



US 20050196893A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0196893 A1****Kim et al.**(43) **Pub. Date:****Sep. 8, 2005**(54) **METHOD OF FABRICATING ORGANIC  
LIGHT EMITTING DISPLAY**(57) **ABSTRACT**(76) Inventors: **Mu-Hyun Kim**, Suwon-si (KR);  
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**Washington, DC 20005 (US)**(21) Appl. No.: **11/018,577**(22) Filed: **Dec. 22, 2004**(30) **Foreign Application Priority Data**

Feb. 19, 2004 (KR) ..... 2004-11155

**Publication Classification**(51) **Int. Cl.<sup>7</sup>** ..... **H01L 29/08**(52) **U.S. Cl.** ..... **438/82**

A method of fabricating an organic light emitting display is capable of improving device characteristics by patterning a plurality of organic layers of an emission layer and a charge transport layer using a thermal transfer method to optimize thicknesses of the organic layers corresponding to R, G and B pixels. The method includes: forming lower electrodes of R, G and B pixels on a substrate; forming an organic layer on the layer; and forming an upper electrode on the organic layer. Formation of the organic layer includes forming a portion of a hole injection layer and a hole transport layer of the R, G and B pixels over an entire surface of the substrate, the organic layer comprising a first portion and a second portion, the organic layer having a thickness equal to a sum of the thicknesses of the hole injection layer and the hole transport layer. Formation of the organic layer further comprises patterning the second portion of the organic layer, and patterning emission layers of the R, G and B pixels. The second portion of the organic layer and the emission layers of the R, G and B pixels are simultaneously formed by a thermal transfer method using a thermal transfer device having the second portion of the organic layer and the emission layers of the R, G and B pixels as a transfer layer.

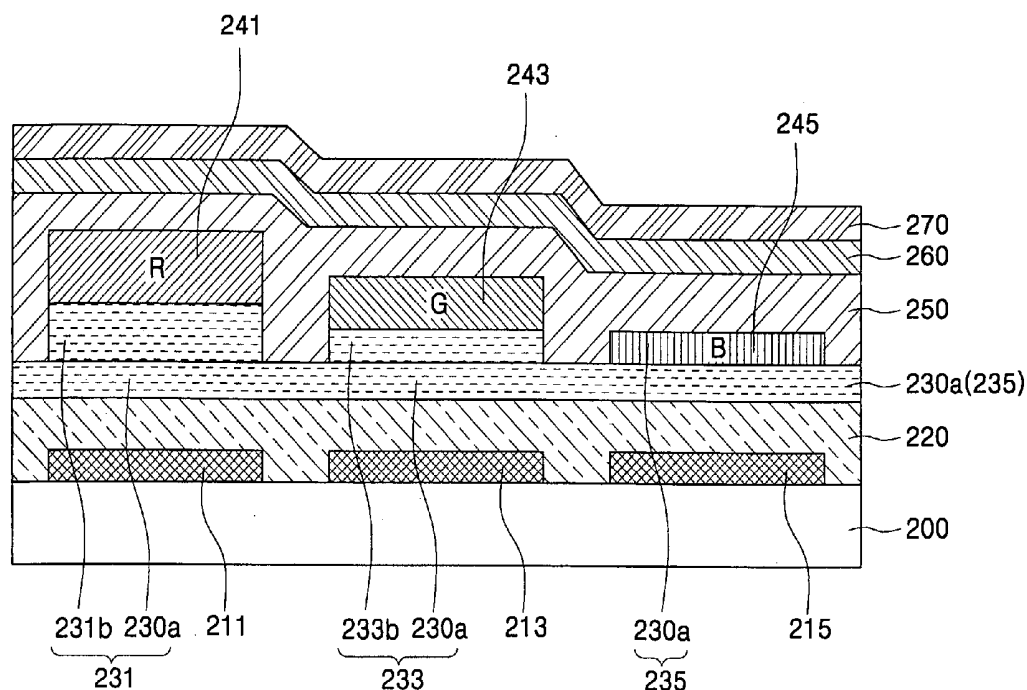


FIG. 1

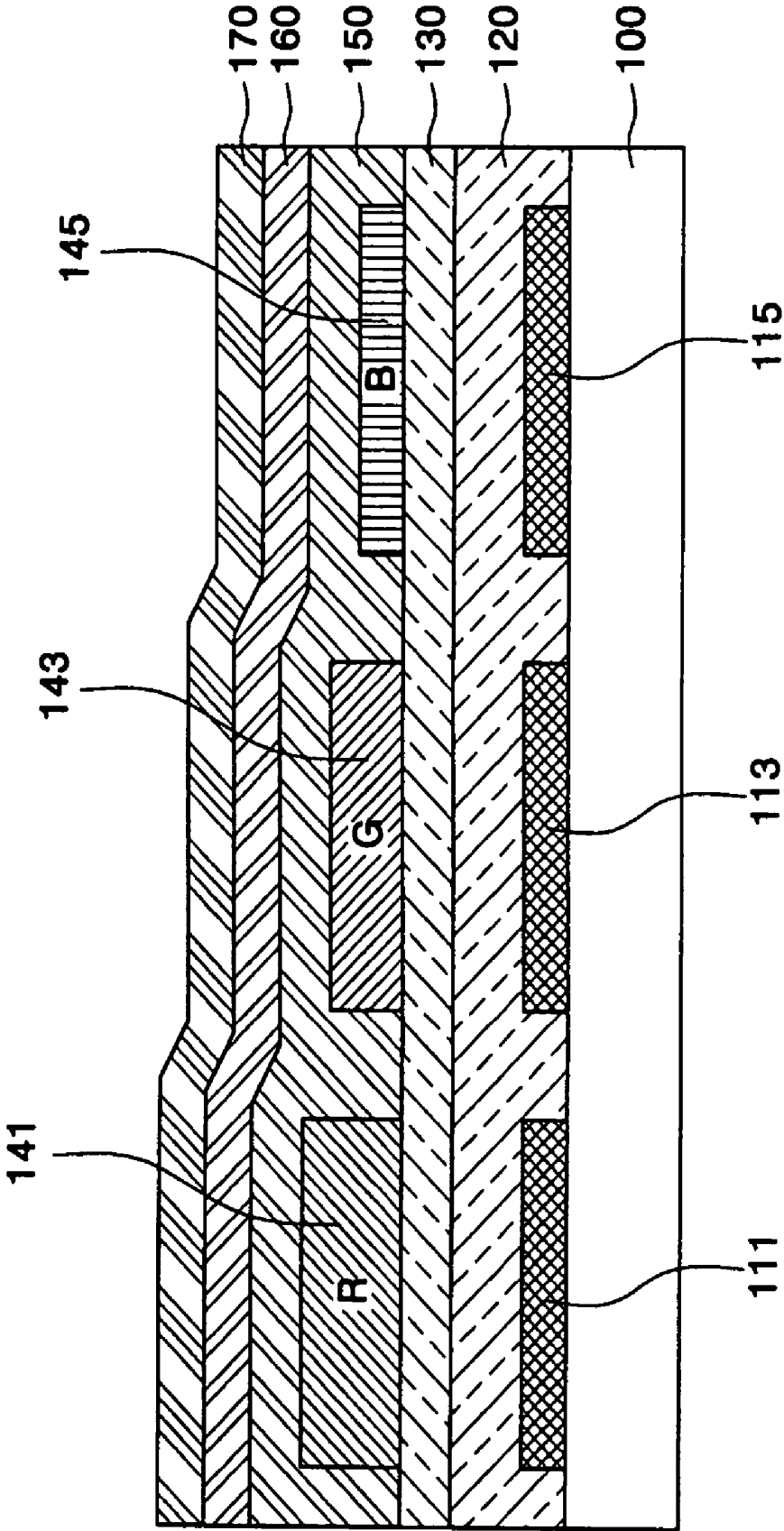
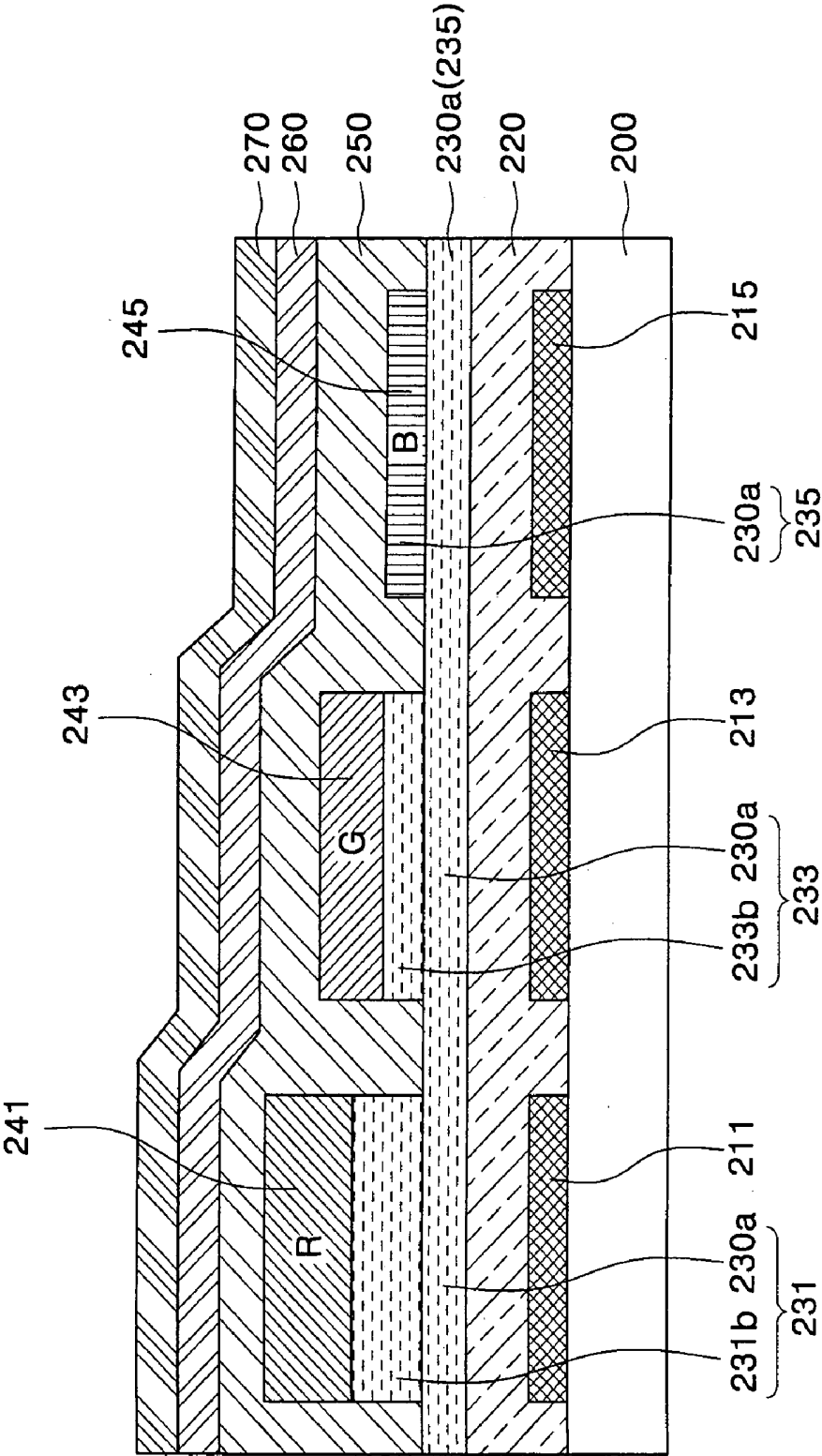
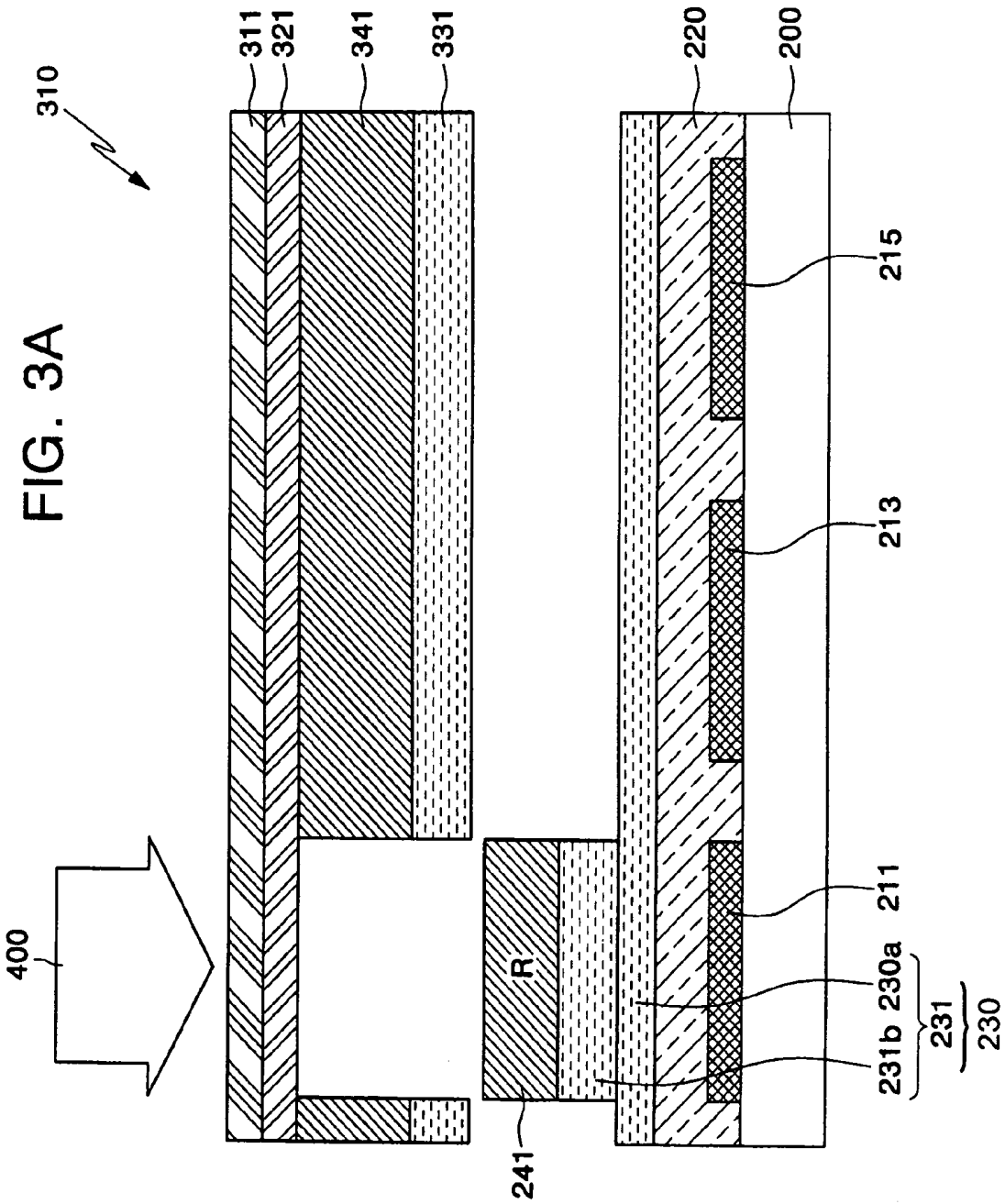


FIG. 2





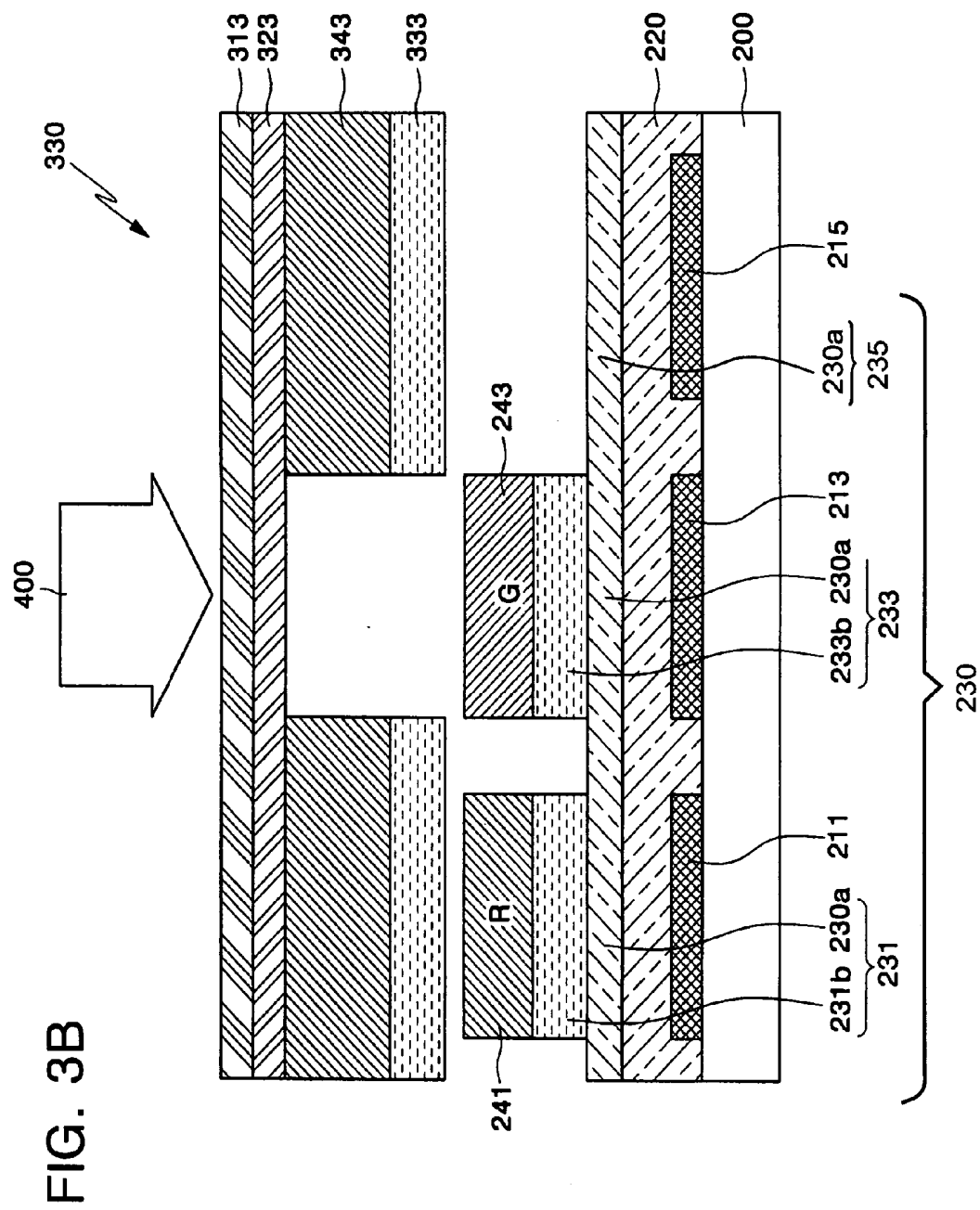


FIG. 4

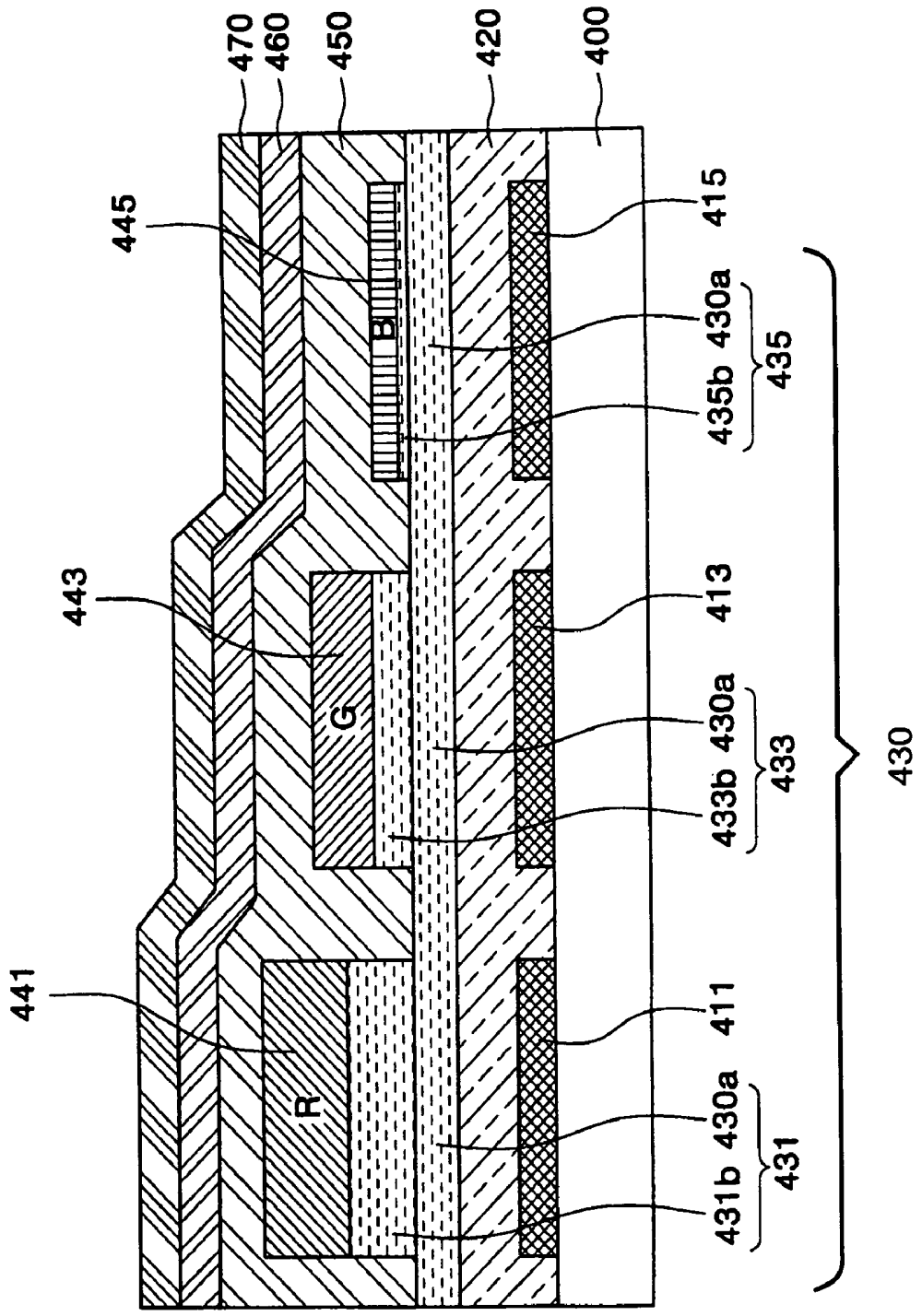
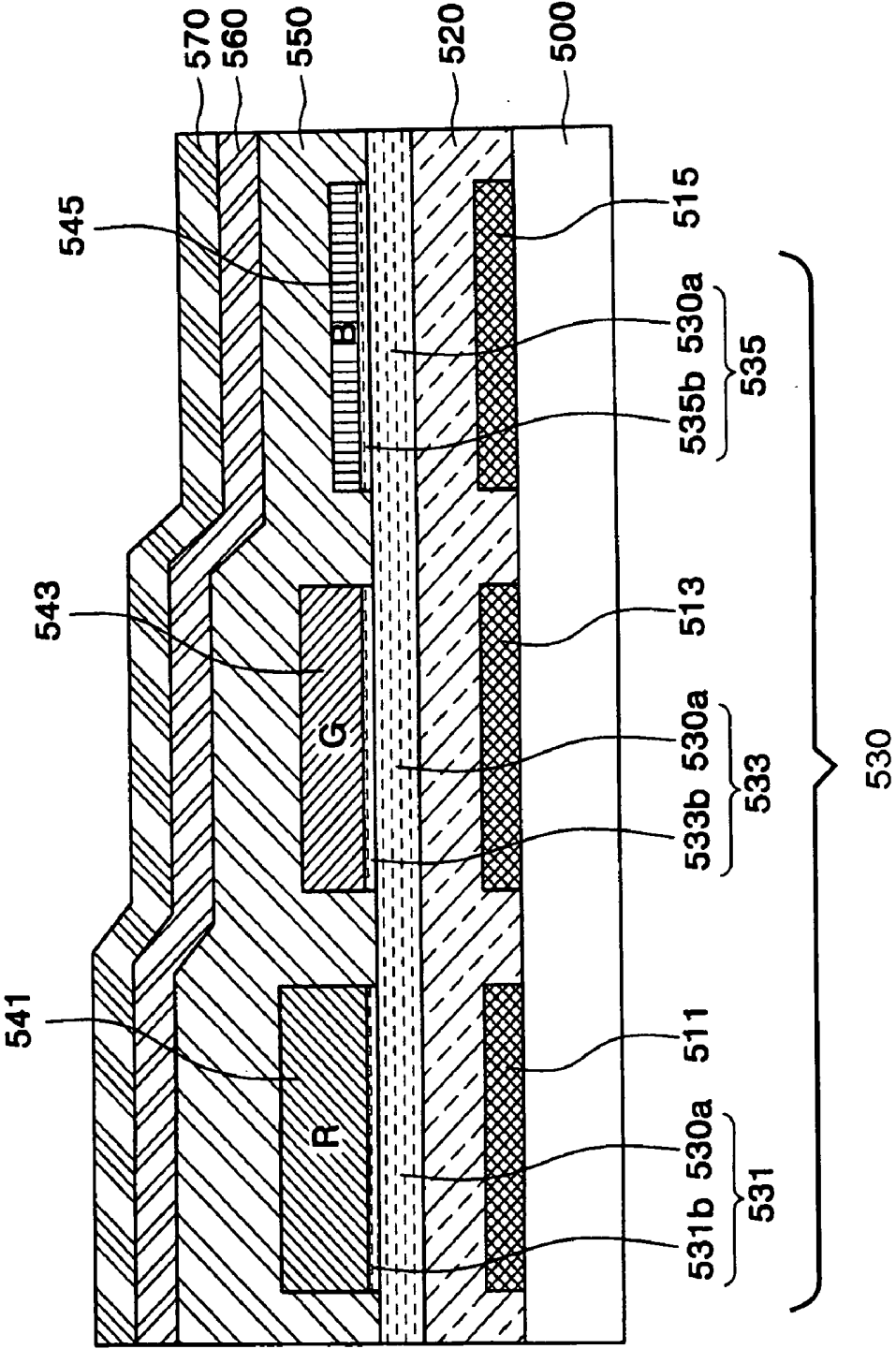
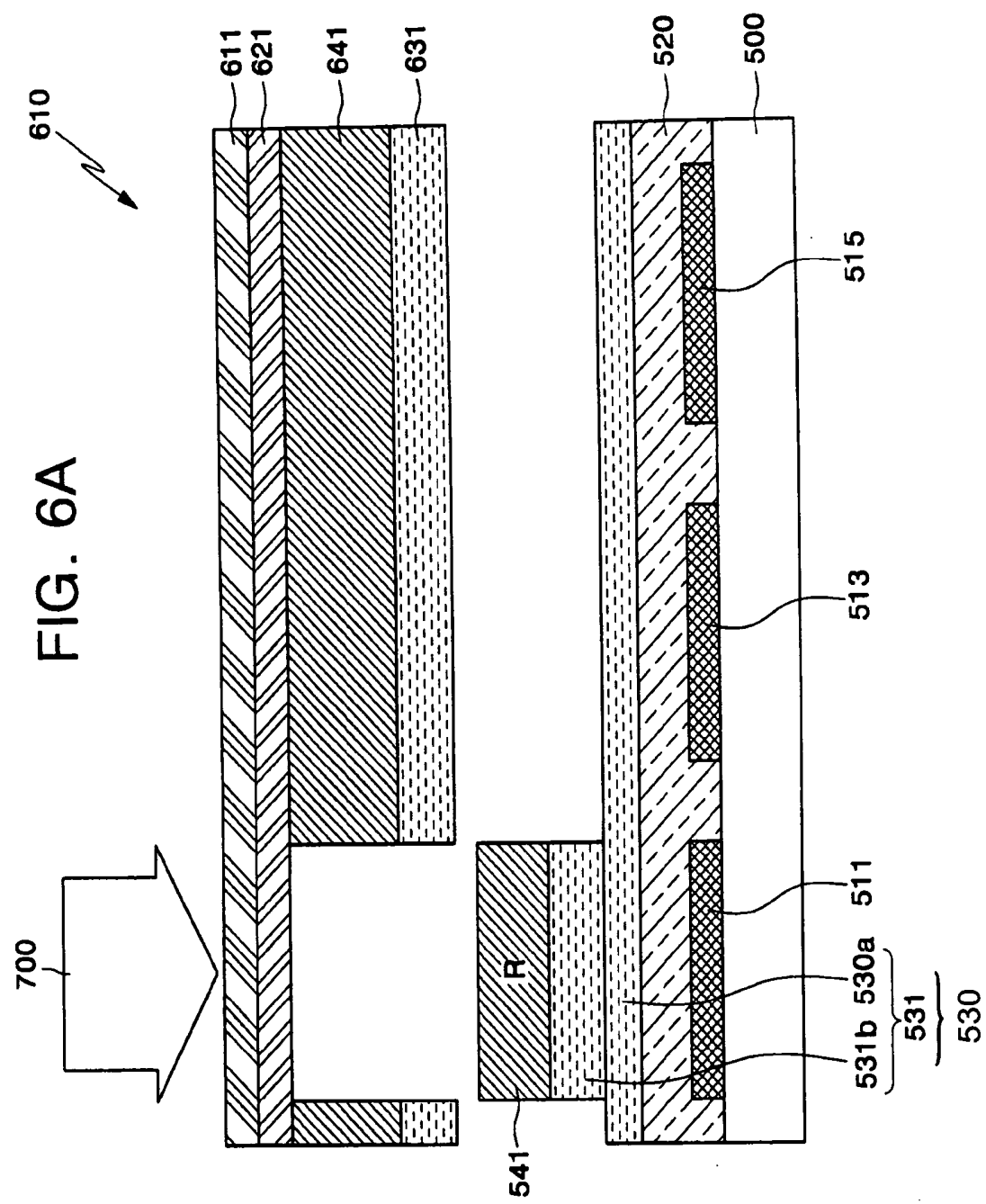


FIG. 5







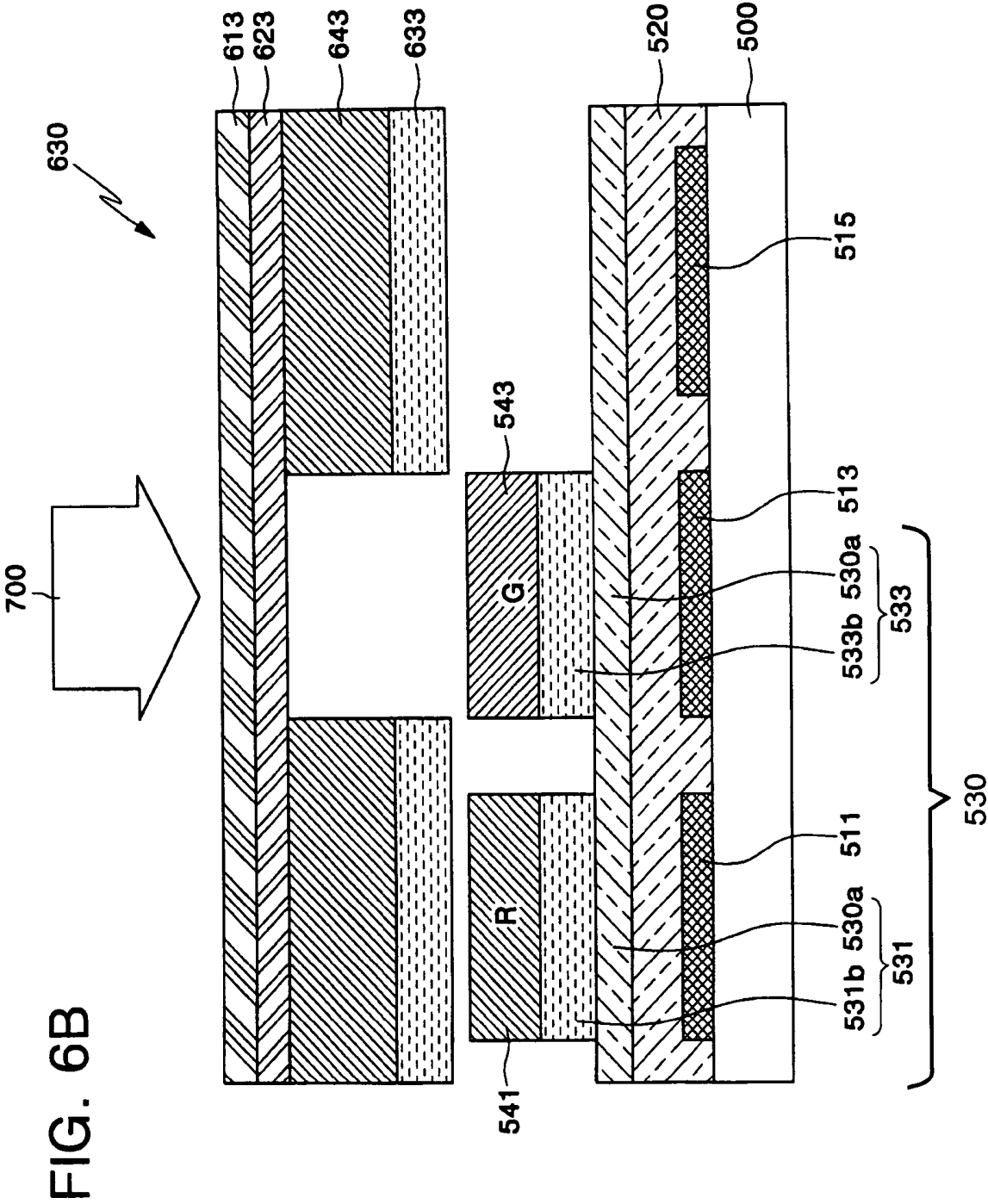
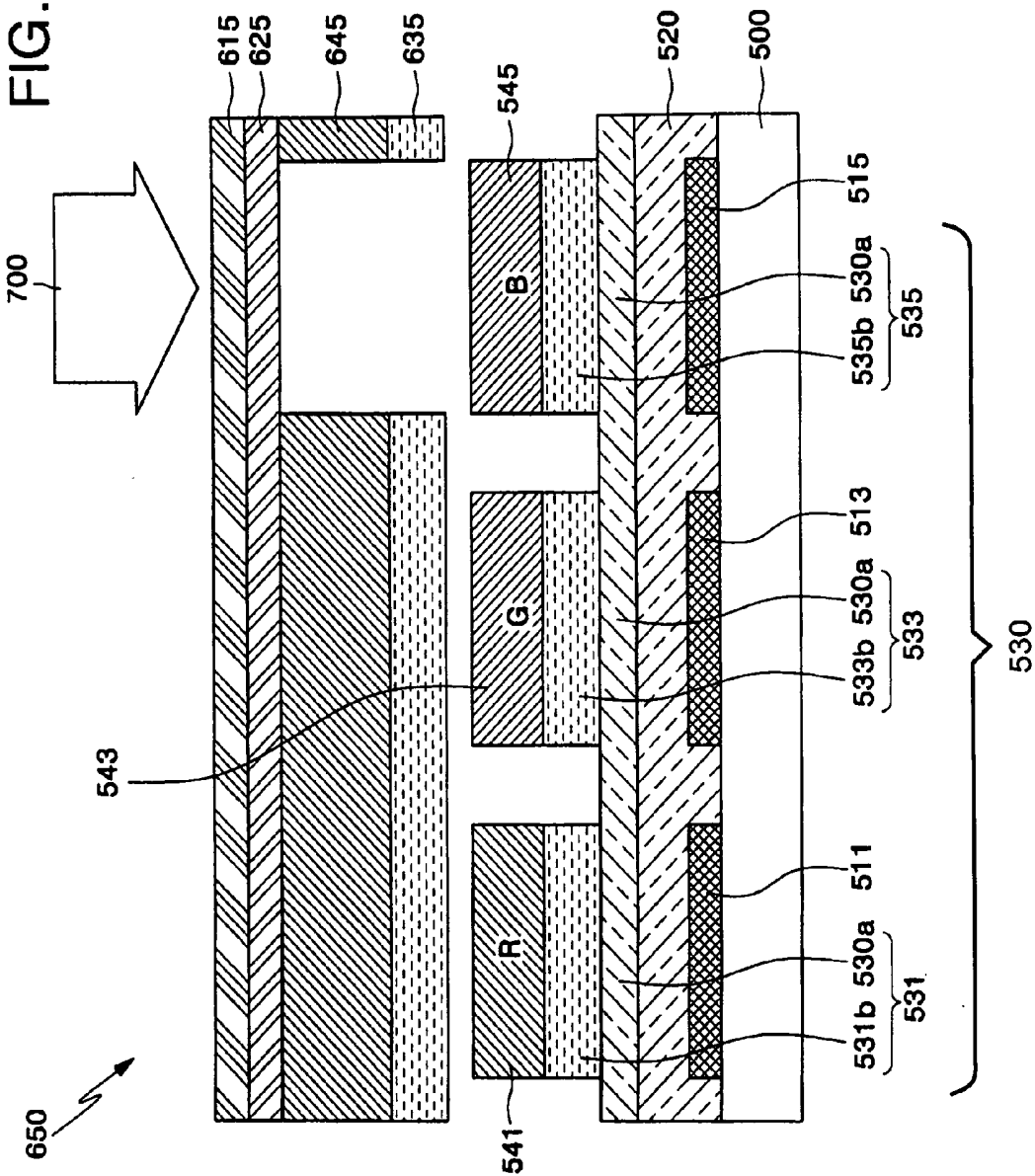


FIG. 6C



## METHOD OF FABRICATING ORGANIC LIGHT EMITTING DISPLAY

### CLAIM OF PRIORITY

[0001] This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application for METHOD OF FABRICATING ORGANIC LIGHT EMITTING DISPLAY Yearlier filed in the Korean Intellectual Property Office on 19 Feb. 2004 and thereby duly assigned Serial No. 2004-11155.

### BACKGROUND OF THE INVENTION

#### [0002] 1. Field of the Invention

[0003] The present invention relates to a flat panel display and, more particularly, to a method of fabricating an organic light emitting display capable of improving device characteristics by patterning a plurality of organic layers using a thermal transfer method to optimize thicknesses of the organic layers corresponding to R, G and B pixels.

#### [0004] 2. Description of the Related Art

[0005] Generally, an organic light emitting display (OLED) includes lower and upper electrodes formed on an insulating substrate, and a plurality of organic layers formed between the lower and upper electrodes. The organic layer is selected from a hole injection layer, a hole transport layer, an emission layer, a hole blocking layer, an electron transport layer and an electron injection layer depending upon functions of the respective layers. The display device has the upper and lower electrodes formed of a transparent electrode or a non-transparent electrode, so that the display device has such a structure that light is emitted from the organic layer toward the insulating substrate or in a direction opposite to the insulating direction, or is emitted both toward the insulating substrate and in a direction opposite to the insulating substrate.

[0006] When a full color OLED is manufactured by prior art techniques, optical thicknesses of the R, G and B pixels are different so that color coordinates and efficiency characteristics deteriorate.

### SUMMARY OF THE INVENTION

[0007] The present invention solves the aforementioned problems by providing a method of fabricating a top emission OLED capable of improving color coordinates and efficiency characteristics by forming a plurality of organic layers using a thermal transfer method.

[0008] In an exemplary embodiment of the present invention, a method of fabricating an OLED includes: forming lower electrodes of R, G and B pixels on a substrate; forming an organic layer on the substrate; and forming an upper electrode on the organic layer. Formation of the organic layer includes forming a portion of the sum of thicknesses of a hole injection layer and a hole transport layer of the R, G and B pixels on an entire surface of the substrate, patterning the remaining portion of the sum of the thicknesses of the hole injection layer and the hole transport layer, and patterning emission layers of the R, G and B pixels. The remaining portion of the hole injection layer and the hole transport layer, and the emission layers of the R, G and B pixels, are simultaneously formed by a thermal transfer

method using a thermal transfer device having the remaining portion of the hole injection layer and the hole transport layer, and the emission layers of the R, G and B pixels, as a transfer layer.

[0009] The organic layer can be an organic thin layer. The sum of the thicknesses of the hole injection layer and the hole transport layer of the R, G and B pixels, as a charge transport layer, is about 350 Å. The thicknesses of the emission layers of the R, G and B pixels is about 300~400 Å, 250~350 Å and 100~200 Å, respectively. The sum of the thicknesses of a hole blocking layer and an electron transport layer of the R, G and B pixels is about 300 Å. Finally, each of the thicknesses has a tolerance of about 50~200 Å.

[0010] The organic layer can be an organic layer. The sums of the thicknesses of the hole injection layer and the hole transport layer of the R, G and B pixels, as a charge transport layer, are about 2350 Å, 1700 Å, and 1350 Å, respectively. The thicknesses of the emission layers of the R, G and B pixels are about 300~400 Å, 250~350 Å, and 100~200 Å, respectively. The sum of thicknesses of a hole blocking layer and an electron transport layer of the R, G and B pixels is about 350 Å. Finally, each of the thicknesses has a tolerance of about 50~200 Å.

[0011] In another exemplary embodiment according to the present invention, a method of fabricating an OLED includes: forming lower electrodes of R, G and B pixels on a substrate; forming an organic layer on the substrate; and forming an upper electrode on the organic layer. Formation of the organic layer includes forming the hole injection layer of the R, G and B pixels over an entire surface of the substrate, forming a hole transport layer having the smallest thickness of hole transport layers of the R, G and B pixels over the entire surface of the substrate as a common layer, patterning hole transport layers of the remaining pixels, and patterning emission layers of the R, G and B pixels. The pixel having the smallest thickness of the hole transport layers of the R, G and B pixels allows only the emission layers to be patterned by a thermal transfer method using a thermal transfer device having the emission layer as a transfer layer, and the remaining pixels allow the hole transport layer and the emission layer to be simultaneously formed by the thermal transfer method using the thermal transfer device having the hole transport layer and the emission layer as a transfer layer, respectively.

[0012] The pixel including the hole transport layer having the smallest thickness of the R, G and B pixels is the B pixel; the sums of the thicknesses of the hole injection layer and the hole transport layer of the R, G and B pixels, as a charge transport layer, are about 2350 Å, 1700 Å, and 1350 Å, respectively. The thicknesses of the emission layers of the R, G and B pixels are about 300~400 Å, 250~350 Å, and 100~200 Å, respectively. The sum of the thicknesses of the hole blocking layer and the electron transport layer of the R, G and B pixels is about 350 Å. Finally, each thickness has a tolerance of about 50~200 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 same or similar components, wherein:

[0014] **FIG. 1** is a cross-sectional view of a top emission OLED;

[0015] **FIG. 2** is a cross-sectional view of an OLED in accordance with a first embodiment of the present invention;

[0016] **FIGS. 3A and 3B** are cross-sectional views of processes illustrating a method of fabricating an OLED using a thermal transfer method in accordance with the first embodiment of the present invention;

[0017] **FIG. 4** is a cross-sectional view of an OLED in accordance with a second embodiment of the present invention;

[0018] **FIG. 5** is a cross-sectional view of an OLED in accordance with a third embodiment of the present invention; and

[0019] **FIGS. 6A to 6C** are cross-sectional views of processes illustrating a method of fabricating an OLED using a thermal transfer method in accordance with the third embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0020] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings.

[0021] **FIG. 1** is a cross-sectional view of a top emission OLED.

[0022] Referring to **FIG. 1**, anode electrodes **111, 113** and **115** of R, G and B pixels are separately formed on an insulating substrate **100**, an organic layer or layers is or are formed over the insulating substrate **100**, and a cathode electrode **170** is formed over the organic layer(s).

[0023] The organic layers, such as a hole injection layer **120** and a hole transport layer **130**, are sequentially formed over an entire surface of the insulating substrate **100** having the anode electrodes **111, 113** and **115** of the R, G and B pixels formed thereon. Emission layers **141, 143** and **145** of the R, G and B pixels are formed in correspondence to the anode electrodes **111, 113** and **115** of the R, G and B pixels respectively, and a hole blocking layer **150** and an electron transport layer **160** are sequentially formed over an entire surface of the hole transport layer **130** so as to cover the emission layers **141, 143** and **145** of the R, G and B pixels.

[0024] The emission layers (EML) **141, 143** and **145** of the R, G and B pixels have a thickness appropriate to each of R, G and B colors, and are formed over the anode electrodes **111, 113** and **115**, respectively, of the R, G and B pixels. A charge transport layer, such as the hole injection layer (HIL) **120** and the hole transport layer (HTL) **130**, and a common layer such as the hole blocking layer (HBL) **150** and the electron transport layer (ETL) **160**, are formed over the entire surface of the substrate **100**.

[0025] The charge transport layer, such as the hole injection layer **120** and the hole transport layer **130**, is formed over the entire surface of the substrate **100** using a deposition method, the emission layers **141, 143** and **145** of the R,

G and B pixels are formed by the deposition method using shadow masks, and the common layer, such as the hole blocking layer **150** and the electron transport layer **160**, is formed over the entire surface of the substrate **100** by the deposition method.

[0026] **FIG. 2** is a cross-sectional view of an OLED in accordance with a first embodiment of the present invention. The OLED includes an organic thin layer.

[0027] Referring to **FIG. 2**, anode electrodes **211, 213** and **215** of R, G and B pixels are separately formed on a substrate **200** as lower electrodes, an organic layer (described below) is formed over the substrate **200**, and a cathode electrode **270** is formed on the organic layer as an upper electrode. The cathode electrode **270** comprises a transparent electrode or a semi-transparent electrode, and light emitted from the organic layer is emitted in a direction away from the substrate **200**. The organic layer includes emission layers **241, 243** and **245** of the R, G and B pixels patterned in correspondence to the anode electrodes **211, 213** and **215** of the R, G and B pixels, respectively, and a charge transport layer (described below) formed on and under the emission layers **241, 243** and **245**.

[0028] The charge transport layer includes a hole injection layer **220** and a hole transport layer **230** (**231, 233, 235**) formed between the anode electrodes **211, 213** and **215** of the R, G and B pixels and the emission layers **241, 243** and **245** of the R, G and B pixels. In addition, the charge transport layer includes a hole blocking layer **250** and an electron transport layer **260** formed between the R, G and B emission layers **241, 243** and **245** and the cathode electrode **270**.

[0029] A portion of the charge transport layer formed between the anode electrodes **211, 213** and **215** of the R, G and B pixels and the emission layers **241, 243** and **245** of the R, G and B pixels is patterned in correspondence to the emission layers **241, 243** and **245** of the R, G and B pixels.

[0030] In accordance with a first embodiment of the present invention, of the hole transport layer **230** and the hole injection layer **220**, only the hole transport layer **230** is patterned. The hole transport layer **230** comprises R, G and B hole transport layers **231, 233** and **235**, respectively, which includes a common layer **230a** formed over an entire surface of the substrate **200**, and patterning layers **231b** and **233b** formed in correspondence to the R and G emission layers **241** and **243**, respectively. The common layer **230a** is formed over the entire surface of the substrate **200**, and one of the hole transport layers **231, 233** and **235** of the R, G and B pixels has the smallest thickness. For example, the common layer **230a** is formed by a deposition method so that the hole transport layer **235** of the B pixel has the smallest thickness relative to the hole transport layers of the R and G pixels **231** and **233**, respectively.

[0031] Subsequently, the patterning layers **231b, 233b** of the hole transport layers **231, 233, 235** and the emission layers **241, 243, 245** are formed in correspondence to the anode electrodes **211, 213** and **215** of the R, G and B pixels by simultaneously patterning the patterning layers **231b, 233b** of the hole transport layer **230** and the emission layers **241, 243, 245** using the thermal transfer method. A method of simultaneously patterning the hole transport layer **230** and the emission layers **241, 243, 245** using the thermal transfer

method will be described with reference to FIGS. 3A and 3B, and Table 1.

TABLE 1

	Sum of thicknesses of HIL and HTL	Thickness of EML	Sum of thicknesses of HBL and ETL
R	2350 Å	300~400 Å	350 Å
G	1700 Å	250~350 Å	350 Å
B	1350 Å	100~200 Å	350 Å

[0032] Table 1 represents optically optimized thicknesses corresponding to the R, G and B pixels, when the cathode electrode 270 employs indium tin oxide (ITO) having a thickness of about 125 Å and the organic layer is formed in a thick layer. In this regard, the thickness of each layer has a tolerance of about 50~200 Å.

[0033] First, referring to FIG. 3A, the hole injection layer 220 is formed by a deposition method over the entire surface of the substrate 200, on which the anode electrodes 211, 213 and 215 of the R, G and B pixels are formed, and a portion of the hole transport layer 230 (i.e., the common layer 230a of the hole transport layer 230) is formed on the entire surface of the hole injection layer 220 by a deposition method similar to that used to form the hole injection layer 220. The deposition thickness of the common layer 230a of the hole transport layer 230 and the deposition thickness of the hole injection layer 220 are determined in dependence upon the pixel having the smallest sum of the thicknesses of the hole transport layer 230 and the hole injection layer 220 of the R, G and B pixels. Therefore, the common layer 230a of the hole transport layer 230 and the hole injection layer 220 are deposited to a thickness of about 1350 Å, which is equal to the sum of the thicknesses of the hole transport layer 231 and the hole injection layer 220 of the B pixel, as shown in Table 1.

[0034] Next, a thermal transfer device 310 for patterning the patterning layer 231b of the R hole transport layer 231 and the R emission layer 241 is prepared. The thermal transfer device 310 includes a base substrate 311, a light to heat conversion layer 321 formed on the base substrate 311, an organic layer 331 for the R hole transport layer 231 as a transfer layer, and an organic layer 341 for the R emission layer 241.

[0035] Referring to FIG. 3A, a laser 400 is irradiated onto the thermal transfer device 310, simultaneously patterning the organic layers 331 and 341 to form the patterning layer 231b and the emission layer 241. As a result, the patterning layer 231b of the R hole transport layer 231 and the R emission layer 241 are formed on the common layer 230a of the R hole transport layer 231 above the R anode electrode 211.

[0036] Referring to FIG. 3B, in the first embodiment of the present invention, the hole transport layer 230 includes the common layer 230a formed over the entire surface of the substrate 200, and the patterning layers 231b and 233b formed in correspondence to the emission layers 241 and 243 of the R and G pixels, respectively. The R pixel includes the R hole transport layer 231 having the common layer 230a and the patterning layer 231b, the G pixel includes the G hole transport layer 233 having the common layer 230a and the patterning layer 233b, and the B pixel includes the

B hole transport layer 235 having only the common layer 230a. At this point, since the sums of the thicknesses of the hole transport layer 230 and the hole injection layer 220 corresponding to the R, G and B pixels are different from each other as shown in Table 1, the thicknesses of the patterning layers 231b and 233b of the hole transport layers 231 and 233 of the R and G pixels, respectively, are different from each other.

[0037] Next, a thermal transfer device 330 for patterning the patterning layer 233b of the G hole transport layer 233 and the G emission layer 243 is prepared. The thermal transfer device 330 includes a base substrate 313, a light to heat conversion layer 323 formed on the base substrate 313, an organic layer 333 for the G hole transport layer 233 as a transfer layer, and an organic layer 343 for the G emission layer 243.

[0038] A laser 400 is irradiated onto the thermal transfer device 330, simultaneously patterning the organic layers 333 and 343 so as to form the patterning layer and the emission layer, that is, so as to form the patterning layer 233b of the G hole transport layer 233 and the G emission layer 243 on the common layer 230a of the hole transport layer 230 above the G anode electrode 213. Finally, a laser is irradiated onto a thermal transfer device (not shown) for the B emission layer 245 (FIG. 2), simultaneously patterning the thermal transfer device. Therefore, the B emission layer 245 is formed on the common layer 230a above the anode electrode 215 of the B pixel. At this point, in the case of the B pixel, since the B hole transport layer 235 is already formed as the common layer 230a, the thermal transfer device for the B pixel includes only the organic layer for the B emission layer 245, except for the organic layer for the B hole transport layer 235.

[0039] FIG. 4 is a cross-sectional view of an OLED in accordance with a second embodiment of the present invention.

[0040] Referring to FIG. 4, anode electrodes 411, 413 and 415 of R, G and B pixels are separately formed on a substrate 400 as lower electrodes, an organic layer (described below) is formed over the substrate 400, and a cathode electrode 470 is formed on the organic layer as an upper electrode. The cathode electrode 470 comprises a transparent electrode or a semi-transparent electrode, and light emitted from the organic layer is emitted in a direction away from the substrate 400. The organic layer includes emission layers 441, 443 and 445 of the R, G and B pixels patterned in correspondence to the anode electrodes 411, 413 and 415 of the R, G and B pixels, and a charge transport layer formed on and under the emission layers 441, 443 and 445.

[0041] The charge transport layer includes a hole injection layer 420 and a hole transport layer 430 formed between the anode electrodes 411, 413 and 415 of the R, G and B pixels and the emission layers 441, 443 and 445 of the R, G and B pixels. In addition, the charge transport layer includes a hole blocking layer 450 and an electron transport layer 460 formed between the R, G and B emission layers 441, 443 and 445 and the cathode electrode 470.

[0042] A portion of the charge transport layer formed between the anode electrodes 411, 413 and 415, (i.e., the lower electrodes, of the R, G and B pixels) and the emission

layers **441**, **443** and **445** of the R, G and B pixels is patterned in correspondence to the emission layers **441**, **443** and **445** of the R, G and B pixels.

[0043] In the second embodiment of the present invention, of the hole injection layer **420** and the hole transport layer **430**, only the hole transport layer **430** is patterned in correspondence to the R, G and B pixels to a predetermined thickness. The hole transport layer **430** may be entirely patterned in correspondence to the R, G and B pixels, or both of the hole injection layer **420** and the hole transport layer **430** may be entirely patterned in correspondence to the R, G and B pixels, or a portion of the hole injection layer **420** may be patterned in correspondence to the R, G and B pixels and the hole transport layer **430** may be entirely patterned in correspondence to the R, G and B pixels. FIG. 4 illustrates a method of patterning only a portion of the hole transport layer **430** in correspondence to the R, G and B pixels.

[0044] The hole transport layer **430** includes a common layer **430a** formed over the entire surface of the substrate **400**, and patterning layers **431b**, **433b** and **435b** formed in correspondence to the R, G and B emission layers **441**, **443** and **445**, respectively. The R pixel includes the R hole transport layer **431** having the common layer **430a** and the patterning layer **431b**, the G pixel includes the G hole transport layer **433** having the common layer **430a** and the patterning layer **433b**, and the B pixel includes the B hole transport layer **435** having the common layer **430a** and the patterning layer **435b**.

[0045] The sum of the thicknesses of the hole transport layer **430** and the hole injection layer **420** of the R, G and B pixels becomes the sum of the thicknesses of the hole injection layer **420**, and the common layer **430a** and the R, G and B patterning layers **431b**, **433b** and **435b** of the hole transport layer **430**. In addition, the patterning layers **431b**, **433b** and **435b** of the R, G and B pixels have different values from each other. At this point, where the sum of the thicknesses of the hole injection layer **420** and the hole transport layer **430** of the R, G and B pixels are yr, yg, and yb, respectively, and where the sum of the thicknesses of the common layer **430a** of the hole transport layer **430** and the hole injection layer **420** is x, the thicknesses xr, xg and xb of the patterning layers **431b**, **433b** and **435b** of the hole transport layer **430** of the R, G and B pixels become yr-x, yg-x and yb-x, respectively. For example, where x is 1300 Å, since yr, yg and yb are 2350 Å, 1700 Å and 1350 Å, respectively, from Table 1, xr, xg and xb become 1350 Å, 400 Å and 50 Å, respectively.

[0046] Therefore, in the second embodiment of the present invention, the thicknesses of patterned portions of the hole injection layer **420** and the hole transport layer **430** are determined by the smallest sum of the thicknesses of the hole injection layer **420** and the hole transport layer **430** among the R, G and B pixels, and the thicknesses of the patterned portions of the hole injection layer **420** and the hole transport layer **430** are determined by the sum of the thicknesses of the hole injection layer **420** and the hole transport layer **433** of the B pixel. That is, the thicknesses of the patterned portions of the hole injection layer **420** and the hole transport layer **430** are greater than zero, and equal to or smaller than the thickness of the hole injection layer **420** and the hole transport layer **430**. In this connection, the thickness of the patterned portion being greater than zero

means that at least a portion of the hole transport layer **430** and the hole injection layer **420** was patterned, and the thickness of the patterned portion being equal to the thicknesses of the hole injection layer **420** and the hole transport layer **430** means that the hole injection layer **420** and the hole transport layer **430** were entirely patterned.

[0047] The process of forming the organic layer is performed by the same method as in the first embodiment shown in FIGS. 3A and 3B, except that the thermal transfer device for patterning the hole transport layer **435** and the emission layer **445** of the B pixel additionally includes both of the organic layers for patterning the hole transport layer **435** and the emission layer **445**.

[0048] FIG. 5 is a cross-sectional view of an OLED in accordance with a third embodiment of the present invention, which includes an organic thin layer.

[0049] Referring to FIG. 5, anode electrodes **511**, **513** and **515** of R, G and B pixels are separately formed on a substrate **500** as lower electrodes, an organic layer is formed over the substrate **500**, and a cathode electrode **570** is formed on the organic layer as an upper electrode. The cathode electrode **570** as the upper electrode comprises a transparent electrode or a semi-transparent electrode, and light emitted from the organic layer is emitted in a direction away from the substrate **500**. The organic layer includes emission layers **541**, **543** and **545** of the R, G and B pixels patterned in correspondence to the anode electrodes **511**, **513** and **515** of the R, G and B pixels, and a charge transport layer formed on and under the emission layers **541**, **543** and **545**.

[0050] The charge transport layer includes a hole injection layer **520** and a hole transport layer **530** formed between the anode electrodes **511**, **513** and **515** of the R, G and B pixels and the emission layers **541**, **543** and **545** of the R, G and B pixels. In addition, the charge transport layer includes a hole blocking layer **550** and an electron transport layer **560** formed between the R, G and B emission layers **541**, **543** and **545** and the cathode electrode **570**.

[0051] A portion of the charge transport layer formed between the anode electrodes **511**, **513** and **515** (i.e., the lower electrodes, of the R, G and B pixels) and the emission layers **541**, **543** and **545** of the R, G and B pixels is patterned in correspondence to the emission layers **541**, **543** and **545** of the R, G and B pixels.

[0052] In a third embodiment of the present invention, of the hole injection layer **520** and the hole transport layer **530**, only the hole transport layer **530** is patterned in correspondence to the R, G and B pixels to a uniform thickness. The hole transport layer **530** may be entirely patterned in correspondence to the R, G and B pixels, or both the hole injection layer **520** and the hole transport layer **530** may be entirely patterned in correspondence to the R, G and B pixels, or a portion of the hole injection layer **520** may be patterned in correspondence to the R, G and B pixels and the hole transport layer **530** may be entirely patterned in correspondence to the R, G and B pixels. FIG. 5 illustrates a method of patterning only a portion of the hole transport layer **530** in correspondence to the R, G and B pixels.

[0053] The hole transport layer **530** includes a common layer **530a** formed over the entire surface of the substrate **500**, and patterning layers **531b**, **533b** and **535b** formed in

correspondence to the R, G and B emission layers **541**, **543** and **545**, respectively. The R pixel includes R hole transport layer **531** having the common layer **530a** and the patterning layer **531b**, the G pixel includes G hole transport layer **533** having the common layer **530a** and the patterning layer **533b**, and the B pixel includes B hole transport layer **535** having the common layer **530a** and the patterning layer **535b**.

[0054] Therefore, the sum of the thicknesses of the hole transport layer **530** and the hole injection layer **520** of the R, G and B pixels becomes the sum of the thicknesses of the hole injection layer **520**, and the common layer **530a** and the R, G and B patterning layers **531b**, **533b** and **535b** of the hole transport layer **530**. In the third embodiment using an organic thin layer, in contrast to the second embodiment, since the thicknesses of the hole transport layer **530** and the hole injection layer **520** of the R, G and B pixels are equal as shown in Table 2, the thicknesses of the patterning layers **531b**, **533b** and **535b** have the same value. At this point, where the sum of the thicknesses of the hole injection layer **520** and the hole transport layer **530** of the R, G and B pixels is y, and where the sum of the thicknesses of the common layer **530a** of the hole transport layer **530** and the hole injection layer **520** is x, the thicknesses  $x_r$ ,  $x_g$  and  $x_b$  of the patterning layers **531b**, **533b** and **535b** of the hole transport layer **530** of the R, G and B pixels become  $y-x$  equally. For example, where x is 100 Å, since y is 350 Å from Table 2,  $x_r$ ,  $x_g$  and  $x_b$  become 250 Å equally.

[0055] Therefore, in the third embodiment of the present invention, since the thicknesses of patterned portions of the hole injection layer **520** and the hole transport layer **530** are determined by the sum of the thicknesses of the hole injection layer **520** and the hole transport layer **530**, the thicknesses of the patterned portions of the hole injection layer **520** and the hole transport layer **530** are greater than zero, and equal to or smaller than the thicknesses of the hole injection layer and the hole transport layer **530**.

[0056] In this connection, the thickness of the patterned portion being greater than zero means that at least a portion of the hole transport layer **530** and the hole injection layer **520** is patterned, and the thickness of the patterned portion being equal to the thicknesses of the hole injection layer **520** and the hole transport layer **530** means that the hole injection layer **520** and the hole transport layer **530** are entirely patterned.

[0057] A process of forming the organic layer through a method of simultaneously patterning the hole transport layer **530** and the emission layers **541**, **543**, **545** using a thermal transfer method will be described with reference to FIGS. 6A to 6C, and Table 2.

TABLE 2

	Sum of thicknesses of HIL and HTL	Thickness of EML	Sum of thicknesses of HBL and ETL
R	350 Å	300~400 Å	300 Å
G	350 Å	250~350 Å	300 Å
B	350 Å	100~200 Å	300 Å

[0058] Table 2 represents optically optimized thicknesses corresponding to the R, G and B pixels, when the cathode electrode **570** comprises ITO having a thickness of about

125 Å and the organic layer is formed of a thin layer. At this point, the thickness of each layer has a tolerance of about 50~200 Å.

[0059] First, referring to FIG. 6A, a hole injection layer **520** is formed on the entire surface of a substrate **500**, at which anode electrodes **511**, **513** and **515** of the R, G and B pixels are formed, by a deposition method, and a portion of the hole transport layer **530** (i.e., a common layer **530a** of the hole transport layer **530**) is formed on the entire surface of the hole injection layer **520** by a deposition method similar to that used to form the hole injection layer **520**.

[0060] Next, a thermal transfer device **610** for patterning a patterning layer **531b** of the R hole transport layer **531** and an R emission layer **541** is prepared. The thermal transfer device **610** includes a base substrate **611**, a light conversion layer **621** formed on the base substrate **611**, an organic layer **631** for the R hole transport layer **531** as a transfer layer, and an organic layer **641** for the R emission layer.

[0061] A laser **700** is irradiated onto the thermal transfer device **610**, simultaneously patterning the organic layers **631** and **641** so as to form the patterning layer **531b** and the emission layer **541**. As a result, the patterning layer **531b** of the R hole transport layer **531** and the R emission layer **541** are formed on the common layer **530a** of the hole transport layer **530** above the R anode electrode **511**.

[0062] Next, as shown in FIG. 6B, a thermal transfer device **630** for patterning a patterning layer **533b** of the G hole transport layer **533** and a G emission layer **543** is prepared. The thermal transfer device **630** includes a base substrate **613**, a light to heat conversion layer **623** formed on the base substrate **613**, an organic layer **633** for the G hole transport layer **533** as a transfer layer, and an organic layer **643** for the G emission layer **543**.

[0063] A laser **700** is irradiated onto the thermal transfer device **630**, simultaneously patterning the organic layers **633** and **643** so as to form the patterning layer **533b** and the emission layer **543**. As a result, the patterning layer **533b** of the G hole transport layer **533** and the G emission layer **543** are formed on the common layer **530a** of the hole transport layer **530** above the G anode electrode **513**.

[0064] Finally, as shown in FIG. 6C, a thermal transfer device **650** for patterning a patterning layer **535b** of the B hole transport layer **535** and a B emission layer **545** is prepared. The thermal transfer device **650** includes a base substrate **615**, a light to heat conversion layer **625** formed on the base substrate **615**, an organic layer **635** for the B hole transport layer **535** as a transfer layer, and an organic layer **645** for the B emission layer **545**.

[0065] A laser **700** is irradiated onto the thermal transfer device **650**, simultaneously patterning the organic layers **635** and **645** so as to form the patterning layer **535b** and the emission layer **545**. Therefore, the patterning layer **535b** of the B hole transport layer **535** and the emission layer **545** are formed on the common layer **530a** above the B anode electrode **515**.

[0066] While the embodiments of the present invention describe the thermal transfer device as having a structure such that the light to heat conversion layer and the transfer layer are deposited on the base substrate, a layer for improving thermal transfer characteristics (for example, an inter-

mediate layer etc.) may be inserted therebetween. In addition, the thicknesses described in Tables 1 and 2 may be varied depending upon changes in process conditions and device characteristics.

[0067] As can be seen from the foregoing, since the charge transport layer and the emission layer are simultaneously patterned using the thermal transfer method, the method of the present invention is capable of improving color coordinates and efficiency characteristics by optimizing the optical thicknesses according to the R, G and B pixels, thereby improving display quality and applying to a high resolution OLED.

[0068] 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. A method of fabricating an organic electroluminescence display (OLED), comprising the steps of:

forming lower electrodes of R, G and B pixels on a substrate;

forming an organic layer over the substrate; and

forming an upper electrode on the organic layer;

wherein the step of forming the organic layer comprises forming a hole injection layer and a hole transport layer of the R, G and B pixels over an entire surface of the substrate, said organic layer comprising a first portion and a second portion, said organic layer having a thickness equal to a sum of thicknesses of the hole injection layer and the hole transport layer;

said step of forming the organic layer further comprising patterning the second portion of the organic layer, and patterning emission layers of the R, G and B pixels, wherein the second portion of the organic layer and the emission layers of the R, G and B pixels are simultaneously formed by a thermal transfer method using a thermal transfer device having the second portion of the organic layer and the emission layers of the R, G and B pixels as a transfer layer.

2. The method according to claim 1, wherein the sum of the thicknesses of the hole injection layer and the hole transport layer of the R, G and B pixels as a charge transport layer is about 350 Å; thicknesses of R, G and B emission layers are about 300~400 Å, 250~350 Å, and 100~200 Å, respectively; a sum of thicknesses of a hole blocking layer

and an electron transport layer of the R, G and B pixels is about 300 Å; and each thickness has a tolerance of about 50~200 Å.

3. The method according to claim 1, wherein the sums of the thicknesses of the hole injection layer and the hole transport layer of the R, G and B pixels as a charge transport layer are about 2350 Å, 1700 Å, and 1350 Å, respectively; thicknesses of R, G and B emission layers are about 300~400 Å, 250~350 Å, and 100~200 Å, respectively; a sum of thicknesses of a hole blocking layer and an electron transport layer of the R, G and B pixels is about 350 Å; and

each thickness has a tolerance of about 50~200 Å.

4. A method of fabricating an organic electroluminescence display (OLED), comprising the steps of:

forming lower electrodes of R, G and B pixels on a substrate;

forming an organic layer over the substrate; and

forming an upper electrode on the organic layer;

wherein the step of forming the organic layer comprises forming a hole injection layer of the R, G and B pixels over an entire surface of the substrate, forming a hole transport layer having a smallest thickness of hole transport layers of the R, G and B pixels over the entire surface of the substrate as a common layer, patterning hole transport layers of remaining pixels, and patterning emission layers of the R, G and B pixels;

wherein a pixel having the smallest thickness of the hole transport layers of the R, G and B pixels allows only the emission layers to be patterned by a thermal transfer method using a thermal transfer device having the emission layers as a transfer layer, and remaining pixels allow the hole transport layers and the emission layers to be simultaneously formed by the thermal transfer method using the thermal transfer device having the hole transport layers and the emission layers as a transfer layer, respectively.

5. The method according to claim 4, wherein the pixel which includes the hole transport layer having the smallest thickness of the hole transport layers of the R, G and B pixels is the B pixel; sums of thicknesses of the hole injection layer and the hole transport layer of the R, G and B pixels, as a charge transport layer, are about 2350 Å, 1700 Å, and 1350 Å, respectively; thicknesses of the emission layers of the R, G and B pixels are about 300~400 Å, 250~350 Å, and 100~200 Å, respectively; a sum of thicknesses of a hole blocking layer and an electron transport layer of the R, G and B pixels is about 350 Å; and each thickness has a tolerance of about 50~200 Å.

\* \* \* \* \*



专利名称(译)	制造有机发光显示器的方法		
公开(公告)号	<a href="#">US20050196893A1</a>	公开(公告)日	2005-09-08
申请号	US11/018577	申请日	2004-12-22
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IPC分类号	H05B33/10 H01L29/08 H01L51/50 H05B33/12 H05B33/14 H05B33/20		
CPC分类号	H01L27/3211 H01L51/0013 H01L2251/558 H01L2251/5315 H01L51/5064		
优先权	1020040011155 2004-02-19 KR		
其他公开文献	US8338222		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

# 摘要(译)

制造有机发光显示器的方法能够通过使用热转移方法图案化发光层和电荷传输层的多个有机层来改善器件特性，以优化对应于R，G和B的有机层的厚度。像素。该方法包括：在衬底上形成R，G和B像素的下电极；在层上形成有机层；在有机层上形成上电极。有机层的形成包括在基板的整个表面上形成空穴注入层的一部分和R，G和B像素的空穴传输层，有机层包括第一部分和第二部分，有机层厚度等于空穴注入层和空穴传输层的厚度之和。有机层的形成还包括图案化有机层的第二部分，以及图案化R，G和B像素的发光层。有机层的第二部分和R，G和B像素的发光层通过热转印方法同时形成，该热转印方法使用具有有机层的第二部分和R，G的发光层的热转印装置和B像素作为转移层。

