)-5-phenyl-1,2,4-triazole (TAZ) or spiro-TAZ.

[0029] The HBL serves to prevent a hole from moving into the EIL when hole mobility is larger than electron mobility in the organic emission layer. The HBL may be formed of one selected from the group consisting of 2-(4-biphenyl)-5-(4-butylphenyl)-1,3,4-oxadiazole(PBD), spiro-PBD, and 3-(4-biphenyl)-4-phenyl-5-(4-tert-butyl phenyl)-1,2,4-triazole(TAZ).

[0030] The ETL is formed of a metal compound capable of readily receiving an electron, and may be formed of 8-hydroquinoline aluminum (Alq_3) having excellent characteristics capable of safely transporting the electron supplied from a cathode electrode.

[0031] The EIL may be formed of at least one selected from the group consisting of 1,3,4-oxadiazole derivatives, 1,2,4-triazole derivatives and LiF.

[0032] In addition, the organic layer 120 may be formed by one of a vacuum deposition method, an ink jet printing method, and a laser induced thermal imaging method.

[0033] A second electrode 130 including stacked layers of Yb and Ag 130a and 130b is formed on the organic layer 120. The second electrode 130 is formed by respectively depositing Yb and Ag using a sputtering method or a vacuum deposition method. Here, the second electrode 130 is formed to a thickness of 90Å to 120Å. When the thickness of the second electrode is larger than 90Å, the electrode may effectively operate as an upper electrode since it has a sheet resistance of 45 ohm/square or lower, and when the thickness of the second electrode is smaller than 120Å, a transmittance of 40% or more may be attained over the entire emission wavelength range of the emission layer. More specifically, Yb is formed to a thickness of 20Å to 30Å, and Ag is formed to a thickness of 70Å to 90Å. When the thickness of Yb ranges from 20Å to 30Å or when the thickness of Ag is 70Å or larger, a sheet resistance of 45 ohm/square or lower may be obtained, so that the second electrode may effectively operate as an upper electrode. Also, when the thickness of Ag is 90Å or smaller, a transmittance of 40% or higher may be obtained over the emission wavelength range of the emission layer, i.e., within a range of 380nm to 765nm.

[0034] The second electrode 130 including the stacked layers of Yb and Ag has an excellent transmittance over the entire emission wavelength range, so that much higher emission efficiency may be attained compared to the conventional second electrode formed of a semi-transmissive metal layer. Furthermore, microcavity effects generated when the second electrode is formed of a semi-transmissive metal layer may be efficiently removed, so that it may prevent emitted light from leaning to a certain wavelength range. Therefore, in the OLED display device including the white light emission layer implemented by mixing light of different wavelengths, when the second electrode is formed of stacked layers of Yb and Ag, light of each corresponding wavelength may uniformly pass through the second electrode to thereby implement the pure white light. Moreover, since the electrode has a sheet resistance lower than that suitable for an electrode to be used at a predetermined thickness, it effectively acts as an upper electrode in a top-emitting type.

[0035] A transparent passivation layer may be disposed on the second electrode 130. The transparent passivation layer may be formed of an inorganic layer, an organic layer or a combination thereof. The inorganic layer may be formed of ITO, IZO, $Si0_2$, SiNx, Y_2O_3 or Al_2O_3, and the organic layer may be formed of parylene or HDPE. The transparent passivation layer may serve to prevent the lower organic layers from being damaged by external moisture or oxygen.

[0036] A color filter layer or color conversion layer 140R, 140G, and 140B is disposed on the transparent passivation layer. The color filter layer may include a pigment and a polymer binder, and may be classified into red, green, and blue light filter layers depending on the type of the pigment. Each color filter layer is characterized in that it can select wavelengths of a red light region, a green light region, and a blue light region from white incident light from emitted the emission layer. The color conversion layer may include a fluorescent material and a polymer binder. The fluorescent material is excited by the light incident from the emission layer and transitions to a ground state to thereby emit light with wavelengths longer than the incident light. The color conversion layer is classified into red, green and blue color conversion layers converting the blue light incident from the emission layer to red, green and blue colors, respectively, depending on the type of the fluorescent material.

[0037] FIG. 2 is a cross-sectional view of a top-emitting OLED display device according to a second embodiment of the present invention.

[0038] In this device, red, green and blue emission layers are respectively formed in red (R), green (G), and blue (B) unit pixel regions. Unless otherwise indicated, when describing this second embodiment, reference will be made to the disclosure of the first embodiment.

[0039] Referring to FIG. 2, a substrate 200 having red (R), green (G), and blue (B) unit pixel regions is provided. First electrodes 210R, 210G and 210B are disposed in each unit pixel region of the substrate. The substrate 200 may have thin film transistors (not shown), each of which is in contact with the first electrodes 210R, 210G and 210B. An insulating layer 220 defining a pixel region is disposed between the first electrodes.

[0040] Organic layers 230R, 230G and 230B respectively including red, green and blue emission layers are disposed on each first electrode in each pixel region. The emission layer may be formed by a vacuum deposition method using a fine metal mask, an ink jet printing method, or a laser induced thermal imaging method.

[0041] The organic layer may further include at least one layer selected from the group consisting of a hole injection layer (HIL), a hole transport layer (HTL), an electron blocking layer (EBL), a hole blocking layer (HBL), an electron injection layer (EIL), and an electron transport layer (ETL).

[0042] A second electrode layer 240 including stacked layers 240a and 240b of Yb and Ag is formed on the organic layer.

[0043] Since the second electrode layer 240 including the stacked layers of Yb and Ag has an excellent transmittance over the entire emission wavelength range, external emission efficiency of light generated from each emission layer of the red, green and blue pixel regions is increased to thereby have a much higher emission efficiency than the conventional second electrode formed of a semi-transmissive metal layer. Also, since the electrode has a sheet resistance of an appropriate value suitable for an electrode to be used at a predetermined thickness, it is suitable for an upper electrode in a top-emitting structure.

[0044] Experimental examples will be described below in order to help understand the present invention. The following examples are only intended to help understand and not to restrict the present invention.

Experimental Example 1

[0045] A first electrode having an area of 2mm x 2mm was formed on a substrate using ITO, and was subjected to ultrasonic cleaning and pretreatment process (a UV-O_3 process, and a heat treatment process). A hole injection layer was formed by vacuum depositing IDE406 (available from Idemitsu Co. Ltd.) to a thickness of 750Å on the first electrode. A hole transport layer was formed by vacuum depositing IDE320 (available from Idemitsu Co. Ltd.) to a thickness of 150Å on the hole injection layer. A blue light emission layer was formed by doping 5wt% BD052 (available from Idemitsu Co. Ltd.) into BH215 (available from Idemitsu Co. Ltd.) and vacuum depositing the resultant to a thickness of 80Å on the hole transport layer. A green light emission layer was formed by doping 7wt% $Ir(PPy)_3$ into TMM004 (available from Merck & Co.) and vacuum depositing the resultant to a thickness of 100Å on the blue light emission layer. A red light emission layer was formed by doping 15wt% TER021 (available from Merck & Co.) into TMM004 (available from Merck & Co.) and vacuum depositing the resultant to a thickness of 120Å on the green light emission layer. As a result, a white light emission layer, in which the green, blue, and red emission layers were stacked, respectively, was formed. A hole block layer, an electron transport layer, and an electron injection layer were sequentially formed by vacuum depositing Balq to a thickness of 50Å, vacuum depositing Alq_3 to a thickness of 300Å, and vacuum depositing LiQ to a thickness of 5Å on the red light emission layer. A second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 10Å and vacuum depositing Ag to a thickness of 70Å on the electron injection layer.

[0046] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 2

[0047] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 20Å and vacuum depositing Ag to a thickness of 70Å.

[0048] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 3

[0049] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 30Å and vacuum depositing Ag to a thickness of 70Å.

[0050] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 4

[0051] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 40Å and vacuum depositing Ag to a thickness of 70Å.

[0052] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 5

[0053] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 20Å and vacuum depositing Ag to a thickness of 50Å.

[0054] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 6

[0055] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 20Å and vacuum depositing Ag to a thickness of 60Å.

[0056] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 7

[0057] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 20Å and vacuum depositing Ag to a thickness of 80Å.

[0058] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Experimental Example 8

[0059] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode including stacked layers of Yb and Ag was formed by vacuum depositing Yb to a thickness of 20Å and vacuum depositing Ag to a thickness of 90Å.

[0060] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Comparative Example 1

[0061] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode was formed to a thickness of 120Å by mixing Mg and Ag at an atomic ratio of 10:1.

[0062] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Comparative Example 2

[0063] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example

1, and a second electrode was formed to a thickness of 140Å by mixing Mg and Ag at an atomic ratio of 10:1.

[0064] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Comparative Example 3

[0065] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode was formed to a thickness of 160Å by mixing Mg and Ag at an atomic ratio of 10:1.

[0066] A transmittance of the OLED display device and a sheet resistance of the second electrode are measured.

Comparative Example 4

[0067] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode was formed to a thickness of 180Å by mixing Mg and Ag at an atomic ratio of 10:1.

[0068] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

Comparative Example 5

[0069] A substrate, a first electrode, and an emission layer were formed by the same method as Experimental Example 1, and a second electrode was formed to a thickness of 200Å by mixing Mg and Ag at an atomic ratio of 10:1.

[0070] A transmittance of the OLED display device and a sheet resistance of the second electrode were measured.

[0071] A sheet resistance of an upper electrode of an OLED display device measured according to Experimental Examples 1 to 8 and Comparative Examples 1 to 5 is shown in Table 1.

[0072] Referring to Table 1, sheet resistances of Experimental Examples 2, 3, 7 and 8 are 45 ohm/square or less, but sheet resistances of Experimental Examples 1, 4, 5 and 6 exceed 45 ohm/square. It is preferred (but not essential) that the sheet resistance of the upper electrode of the OLED display device is 45 ohm/square or less, in view of the operability of the electrode. Therefore, Yb is preferably formed to a thickness of 20Å to 30Å, and Ag is preferably formed to a thickness of 70Å to 90Å.

〈Table 1〉

	Thickness(Å)	Sheet Resistance (ohm/square)					Average
Experimental Example 1	10/70	44.4	44	47	46.1	47.5	45.80
2	20/70	41.9	40.9	41.3	40.7	40.7	41.10
3	30/70	41.2	41.2	43.3	42.1	42.2	42.00
4	40/70	46.7	46.4	46.4	45.9	45.4	46.16
5	20/50	over range					
6	20/60	1127	1281	1255	1423	969	1211
7	20/80	36.48	34.89	36.26	36.11	36.11	35.97
8	20/90	24.2	23.58	23.9	23.9	23.87	23.89
Comparative Example 1	120Å	38.67	38.31	38.74	40.51	39.62	39.33
2	140Å	30.24	30.19	30.16	31.18	31.54	30.92
3	160Å	25.22	25.03	25.31	26.14	25.66	25.54
4	180Å	19.86	20.25	19.89	20.04	20.3	20.06
5	200Å	17.85	17.62	18.55	18.36	18.28	18.14

[0073] FIGS. 3 to 5 are graphs showing a transmittance of an OLED display device according to Experimental Examples 1 to 8 and Comparative Examples 1 to 5.

[0074] Referring to FIG. 3, a transmittance of 50% to 80% over the entire emission wavelength range is represented in Experimental Example 1, and a transmittance of 60% to 80% is represented in Experimental Example 2. Also, a transmittance of 57% to 87% is represented in Experimental Example 3, and a transmittance of 62% to 90% is represented in Experimental Example 4.

[0075] Referring to FIG. 4, a transmittance of 52% to 81% over the entire emission wavelength range is represented in Experimental Example 5, a transmittance of 46% to 76% is represented in Experimental Example 6, and a transmittance of 50% to 75% is represented in Experimental Example 7. In addition, a transmittance of 46% to 78% is represented in Experimental Example 8.

[0076] Referring to FIG. 5, a transmittance of 25% to 61% over the entire emission wavelength range is represented in Comparative Example 1, a transmittance of 18% to 50% is represented in Comparative Example 2, and a transmittance of 15% to 45% is represented in Comparative Example 3. Also, a transmittance of 10% to 35% is represented in Comparative Example 4, and a transmittance of 9% to 33% is represented in Comparative Example 5.

[0077] As a result, the OLED display device including the second electrode formed of the stacked layer of Yb and Ag according to Experimental Examples 1 to 8 has a higher transmittance over the entire emission wavelength range of the emission layer than the OLED display device including the second electrode formed of MgAg according to Comparative Examples 1 to 5. In particular, in the case of the OLED display device according to Experimental Examples 2, 3, 7 and 8, since the OLED display device has a sheet resistance of 45 ohm/square or less and a higher transmittance than the OLED according to Comparative Examples 1 to 5 according to a conventional art, it may be preferable as a second electrode.

[0078] Comparing Experimental Example 8 with Comparative Example 1, while the second electrode according to Experimental Example 8 formed to a thickness of 110Å is thinner than the second electrode according to Comparative Example 1 formed to a thickness of 120Å, it has a 20% higher transmittance over the entire emission wavelength range and a lower sheet resistance than the second electrode according to Comparative Example 1 by 15.5ohm/square.

[0079] Also, in the OLED display device according to Experimental Examples 1 to 8, the second electrode has a high transmittance over the entire emission wavelength range to thereby minimize microcavity effects. Therefore, when an emission layer is formed by mixing two or more colors of light having different wavelengths to thereby emit white light, an emission wavelength corresponding to each color of light does not incline to a certain wavelength due to removal of the microcavity effects, and may pass with a high transmittance, so that it may implement the white light.

[0080] Consequently, in a top-emitting OLED display device according to an embodiment of the present invention, an upper electrode is formed of stacked layers of Yb and Ag to thereby improve a transmittance over the entire emission wavelength range, and as a result, emission efficiency is also improved. In addition, microcavity effects are minimized, and in particular, when white light is implemented by mixing light of different wavelengths, balanced colors of light may be implemented due to the removal of the microcavity effects, so that it may be optimized to implement the white light.

[0081] Although the present invention has been described with reference to certain 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 scope of the present invention defined in the appended claims.

Claims

1. An organic light emitting diode (OLED) display device, comprising:

a substrate (100);
a first electrode (110) disposed on the substrate;
an organic layer (120) comprising an emission layer, the organic layer formed on the first electrode; and
a second electrode (130), which is a cathode, comprising an ytterbium (Yb) layer formed on the organic layer and a silver (Ag) formed on the ytterbium layer,
characterised in that the second electrode is formed to a thickness of 90 Å to 120 Å and the Yb layer of the second electrode is formed to a thickness of 20 Å to 30 Å, and the Ag layer is formed to a thickness of 70 Å to 90 Å.

2. A device according to claim 1, wherein the second electrode has a transmittance of 46% to 90% within a wavelength range of 380nm to 765nm.

3. A device according to any preceding claim, wherein the second electrode has a sheet resistance of 45 ohm/square or less.

4. A device according to any preceding claim, wherein the emission layer is a white light emission layer.

5. A device according to Claim 4, further comprising at least one of a color filter layer and a color conversion layer formed on the second electrode.

6. The device according to claim 5, wherein the white light emission layer has a structure, in which a plurality of emission layers emitting light of different wavelength regions are stacked.

7. A device according to one of Claims 1 to 3, wherein the emission layer is a blue light emission layer.

8. A device according to claim 7, further comprising a color conversion layer formed on the second electrode.

9. The device according to claim 1, wherein the emission layer comprises red, green, and blue light emission layers respectively formed in red, green and blue pixel regions.

10. A device according to any preceding claim, wherein the first electrode comprises a reflective layer and a transparent electrode material formed on the reflective layer.

11. A device according to Claim 10, wherein the reflective layer is formed of a material selected from the group consisting of silver (Ag), aluminum (Al), chrome (Cr), molybdenum (Mo), tungsten (W), titanium (Ti), gold (Au), palladium (Pd) and an alloy thereof.

12. A method of manufacturing an OLED display device, comprising:

providing a substrate (100);
forming a first electrode (110) on the substrate;
forming an organic layer (120) comprising an emission layer on the first electrode; and
forming a second electrode (130), where the second electrode is a cathode, comprising an ytterbium (Yb) layer and a silver (Ag) layer on the organic layer,
characterised in that the second electrode is formed to a thickness of 90 Å to 120 Å and wherein the Yb layer is formed to a thickness of 20 Å to 30 Å, and the Ag layer is formed to a thickness of 70 Å to 90 Å.

13. A method according to Claim 12, wherein the second electrode is formed by a sputtering method or a vacuum deposition method.

14. A method according to Claim 12 or 13, wherein the first electrode is formed by forming a reflective layer on the substrate and stacking a transparent electrode material on the reflective layer.

Patentansprüche

1. Organische LED-Anzeigevorrichtung (OLED-Anzeigevorrichtung), umfassend:

ein Substrat (100);
eine auf dem Substrat angeordnete erste Elektrode (110);
eine organische Schicht (120), die eine Emissionsschicht umfasst, wobei die organische Schicht auf der ersten Elektrode ausgebildet ist; und
eine zweite Elektrode (130), die eine Kathode ist und eine auf der organischen Schicht ausgebildete Ytterbiumschicht (Yb-Schicht) und eine auf der Ytterbiumschicht ausgebildete Silberschicht (Ag-Schicht) umfasst,
dadurch gekennzeichnet, dass
die zweite Elektrode bis zu einer Stärke von 90 Å bis 120 Å ausgebildet ist und die Yb-Schicht der zweiten Elektrode bis zu einer Stärke von 20 Å bis 30 Å ausgebildet ist und die Ag-Schicht bis zu einer Stärke von 70 Å bis 90 Å ausgebildet ist.

2. Vorrichtung nach Anspruch 1, wobei die zweite Elektrode eine Durchlässigkeit von 46 % bis 90 % innerhalb eines Wellenlängenbereichs von 380 nm bis 765 nm aufweist.

3. Vorrichtung nach einem der vorangehenden Ansprüche, wobei die zweite Elektrode einen Flächenwiderstand von 45 Ohm/sq oder weniger aufweist.

4. Vorrichtung nach einem der vorangehenden Ansprüche, wobei die Emissionsschicht eine Weißlicht-Emissionsschicht ist.

5. Vorrichtung nach Anspruch 4, ferner umfassend zumindest eine Farbfilterschicht und/oder eine Farbumwandlungsschicht, die auf der zweiten Elektrode ausgebildet sind.

6. Vorrichtung nach Anspruch 5, wobei die Weißlicht-Emissionsschicht eine Struktur aufweist, bei der eine Mehrzahl von Emissionsschichten, die Licht unterschiedlicher Wellenlängenbereiche emittieren, gestapelt ist.

7. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei die Emissionsschicht eine Blaulicht-Emissionsschicht ist.

8. Vorrichtung nach Anspruch 7, ferner umfassend eine auf der zweiten Elektrode ausgebildete Farbumwandlungsschicht.

9. Vorrichtung nach Anspruch 1, wobei die Emissionsschicht Rotlicht-, Grünlicht- und Blaulicht-Emissionsschichten umfasst, die jeweils in roten, grünen und blauen Pixelbereichen ausgebildet sind.

10. Vorrichtung nach einem der vorangehenden Ansprüche, wobei die erste Elektrode eine reflektierende Schicht umfasst und auf der reflektierenden Schicht ein transparentes Elektrodenmaterial ausgebildet ist.

11. Vorrichtung nach Anspruch 10, wobei die reflektierende Schicht aus einem Material ausgebildet ist, das aus der Gruppe, bestehend aus Silber (Ag), Aluminium (Al), Chrom (Cr), Molybdän (Mo), Tungsten (W), Titan (Ti), Gold (Au), Palladium (Pd) und einer Legierung derselben, ausgewählt ist.

12. Verfahren zur Herstellung einer OLED-Anzeigevorrichtung, umfassend:

    Bereitstellen eines Substrats (100);
    Ausbilden einer ersten Elektrode (110) auf dem Substrat;
    Ausbilden einer organischen Schicht (120), die eine Emissionsschicht umfasst, auf der ersten Elektrode und
    Ausbilden einer zweiten Elektrode (130), wobei die zweite Elektrode eine Kathode ist und eine Ytterbiumschicht (Yb-Schicht) und eine Silberschicht (Ag-Schicht) auf der organischen Schicht umfasst,
    dadurch gekennzeichnet, dass
    die zweite Elektrode bis zu einer Stärke von 90 Å bis 120 Å ausgebildet ist und wobei die Yb-Schicht bis zu einer Stärke von 20 Å bis 30 Å ausgebildet ist und die Ag-Schicht bis zu einer Stärke von 70 Å bis 90 Å ausgebildet ist.

13. Verfahren nach Anspruch 12, wobei die zweite Elektrode durch ein Sputterverfahren oder ein Vakuumdepositionsverfahren ausgebildet ist.

14. Verfahren nach Anspruch 12 oder 13, wobei die erste Elektrode durch Ausbilden einer reflektierenden Schicht auf dem Substrat und Stapeln eines transparenten Elektrodenmaterials auf der reflektierenden Schicht ausgebildet ist.

Revendications

1. Dispositif d'affichage à diode électroluminescente organique (OLED), comprenant :

    un substrat (100) ;
    une première électrode (110) disposée sur le substrat ;
    une couche organique (120) comprenant une couche d'émission, la couche organique étant formée sur la première électrode ; et
    une deuxième électrode (130), qui est une cathode, comprenant une couche d'ytterbium (Yb) formée sur la couche organique et une couche d'argent (Ag) formée sur la couche d'ytterbium,
    caractérisé en ce que
    la deuxième électrode est formée à une épaisseur de 90 Å à 120 Å et la couche d'Yb de la deuxième électrode est formée à une épaisseur de 20 Å à 30 Å, et la couche d'Ag est formée à une épaisseur de 70 Å à 90 Å.

2. Dispositif selon la revendication 1, dans lequel la deuxième électrode a une transmittance de 46 % à 90 % dans une plage de longueur d'onde allant de 380 nm à 765 nm.

3. Dispositif selon l'une des revendications précédentes, dans lequel la deuxième électrode a une résistance de couche inférieure ou égale à 45 ohm/carré.

4. Dispositif selon l'une des revendications précédentes, dans lequel la couche d'émission est une couche d'émission

de lumière blanche.

5. Dispositif selon la revendication 4, comprenant en outre une couche de filtre coloré et/ou une couche de conversion de couleur formée(s) sur la deuxième électrode.

6. Dispositif selon la revendication 5, dans lequel la couche d'émission de lumière blanche présente une structure, dans laquelle une pluralité de couches d'émission émettant de la lumière de régions de longueur d'onde différentes sont empilées.

7. Dispositif selon l'une des revendications 1 à 3, dans lequel la couche d'émission est une couche d'émission de lumière bleue.

8. Dispositif selon la revendication 7, comprenant en outre une couche de conversion de couleur formée sur la deuxième électrode.

9. Dispositif selon la revendication 1, dans lequel la couche d'émission comprend des couches d'émission de lumière rouge, verte et bleue respectivement formées dans des régions de pixel rouge, verte et bleue.

10. Dispositif selon l'une des revendications précédentes, dans lequel la première électrode comprend une couche réfléchissante et un matériau d'électrode transparente formé sur la couche réfléchissante.

11. Dispositif selon la revendication 10, dans lequel la couche réfléchissante est formée d'un matériau choisi dans le groupe consistant en argent (Ag), aluminium (Al), chrome (Cr), molybdène (Mo), tungstène (W), titane (Ti), or (Au), palladium (Pd) et en un alliage de ceux-ci.

12. Procédé de fabrication d'un dispositif d'affichage à OLED, comprenant le fait :

   de fournir un substrat (100) ;
   de former une première électrode (110) sur le substrat ;
   de former une couche organique (120) comprenant une couche d'émission sur la première électrode ; et
   de former une deuxième électrode (130), où la deuxième électrode est une cathode, comprenant une couche d'ytterbium (Yb) et une couche d'argent (Ag) couche sur la couche organique,
   caractérisé en ce que
   la deuxième électrode est formée à une épaisseur de 90 Å à 120 Å et où la couche d'Yb est formée à une épaisseur de 20 Å à 30 Å, et la couche d'Ag est formée à une épaisseur de 70 Å à 90 Å.

13. Procédé selon la revendication 12, dans lequel la deuxième électrode est formée par un procédé de pulvérisation cathodique ou un procédé de dépôt sous vide.

14. Procédé selon la revendication 12 ou 13, dans lequel la première électrode est formée par formation d'une couche réfléchissante sur le substrat et par empilement d'un matériau d'électrode transparente sur la couche réfléchissante.

FIG. 1

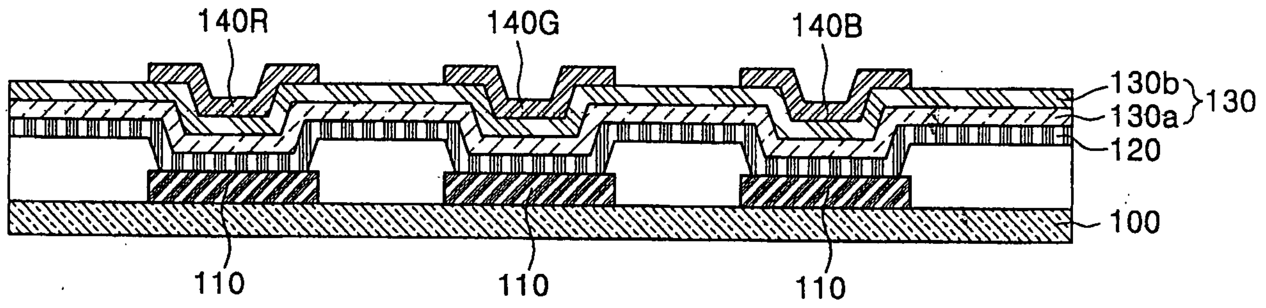


FIG. 2

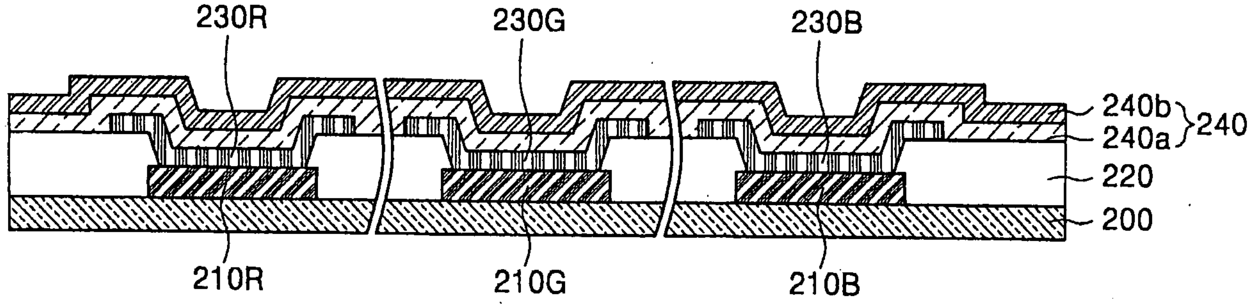
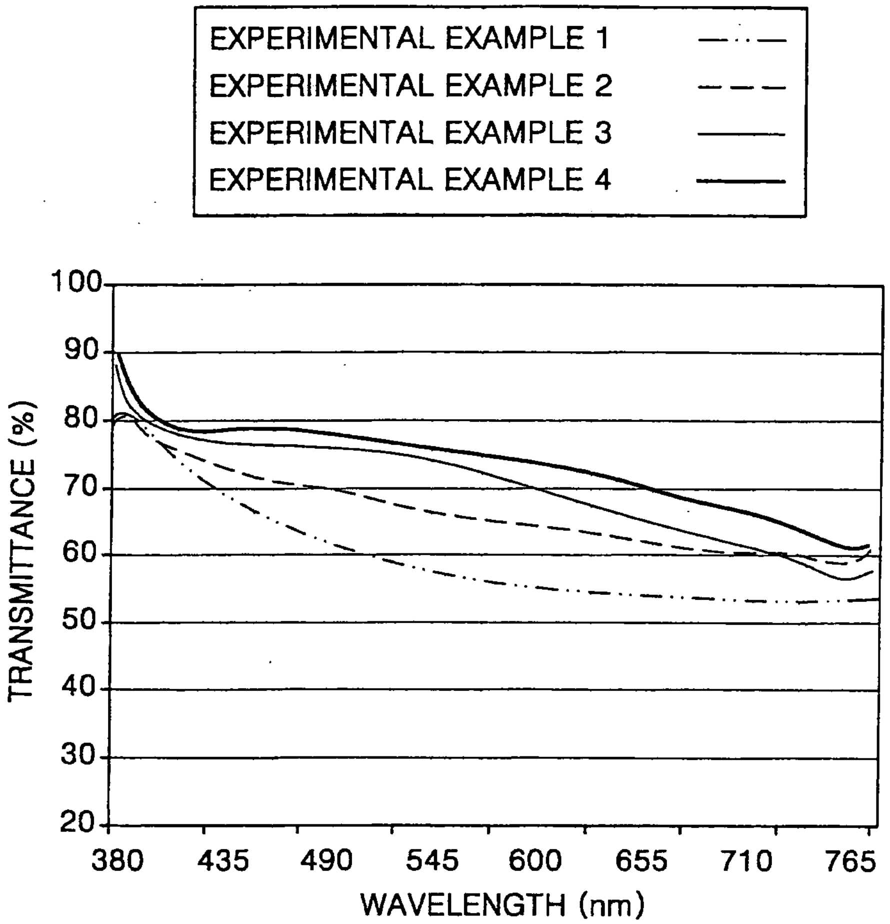


FIG. 3


EXPERIMENTAL EXAMPLE 1
EXPERIMENTAL EXAMPLE 2
EXPERIMENTAL EXAMPLE 3
EXPERIMENTAL EXAMPLE 4
TRANSMITTANCE (%)
100
90
80
70
60
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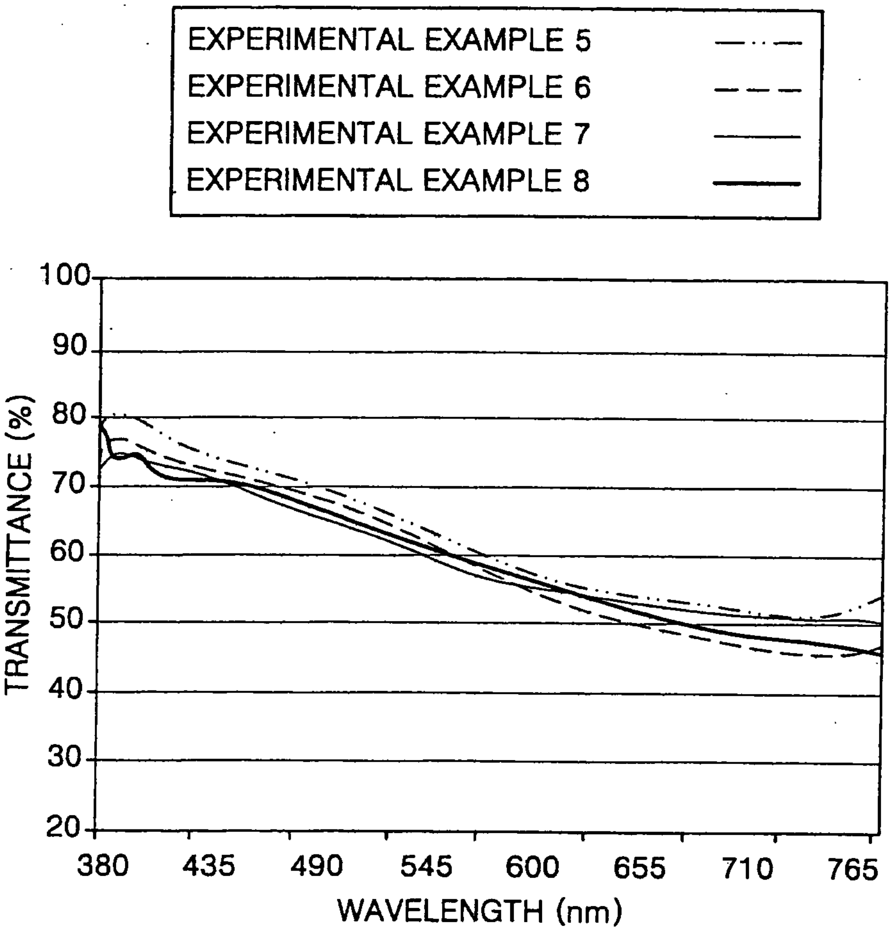
40
30
20
380
435
490
545
600
655
710
765
WAVELENGTH (nm)

FIG. 4


EXPERIMENTAL EXAMPLE 5
EXPERIMENTAL EXAMPLE 6
EXPERIMENTAL EXAMPLE 7
EXPERIMENTAL EXAMPLE 8
TRANSMITTANCE (%)
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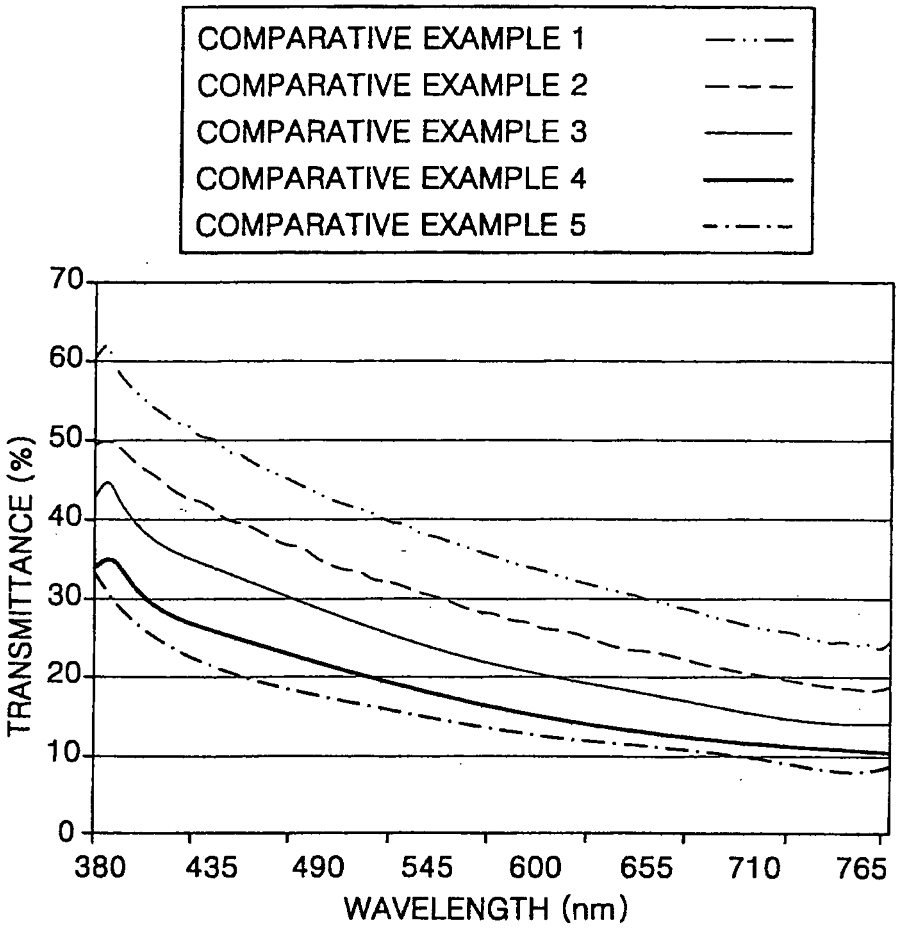
90
80
70
60
50
40
30
20
380
435
490
545
600
655
710
765
WAVELENGTH (nm)

FIG. 5


COMPARATIVE EXAMPLE 1
COMPARATIVE EXAMPLE 2
COMPARATIVE EXAMPLE 3
COMPARATIVE EXAMPLE 4
COMPARATIVE EXAMPLE 5
TRANSMITTANCE (%)
70
60
50
40
30
20
10
0
380
435
490
545
600
655
710
765
WAVELENGTH (nm)

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- WO 9954943 A **[0007]**
- US 20050084994 A **[0007]**

专利名称(译)	有机发光二极管显示装置及其制造方法		
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[标]申请(专利权)人(译)	三星斯笛爱股份有限公司		
申请(专利权)人(译)	三星SDI CO. , LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
[标]发明人	SUNG YEUN JOO KHO SAM IL YOO BYEONG WOOK		
发明人	SUNG, YEUN-JOO KHO, SAM-IL YOO, BYEONG-WOOK		
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摘要(译)

有机发光二极管（OLED）显示装置包括基板（100），设置在基板上的第一电极（110），包括设置在第一电极上的发光层的有机层（120），以及第二电极（130））包括在有机层上堆叠的Yb和Ag层。公开了一种制造该装置的方法。

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(54) **Organic light emitting diode display device and method of fabricating the same**
Organische LED-Anzeigevorrichtung und Verfahren zu ihrer Herstellung
Dispositif d'affichage à diode électroluminescente organique et son procédé de fabrication

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(73) Proprietor: **Samsung Display Co., Ltd.**
Gyeonggi-do (KR)

(72) Inventors:
- **Sung, Yeun-Joo**
  Suwon-si
  Gyeonggi-do (KR)
- **Kho, Sam-Il**
  Suwon-si
  Gyeonggi-do (KR)
- **Yoo, Byeong-Wook**
  Suwon-si
  Gyeonggi-do (KR)

(74) Representative: **Mounteney, Simon James**
Marks & Clerk LLP
90 Long Acre
London
WC2E 9RA (GB)

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