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(54) Organic light-emitting display apparatus and method of manufacturing the same

Organische lichtemittierende Anzeigevorrichtung und Herstellungsverfahren dafür

Appareil à affichage luminescent organique et son procédé de fabrication

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

(72) Inventor: **Song, Myung-Won**
Seocho-gu, Seoul (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] Aspects of the present invention relate to an organic light-emitting display device and a method of manufacturing the same, and more particularly, to an organic light-emitting display device including an easily and precisely deposited intermediate layer, and a method of manufacturing the same.

2. Description of the Related Art

[0002] Organic light-emitting display devices are considered to be the next-generation of display devices, since they have a wide viewing angle, a high contrast, and a quick response speed. In general, an organic light-emitting display device has a stacked structure, in which an emission layer is interposed between an anode and a cathode. A color display can thereby be realized, based on a principle that light is emitted, by reuniting holes injected from the anode and electrons injected from the cathode, on the emission layer. However, such a structure makes it difficult to achieve efficient light emission. Thus, intermediate layers, such as an electron injection layer, an electron transport layer, a hole transport layer, and a hole injection layer, are selectively inserted between each of the electrodes and the emission layer.

[0003] However, it difficult to finely pattern a thin organic layer, such as an emission layer, or an intermediate layer, and the luminous efficiencies of red, green, and blue sub-pixels depend on the organic layers being precisely patterned. Thus, a conventional organic light-emitting display device should be improved, since it is difficult to achieve a desirable driving voltage, current density, brightness, color purity, luminous efficiency, and lifetime.

[0004] An organic light-emitting display device can also be structured to include an emission layer and an intermediate layer, between a first electrode and a second electrode. In this case, the first and second electrodes and the intermediate layer may be fabricated in various ways, e.g., by a deposition method. In order to manufacture an organic light-emitting display device according to the deposition method, a thin layer is formed in a predetermined pattern, by closely adhering a mask, having the same pattern as the thin layer, to a plane on which the thin layer is to be formed, and then depositing a material for the thin layer, on the resultant structure.

[0005] FIG. 1A is a plan view schematically illustrating an emission layer/intermediate layer pattern of a conventional organic light-emitting display device 10. FIG. 1B is a plan view schematically illustrating a mask 10Bm for depositing a blue emission layer of the conventional organic light-emitting display device 10. Referring to FIGS. 1A and 1B, pixels 11, 12, 13, and 14 of the conventional organic light-emitting display device 10 respectively include a plurality of emission layers 11 R, 12R, 13R, 14R, 11G, 12G, 13G, 14G, 11 B, 12B, 13B, and 14B that emit red, green, or blue light. Three sub-pixels respectively emitting red, green, and blue light form one pixel.

[0006] As described above, the emission layers 11 R through 14B of the pixels 11 through 14 are formed through deposition, using a mask. For example, the emission layers of red sub-pixels are simultaneously formed through deposition, the emission layers of green sub-pixels are simultaneously formed through deposition, and then the emission layers of blue sub-pixels are simultaneously formed through deposition. Thus, the conventional mask 10Bm having a plurality of openings 11 Bm, 12Bm, 13Bm, and 14Bm, as illustrated in FIG. 1B, is used to obtain a blue emission layer pattern of the conventional organic light-emitting display device 10, as illustrated in FIG. 1A. Also, a mask having a plurality of openings formed at the same intervals as in the conventional mask 10Bm needs to be used, in order to form each red and green emission layer pattern of the organic light-emitting display device 10.

[0007] Since the intermediate layer is also formed in the same pattern as the emission layer, a mask having a plurality of openings formed at the same intervals as in the conventional mask 10Bm needs to be used, in order to obtain an intermediate layer pattern of the organic light-emitting display device 10. However, as the distances between sub-pixels become smaller, in order to manufacture high-definition display devices, the sizes of the openings of the masks become smaller. That is, referring to FIG. 1B, the widths $\ell 0$ of the openings 11 Bm through 14Bm become smaller. Thus, a mask having smaller openings is used, in order to realize a high-definition organic light-emitting display device. However, there is a limit as to how fine-pitched a mask can be.

[0008] Also, as a mask pattern becomes finer, it is more difficult to pattern the mask and align the mask with respect to a region on which an emission layer/intermediate layer is to be deposited. Even a slight error may cause an emission layer to overlap an adjacent emission layer. Furthermore, display devices, other than an organic light-emitting display device, manufactured through such deposition, also have the above-described disadvantages.

[0009] US 2005/0280355 discloses an organic light-emitting display device that includes a substrate having first, second and third pixel regions. A first hole transport layer is provided over the first, second and third pixel regions. A second hole transport layer is formed on the first hole transport layer in any two adjacent pixel regions. A third hole transport layer may be formed on the second hole transport layer in any one of the two adjacent pixel regions.

[0010] US 2007/0296334 discloses an organic light-emitting device in which the organic light-emitting elements for respective luminescent colors are different from each other in thickness of an electron injection layer.

[0011] EP 1 052 708 discloses an organic electroluminescence multi-color display comprising a plurality of organic compound material layers on a transparent substrate. Each of the functional layers, having the same function, of the organic compound material layers excluding the light-emitting layers are different in thickness corresponding to a color of emitted light.

[0012] JP 2004207126 discloses an organic EL panel with different luminescent colors arranged on the same plane. In this arrangement, adjoining pixels having the same luminescent color are continuous and integral with each other.

[0013] US 2007/0046195 discloses an OLED display and a manufacturing method for the same, comprising a plurality of organic luminescent layers over three subpixel regions.

SUMMARY OF THE INVENTION

[0014] Aspects of the present invention provide a display device, in which an intermediate layer of each subpixel can be easily and precisely deposited.

[0015] According to an aspect of the present invention, there is provided an organic light-emitting display device as set out in claim 1.

[0016] According to aspects of the present invention, in each pixel, the red sub-pixel is arranged between the blue and green sub-pixels. The thickness of the intermediate layer may be at a maximum in the red sub-pixels.

[0017] According to aspects of the present invention, the sum of the thickness of the intermediate layer of the green sub-pixel and the thickness of the intermediate layer of the blue sub-pixel is equal to the thickness of the intermediate layer in the red sub-pixel.

[0018] According to aspects of the present invention, an intermediate layer may be formed as one piece, within each of the pixels.

[0019] According to aspects of the present invention, each of the sub-pixels may further comprise: opposing first and second electrodes; an intermediate layer disposed between the electrodes; and red, green, and blue emission layers disposed within the intermediate layer. The thickness of the intermediate layer in a region having the red emission layer is greater than of at least one of a region having the green emission layer and a region having the blue emission layer.

[0020] According to aspects of the present invention, the sub-pixels included in the adjacent pixels may be arranged such that the respective sub-pixels of a pixel are symmetrical with respect to a boundary between the adjacent pixels.

[0021] According to aspects of the present invention, an intermediate layer may be formed as one piece, and can extend across adjacent pixels.

[0022] According to aspects of the present invention, the intermediate layer may comprise: a hole injection layer formed within each of the pixels to a generally constant thickness; and a hole transport layer formed on the hole injection layer, having a thickness that varies according to the respective sub-pixels.

[0023] According to aspects of the present invention, the intermediate layer may comprise: a hole injection layer having a thickness that varies according to the respective sub-pixels; and a hole transport layer formed on the hole injection layer, having a uniform thickness.

[0024] According to aspects of the present invention, the intermediate layer may comprise: a hole injection layer having a thickness that varies according to the respective sub-pixels; and a hole transport layer formed on the hole injection layer, having a thickness that varies according to the respective sub-pixels.

[0025] According to aspects of the present invention, the intermediate layer may comprise an electron transport layer having a thickness that varies according to the respective sub-pixels.

[0026] According to another aspect of the present invention, there is provided a method of manufacturing an organic light-emitting display device as set out in claim 10.

[0027] According to aspects of the present invention, the forming of the intermediate layer comprises depositing the first portion of the intermediate layer in a first region; and depositing the second portion of the intermediate layer in a second region, which partly overlaps the first region.

[0028] According to aspects of the present invention, the forming of the emission layer comprises forming a red emission layer in a region where the first region and the second region overlap each other.

[0029] According to aspects of the present invention, the forming of the intermediate layer may comprise: forming the intermediate layer, as one piece, in a region having the red and green sub-pixels; and forming the intermediate layer, as one piece, in a region having the red and green sub-pixels.

[0030] According to aspects of the present invention, the forming of the intermediate layer, as one piece, in the region having the red and green sub-pixels, comprises patterning the intermediate layer by using a first mask, in which the region having the red and green sub-pixels is formed as one opening.

[0031] According to aspects of the present invention, the forming of the intermediate layer, as one piece, in the region having the red and blue sub-pixels, may comprise patterning the intermediate layer by using a second mask, in which the region having the red and blue sub-pixels is formed as one opening.

[0032] According to aspects of the present invention, the forming of the intermediate layer may comprise forming an intermediate layer, as one piece, within each of the pixels.

[0033] According to aspects of the present invention, the forming of the emission layer and the intermediate layer may comprise: forming an intermediate layer on the first electrode, such that the thickness of a part of the intermediate layer varies according to sub-pixels; and forming an emission layer on the intermediate layer.

[0034] According to aspects of the present invention, the forming of the intermediate layer may comprises: forming a hole injection layer on the first electrode to a generally constant thickness; and forming a hole transport layer on the hole injection layer, such that the thickness of a part of the hole transport layer varies according to sub-pixels.

[0035] According to aspects of the present invention, the forming of the intermediate layer may comprise: forming a hole injection layer on the first electrode, such that the thickness of a part of the hole injection layer varies according to sub-pixels.

[0036] According to aspects of the present invention, the forming of the intermediate layer may comprises: forming a hole injection layer on the first electrode, such that the thickness of the hole injection layer varies according to sub-pixels; and forming a hole transport layer on the hole injection layer, such that the thickness of the hole transport layer varies according to the sub-pixels.

[0037] According to aspects of the present invention, the forming of the emission layer and the intermediate layer may comprise: forming an emission layer on the first electrode; and forming an intermediate layer on the emission layer, such that the thickness the intermediate layer varies according to sub-pixels.

[0038] According to aspects of the present invention, the forming of the intermediate layer may comprise forming an electron transport layer on the emission layer, such that the thickness of the electron transport layer varies according to sub-pixels.

[0039] According to another aspect of the present invention, there is provided an organic light-emitting display device comprising: a substrate; opposing first and second electrodes disposed on the substrate; and an intermediate layer disposed between the electrodes; and a plurality of emission layers disposed in the intermediate layer. A red emission layer is arranged between blue and green emission layers at the center of one pixel. The thickness of an intermediate layer is at a maximum adjacent to the red emission layer.

[0040] According to aspects of the present invention, the intermediate layer may comprise at least one of a hole injection layer, a hole transport layer, and an electron transport layer.

[0041] According to aspects of the present invention, the intermediate layer may be formed as one piece within each pixel.

[0042] According to aspects of the present invention, the first electrode may be a reflective electrode, and the second electrode may be a semi-transparent electrode, or a transparent electrode.

[0043] According to aspects of the present invention, a resonance may occur between the first electrode and the second electrode, when the device is driven.

[0044] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1A is a plan view schematically illustrating an emission layer/intermediate layer pattern of a conventional organic light-emitting display device;

FIG. 1B is a plan view schematically illustrating a conventional mask for depositing a blue emission layer of the organic light-emitting display device of FIG. 1A;

FIG. 2 is a cross-sectional view of an organic light-emitting display device, according to a first embodiment of the present invention;

FIGS. 3A through 3E are cross-sectional views sequentially illustrating a method of manufacturing the organic light-emitting display device, according to the first embodiment of the present invention;

FIGS. 4 and 5 are plan views schematically illustrating masks for depositing intermediate layers of an organic light-emitting display device;

FIG. 6 is a cross-sectional view of an organic light-emitting display device, according to a second embodiment of the present invention;

FIGS. 7A through 7E are cross-sectional views sequentially illustrating a method of manufacturing the organic light-emitting display device, according to the second embodiment of the present invention;

FIG. 8 is a cross-sectional view of an organic light-emitting display device, according to a third embodiment of the present invention;

FIGS. 9A through 9E are cross-sectional views sequentially illustrating a method of manufacturing the organic light-emitting display device according to the third embodiment of the present invention;

FIG. 10A is a plan view schematically illustrating an intermediate layer pattern of an organic light-emitting display device, according to a fourth embodiment of the present invention;

FIG. 10B is a plan view schematically illustrating a mask for depositing red-green intermediate layers of the organic light-emitting display device of FIG. 10A, according to an embodiment of the present invention;

FIG. 10C is a plan view schematically illustrating a mask for depositing red-blue intermediate layers of the organic light-emitting display device of FIG. 10A, according to an embodiment of the present invention;

FIG. 11 is a cross-sectional view of a passive matrix (PM) light-emitting device, according to an embodiment of the present invention; and

FIG. 12 is a cross-sectional view of an active matrix (AM) light-emitting device, according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0046] Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below, in order to explain the aspects of the present invention, by referring to the figures. As referred to herein, when a first element is said to be disposed or formed "on", or "adjacent to", a second element, the first element can directly contact the second element, or can be separated from the second element by one or more other elements can be located therebetween. In contrast, when an element is referred to as being disposed "directly on" another element, there are no intervening elements present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0047] FIG. 2 is a cross-sectional view of an organic light-emitting display device, according to a first embodiment of the present invention. Referring to FIG. 2, the organic light-emitting display device includes a substrate 102, first electrodes 131, an insulating layer 132, second electrodes 134, emission layers (EML) 111R (red emission layer), 111 G (green emission layer), and 111 B (blue emission layer), and an intermediate layer that is formed on the top and/or bottom of the emission layers 111 R, 111 G, and 111 B. The intermediate layer includes a hole injection layer (HIL) 141, a hole transport layer (HTL) 142, and an electron transport layer (ETL) 143 The emission layers 111 R, 111 G, 111 B, and the HIL, HTL, and ETL 141, 142, and 143 are formed between the first electrodes 131 and the second electrodes 134. The emission layers 111 R, 111 G, and 111 B may emit red, green, or blue light, according to a material thereof, respectively.

[0048] The first electrodes 131 are patterned on the substrate 102. Then, the insulating layer 132 is formed to fill gaps between the first electrodes 131, thus defining pixel regions. The HIL 141, the HTL 142, the emission layers 111R, 111G, and 111 B, the ETL 143, and an electron injection layer (EIL) (not shown) are deposited on the first electrodes 131, as a single or a composite structure. Then, the second electrodes 134 are formed on the ETL 143.

[0049] One of the first electrodes 131 or the second electrodes 134 are reflective electrodes and the others are semi-transparent or transparent electrodes. Thus, a resonance may occur between the first electrodes 131 and the second electrodes 134, when the organic light-emitting display device is driven. Thus, light generated by the emission layers 111 R, 111 G, and 111B, when the organic light-emitting display device is driven, is emitted outside the organic light-emitting display device, while resonating between the first electrode 131 and the second electrode 134. Accordingly, the brightness and efficiency of light emission may be improved.

[0050] More specifically, the first electrodes 131 may be formed on a surface of the substrate 102. In the present embodiment, the first electrodes 131 may be reflective electrodes, and the second electrodes 134 may be semi-transparent or transparent electrodes. Thus, light generated by the emission layers 111 R, 111 G, and 111 B may be emitted outside the organic light-emitting display device (in the opposite direction of the substrate102), via the second electrodes 134, while resonating between the first and second electrodes 131 and 134.

[0051] An intermediate layer of an organic light-emitting display device, according to an embodiment of the present invention, may include the HIL 141 or the HTL 142, or may include a single layer having hole injection and transport characteristics.

[0052] The organic light-emitting display device, according to the first embodiment, is manufactured in such a manner that an intermediate layer including the HIL 141 or the HTL 142 is deposited at different thicknesses on different sub-pixels. More specifically, the HTL 142 may be formed to a thickness of 1600 Å to 2200 Å in a red sub-pixel R. If the thickness of the HTL 142 is less than 1600 Å, or greater than 2200 A, the emission layer 111 R may not have appropriate hole injection characteristics and/or hole transport characteristics, so as to cause the resonance, and thus, the degree of color purity and the luminous efficiency may be degraded. If the thickness of the HTL 142 is greater than 2200 Å, a driving voltage may increase.

[0053] In a green sub-pixel G, the HTL 142 may be formed to a thickness of 1000 Å to 1200 Å. If the thickness of the HTL 142 is less than 1000 Å, or greater than 1200 A, the emission layer 111G may not have appropriate hole injection characteristics and/or hole transport characteristics, to cause the resonance, and thus, the degree of color purity and the luminous efficiency may be degraded. If the thickness of the HTL 142 is greater than 1200 Å, the driving voltage may increase.

[0054] In a blue sub-pixel B, the HTL 142 may be formed to a thickness of 100 Å to 500 Å. If the thickness of the HTL 142 is less than 100 Å, or greater than 500 A, the emission layer 111 B may not have appropriate hole injection characteristics and/or hole transport characteristics, to cause the resonance, and thus, the degree of color purity and the luminous efficiency may be degraded. If the thickness of the HTL 142 is greater than 500 Å, the driving voltage may increase.

[0055] In the present embodiment, the HTL 142 is formed, as one piece, in the red sub-pixel R and the green red sub-pixel G, and then is formed again, as one piece, in the red sub-pixel and a blue red sub-pixel B. That is, the HTL 142 is deposited on the green and blue sub-pixels G and B only once, but is deposited on the red sub-pixel R twice. Thus, the thickness of the HTL 142 in the red sub-pixel R is greater than in the green and blue sub-pixels G and B. In other words, the thickness of the HTL 142 in the red sub-pixel R is substantially equal to the sum of the thickness of the HTL 142 in the green sub-pixel G and the thickness of the HTL 142 in the blue sub-pixel B. Also, the HTL 142 is formed as one piece within one pixel.

[0056] As described above, in an organic light-emitting display device, according to an embodiment of the present invention, resonance may occur between first and second electrodes, when the organic light-emitting display device is driven. In this case, the thickness of a hole transport layer varies, according to the color of light emitted from an emission layer, thereby achieving good driving voltage, current density, brightness of light emission, degree of color purity, luminous efficiency, lifetime, and so on.

[0057] FIGS. 3A through 3E are cross-sectional views schematically and sequentially illustrating a method of manufacturing the organic light-emitting display device, according to the first embodiment of the present invention. Referring to FIGS. 3A through 3E, the method includes forming the first electrodes 131 on the surface of the substrate 102, forming the HTL 142 on the first electrodes 131, so that the thickness of a part of the HTL 142 is greater than that of the remaining part thereof, forming the emission layers 111 G, 111 R, and 111 B on the HTL 142, and forming second electrodes 134 on the emission layers 111 G, 111 R, and 111 B.

[0058] More specifically, as illustrated in FIG. 3A, the first electrodes 131 are formed on the substrate 102. The substrate 102 can be any substrate used in the field of general organic light-emitting devices. For example, various types of substrates, such as a glass substrate, or a plastic substrate, can be used, in consideration of transparency, smoothness, tractability, water-resistance, and so on.

[0059] The first electrodes 131 may be reflective electrodes, semi-transparent electrodes, or transparent electrodes formed using a conductive metal material selected from the group consisting of lithium (Li), magnesium (Mg), aluminum (Al), an aluminum-lithium alloy (Al-Li), calcium (Ca), a magnesium-indium alloy (Mg-In), a magnesium-silver alloy (Mg-Ag), and a calcium-aluminum alloy (Ca-Al), or a metal oxide material selected from the group consisting of an indium tin oxide (ITO), an indium zinc oxide (IZO), and an indium oxide (IN_2O_3). Otherwise, the first electrodes 131 may be formed using a combination of two or more materials selected from the conductive metals and the metal oxides.

[0060] The insulating layer 132 is formed in a region in which an organic layer is to be formed. The insulating layer 132 can be formed in various ways, including a deposition method or a coating method, using an inorganic substance, such as a silicon oxide and a nitride, or an insulating organic substance.

[0061] As illustrated in FIG. 3B, the HIL 141 is formed on the first electrodes 131 and the insulating layer 132, to a predetermined thickness. The HIL 141 can be formed by various known methods, including a vacuum deposition method, a spin-coating method, a casting method, or a Langmuir-Blodget (LB) method.

[0062] As illustrated in FIG. 3C, a first HTL 142a is formed on the HIL 141, as one piece, in the red sub-pixel R and the green sub-pixel G. Then, as illustrated in FIG. 3D, a second HTL 142b is formed on the HIL 141, as one piece, in the red sub-pixel R and the blue sub-pixel B.

[0063] In detail, as the distances between sub-pixels become smaller, in order to manufacture high-definition display devices, the sizes of openings of a mask for depositing emission layers/intermediate layers of the sub-pixels also becomes smaller. Thus, a fine-pitch mask having smaller openings is used in order to realize a high-definition organic light-emitting display. However there is a limit of the pitch of the mask.

[0064] In order to solve the above problem, according to an embodiment of the present invention, an intermediate layer is deposited, as one piece, in two adjacent sub-pixel regions, i.e., in the red sub-pixel R and the green sub-pixel G, and on the red sub-pixel R, and the blue sub-pixel B.

[0065] The optimal thickness of an intermediate layer varies according to the type of emission layer. The intermediate layer is the thickest at the red sub-pixel R. The green sub-pixel G and the blue sub-pixel B are arranged on either side of the red sub-pixel R. Then, an intermediate layer is formed, as one piece, in the red sub-pixel R and the green sub-pixel G, and then is formed again, as one piece, in the red sub-pixel R and the blue sub-pixel B. That is, the intermediate layer is formed only once in the green sub-pixel G and the blue sub-pixel B, but is formed twice in the red sub-pixel R. Accordingly, the thickness of the intermediate layer in the red sub-pixel R is greater than in the green and blue sub-pixels G and B. In other words, the thickness of the red sub-pixel R is substantially equal to the sum of the thickness of the intermediate layer in the green sub-pixel G and the thickness of the intermediate layer in the blue sub-pixel B.

[0066] In the method of manufacturing the organic light-emitting display device, according to the first exemplary embodiment, masks 110RGm and 110RBm, as illustrated in FIGS. 4 and 5, are used. When the masks 110RGm and 110RBm are used, the width $\ell 1$, of each of a plurality of openings 111 RGm and 112RGm in the mask 110RGm and a plurality of openings 111 RBm and 112RBm in the mask 110RBm, is approximately double the width $\ell 0$ of each of the openings 11 Bm and 12Bm of the conventional mask 10Bm, illustrated in FIG. 1B. Accordingly, it is possible to lessen difficulties in manufacturing and alignment processes of a mask, thereby, increasing the yield and reducing costs in manufacturing a high-quality and high-definition display device.

[0067] As illustrated in FIG. 3E, the emission layers 111 R, 111 G, and 111B are formed on the HTL 142. A material of the emission layers 111 R, 111 G, and 111 B is not particularly limited. Then, the ETL 143 is formed by vacuum-depositing or spin-coating an electron transport material on the emission layers 111 R, 111 G, and 111 B. The electron transport material is not particularly limited and may be Alq3. Then, the second electrodes 134 are formed by depositing a material for a second electrode on the ETL 143. The material for a second electrode may be a conductive, transparent, metal oxide selected from the group consisting of indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), and a zinc oxide (ZnO). Otherwise, the ETL 143 may be formed as a reflective electrode, a semi-transparent electrode, or a transparent electrode, by depositing a thin film using a metallic material selected from the group consisting of lithium (Li), magnesium (Mg), aluminum (Al), an aluminum-lithium alloy (Al-Li), calcium (Ca), a magnesium-indium alloy (Mg-In), a magnesium-silver alloy (Mg-Ag), and a calcium-aluminum alloy (Ca-Al). However, the material for a second electrode is not limited to the described materials. The first electrodes 131 and the second electrodes 134 may respectively function as an anode and a cathode, and vice versa.

[0068] As described above, according to an embodiment of the present invention, a fine-pitch mask for forming intermediate layers can be easily manufactured, since the sizes of openings of the mask may be relatively large. Thus, a high-definition display device can be manufactured using the mask.

[0069] FIG. 6 is a cross-sectional view of an organic light-emitting display device, according to a second embodiment of the present invention. FIGS. 7A through 7E are cross-sectional views schematically and sequentially illustrating a method of manufacturing the organic light-emitting display device.

[0070] Referring to FIGS. 6 and 7, the organic light-emitting display device includes a substrate 202, a plurality of first electrodes 231, an insulating layer 232, a plurality of second electrodes 234, a plurality of emission layers 211 R (red emission layer), 211 G (green emission layer), and 211 B (blue emission layer), and an intermediate layer formed on the top and/or bottom of the emission layers 211R, 211 G, and 211 B. The intermediate layer includes a hole injection layer 241, a hole transport layer 242, and an electron transport layer 243. The emission layers 211R, 211G, and 211 B and the hole injection, hole transport, and electron transport layers 241, 242, and 243 are formed between the first electrodes 231 and the second electrodes 234. The emission layers 211R, 211G, and 211 B may respectively emit red, green, or blue light depending on a material thereof.

[0071] The second embodiment is differs from the first embodiment in that the hole injection layer 241 is formed to different thicknesses for different sub-pixels. In detail, the hole injection layer 241 is formed, as one piece, in a red sub-pixel R and a green sub-pixel G, and is formed again, as one piece, in the red sub-pixel R and a blue sub-pixel B. That is, the hole injection layer 241 is deposited only once in the green sub-pixel G and the blue sub-pixel B, but is deposited twice in the red sub-pixel R. Thus, the thickness of the hole injection layer 241 in the red sub-pixel R is greater than in the green and blue sub-pixels G and B. In other words, the thickness of the hole injection layer 241 in the red sub-pixel R is substantially equal to the sum of the thickness of the hole injection layer 241 in the green sub-pixel G and the thickness of the hole injection layer 241 in the blue sub-pixel B. The hole injection layer 241 is formed as one piece within one pixel. To this end, as illustrated in FIG. 7A, the first electrodes 231 and an insulating layer 232 are formed on the substrate 202.

[0072] Then, as illustrated in FIG. 7B, a hole injection layer 241a is formed, as one piece, on the first electrodes 231 and the insulating layer 232, in both the red sub-pixel R and the green sub-pixel G. Then, as illustrated in FIG. 7C, a hole injection layer 241 b is formed, as one piece, on the first electrodes 231 and the insulating layer 232, in both the red sub-pixel R, and the blue sub-pixel B.

[0073] As illustrated in FIG. 7D, the hole transport layer 242 is formed on the hole injection layer 241. Lastly, as illustrated in FIG. 7E, the emission layers 211 R, 211 G, and 211 B, the electron transport layer 243, and the second electrodes 234 are sequentially formed. As described above, a fine-pitch mask for forming intermediate layers can be easily made, since the sizes of openings can be relatively large, and a high-definition display device can be manufactured using the mask.

[0074] In the first embodiment, a hole injection layer is formed to a predetermined thickness for one pixel, and a hole transport layer is formed on the hole injection layer. The thickness of the hole transport layer can vary at different sub-pixels. In the second embodiment, a hole injection layer is formed to different thicknesses in different sub-pixels, and a hole transport layer is formed on the hole injection layer. However, the present invention is not limited thereto. That is, it is possible to derive from the first and second embodiments an organic light-emitting display device, including a hole injection layer formed to different thicknesses, and a hole transport layer that is formed on the hole injection layer, such that the thickness of the hole transport layer varies in different sub-pixels. FIG. 8 is a cross-sectional view of an organic light-emitting display device, according to a third embodiment of the present invention. FIGS. 9A through 9E are cross-sectional views sequentially illustrating a method of manufacturing the organic light-emitting display device.

[0075] Referring to FIGS. 8 and 9A through 9E, the organic light-emitting display device includes a substrate 302, a plurality of first electrodes 331, an insulating layer 332, a plurality of second electrodes 334, a plurality of emission layers 311R, 311G, and 311 B, and an intermediate layer. The intermediate layer can comprise a hole injection layer 341, a hole transport layer 342, and an electron transport layer 343. The emission layers 311 R, 311 G, and 311 B can be formed within the intermediate layer. The emission layers 311R, 311G, and 311 B and the hole injection, hole transport, and electron transport layers 341, 342, and 343 are formed between the first electrodes 331 and the second electrodes 334. The emission layers 311R, 311G, and 311 B can respectively emit red, green, or blue light, depending on a material thereof.

[0076] The third embodiment is differentiated from the first and second embodiments, in that the electron transport layer 343 is formed to different thicknesses for different sub-pixels. In detail, the electron transport layer 343 is deposited, as one piece, in both a red sub-pixel R and a green sub-pixel G, and then, is deposited, as one piece, in both the red sub-pixel R and a blue sub-pixel B. That is, the electron transport layer 343 is deposited only once in the green and blue sub-pixels G and B, but is deposited twice in the red sub-pixel R. Thus, the thickness of the electron transport layer 343 in the red sub-pixel R is greater than in the green and blue sub-pixels G and B. In other words, the thickness of the electron transport layer 343 in the red sub-pixel R is substantially equal to the sum of the thickness of the electron transport layer 343 in the green sub-pixel G and the thickness of the electron transport layer 343 in the blue sub-pixel B. The electron transport layer 343 is formed as one piece within one pixel.

[0077] As illustrated in FIG. 9A, the first electrodes 331 and the insulating layer 332 are formed on the substrate 302. Then, as illustrated in FIG. 9B, the hole injection layer 341 and the hole transport layer 342 are formed on the first electrodes 331 and the insulating layer 332. The emission layers 311R, 311G, and 311 B are formed on the hole transport layer 342. Then, as illustrated in FIG. 9C, an electron transport layer 343a is formed, as one piece, in the red sub-pixel R and the green sub-pixel G.

[0078] As illustrated in FIG. 9D, an electron transport layer 343b is formed, as one piece, in the red sub-pixel R and the blue sub-pixel B. Then, as illustrated in FIG. 9E, the second electrodes 334 are formed on the electron transport layer 343.

[0079] As described above, according to an embodiment of the present invention, a fine-pitch mask for forming intermediate layers can be easily made, since the sizes of openings can be relatively large, and a high-definition display device can be manufactured using the mask.

[0080] FIG. 10A is a plan view of an intermediate layer pattern of an organic light-emitting display device, according to a fourth embodiment of the present invention. FIG. 10B is a plan view schematically illustrating a mask for depositing red-green intermediate layers of the organic light-emitting display device of FIG. 10A. FIG. 10C is a plan view schematically illustrating a mask for depositing red-blue intermediate layers of the organic light-emitting display device of FIG. 10A. As described above, FIG. 10A schematically illustrates the intermediate layer pattern of the organic light-emitting display device, but may be considered to represent a plurality of sub-pixels, for convenience of explanation.

[0081] The organic light-emitting display device includes a plurality of pixels, each including red, green, and blue sub-pixels sequentially arranged in one direction, e.g., in the x-axis direction, as indicated in FIG. 10A. The sub-pixels are arranged such that the colors of the light emitted from the respective sub-pixels of a first pixel are symmetrical with the colors emitted from corresponding sub-pixels of a second pixel facing the first pixel in the x-axis direction, about the boundary between the first and second pixels. That is, for example, the sub-pixels of the pixels in the x-axis direction are arranged in the order of green, red, blue, blue, red, green, green, red, blue, blue, red, green, etc.

[0082] The organic light-emitting display device according to the fourth embodiment is different from the first and second embodiments, in terms of an intermediate layer shape. Each of the sub-pixels includes a first electrode and a second electrode that face each other and an intermediate layer interposed between the first and second electrodes. In the organic light-emitting display device, according to the fourth embodiment, an intermediate layer is formed as one piece, across two sub-pixels that are adjacent in the x-axis direction. More specifically, in the intermediate layer pattern (sub-pixel pattern) illustrated in FIG. 10A, if the plurality of pixels in the uppermost row are a first pixel 311, a second pixel 312, a third pixel 313, and a fourth pixel 314 in the x-axis direction, the first pixel 311 includes a sub-pixel 311 G (green sub-pixel), a sub-pixel 311 R (red sub-pixel), and a sub-pixel 311 B (blue sub-pixel).

[0083] A plurality of sub-pixels 312B, 312R, and 312G of the second pixel 312, which is adjacent to the first pixel 311, are arranged to be symmetrical with respect to the sub-pixels 311G, 311 R, and 311 B of the first pixel 311, along the boundary between the first and second pixels 311 and 312. Thus, the second pixel 312 includes the sub-pixel 312B, the sub-pixel 312R, and the sub-pixel 312G.

[0084] In the above intermediate layer pattern, an intermediate layer is formed as one piece, in sub-pixels adjacent at the boundary between the first and second pixels 311 and 312. That is, an intermediate layer 311RB is formed as one piece across red and blue sub-pixels 311 Rand 311 B of the first pixel 311. An intermediate layer 312RB is formed as one piece across red and blue sub-pixels 312R and 312B of the second pixel 312. Similarly, an intermediate layer is formed as one piece across sub-pixels adjacent to the boundary between the second pixel 312 and the third pixel 313. That is, an intermediate layer 312RG is formed as one piece for red and green sub-pixels. An intermediate layer 313RG is formed as one piece across red and green sub-pixels in the third pixel 313. Similarly, the other pixels in the x-axis direction also have the above-described pattern.

[0085] In this case, a mask 310RGm illustrated in FIG. 10B is used to form an intermediate layer for red and green sub-pixels. A mask 310RBm illustrated in FIG. 10C is used to form an intermediate layer for red and blue sub-pixels. Referring to FIGS. 10B and 10C, the sizes of openings in the masks 310RGm and 310RBm are relatively large.

[0086] The mask 310RGm illustrated in FIG. 10B is used to deposit an intermediate layer according to the arrangement of sub-pixels in the organic light-emitting display device. The area of each of the openings in the mask 310RGm is approximately four times larger than the openings in the conventional mask 10Bm illustrated in FIG. 1B. Accordingly, a high-definition organic light-emitting display device can be realized.

[0087] The construction of a light-emitting device having the above intermediate layers, which can be included in the organic light-emitting display devices according to the above embodiments, will now be briefly described with reference to FIGS. 11 and 12. A light-emitting device that can be included in the organic light-emitting display devices is formed on a substrate 602. The substrate 602 is manufactured using a transparent glass material, but may be manufactured using various plastic materials, such as acryl, polyimide, polycarbonate, polyester, and MYLAR.

[0088] The light-emitting device may have various shapes. For example, the light-emitting device may be a passive matrix (PM) light-emitting device, or may be an active matrix (AM) light-emitting device that has a thin transistor.

[0089] FIG. 11 is a cross-sectional view of a PM light-emitting device 603, according to an embodiment of the present invention. Referring to FIG. 6, a buffer layer 621 (SiO_2 layer) is formed on the substrate 602. A plurality of first electrodes 631 are formed in a predetermined pattern on the buffer layer 621. Then, an emission layer 633 and a plurality of second electrodes 634 are sequentially formed on the first electrodes 631. An insulating layer 632 may be interposed between lines of the first electrodes 631. The second electrodes 634 may be formed in a pattern orthogonal to the pattern of the first electrodes 631. Although not shown in the drawings, an additional insulating layer may further be included as a pattern orthogonal to the first electrodes 631, in order to obtain the pattern of the second electrodes 634.

[0090] The emission layer 633 may be formed of an organic material or an inorganic material. When the emission layer 633 is formed of an organic material, a small molecule organic material, or a polymer organic material, may be used. If a small molecule organic material is used, a hole injection layer (HIL), a hole transport layer (HTL), an organic emission layer (EML), an electron transport layer (ETL), and an electron injection layer (EIL) may be stacked in a single or composite structure. Various organic materials, such as copper phthalocyanine (CuPc), N,N'-Di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), and tris-8-hydroxyquinoline aluminum (Alq3), can be used. The emission layer 633 is obtained by patterning one of the above small molecule organic materials, and vacuum-depositing the resultant structure using one of the above masks.

[0091] In general, if the emission layer 633 is formed of a polymer organic material, it includes the hole transport layer and the emission layer. In this case, the hole transport layer is formed of Poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT), and the emission layer is formed of a Poly-Phenylenevinylene (PPV)/ Polyfluorene-based polymer organic material.

[0092] The first electrodes 631 can be anode electrodes, and the second electrodes 634 can be cathode electrodes, and vice versa. The first electrodes 631 may be transparent electrodes or reflective electrodes. If the first electrodes 631 are transparent electrodes, ITO, IZO, ZnO, or In_2O_3 may be used. If the first electrodes 631 are reflective electrodes, first electrodes 631 are obtained by forming a reflective layer, by using Ag, Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, or a compound thereof and then depositing a layer made of ITO, IZO, ZnO, or In_2O_3 on the resultant structure.

[0093] The second electrodes 634 may also be transparent electrodes or reflective electrodes. If the second electrodes 634 are transparent electrodes, the second electrodes 634 can be used as cathode electrodes. Thus, the second electrodes 634 may be obtained by depositing a metal material having a small work function, such as Li, Ca, LiF/Ca, LiF/Al, Al, Mg, or a compound thereof on the emission layer 633, which is an organic layer. Auxiliary electrodes or a butt electrode lines can be then formed by using a material, such as ITO, IZO, ZnO, or In_2O_3. If the second electrodes 634 are reflective electrodes, they can be formed by depositing Li, Ca, LiF/Ca, LiF/Al, Al, Mg, or a compound thereof.

[0094] FIG. 12 is a cross-sectional view of an AM light-emitting device 603, according to an embodiment of the present invention. In the AM light-emitting device 603, each sub-pixel includes at least one thin film transistor (TFT), as illustrated in FIG. 12. The construction of the TFT is not limited to the one illustrated in FIG. 12, and a total number and construction of thin transistors TFT can vary.

[0095] As illustrated in FIG. 12, a buffer layer 621 made of SiO_2 is formed on a glass substrate 602, and the TFT is formed on the buffer layer 621. The TFT includes an active layer 622 on the buffer layer 621, a gate insulating layer 623 on the active layer 622 and the buffer layer 621, and a gate electrode 624 on the gate insulating layer 623. The gate electrode 624 is formed at a predetermined location, on the gate insulating layer 623, and is connected to a gate line that transfers an on/off signal of the TFT. The predetermined location on which the gate electrode 624 is formed corresponds to a channel region in the active layer 622.

[0096] An inter-insulator 625 is formed on the gate electrode 624. A source electrode 626 and a drain electrode 627 are formed to respectively contact a source region and a drain region of the active layer 622, via a contact hole.

[0097] A passivation layer 628 made of SiO_2 is formed on the source electrode 626 and the drain electrode 627. A pixel defining layer 629 made of acryl or polyimide is formed on the passivation layer 628, and can protect the TFT, and also can planarize an upper surface of the TFT.

[0098] Although not shown in the drawings, at least one capacitor is connected to the TFT. A circuit having such the TFT is not limited to the one illustrated in FIG. 12.

[0099] The AM light-emitting device 603 is connected to the drain electrode 627 of the TFT. A first electrode 631 of the AM light-emitting device is formed on the passivation layer 628, and the pixel defining layer 629 is formed on the first electrode 631. An emission layer 633 is formed in an opening of the pixel defining layer 629. FIG. 12 illustrates that the emission layer 633 is patterned to correspond to only one sub-pixel, in order to explain the construction of each of the sub-pixels, for convenience, but the emission layer 633 may extend to an adjacent sub-pixel.

[0100] Materials of the first electrode 631 a second electrode 634, the emission layer 633, and intermediate layers (not shown) formed on the top and bottom of the emission layer 633 may be the same as in the PM light-emitting device 603. The AM light-emitting device 603 is sealed on the substrate 602 an opposite unit (not shown). The opposite unit may include a glass or plastic material, or may be formed as a metal cap.

[0101] In a light-emitting display device having such light-emitting devices, intermediate layers are constructed as described above, and thus, pattern precision can be improved, while easily depositing an intermediate layer in each sub-pixel, thereby increasing the resolution of the light-emitting display device.

[0102] The above embodiments of the present invention have been described with respect to a light-emitting display device, but aspects of the present invention can also be applied to any type of a display device, in which each sub-pixel is formed through deposition. A display device according to the above embodiments of the present invention has the following advantages.

[0103] First, it is possible to lessen difficulties in manufacturing and alignment processes of a mask. Thus, it is possible to prevent the yield from decreasing, due to a reduction in the distances between sub-pixels. In is also possible to reduce manufacturing costs when manufacturing a high-quality and high definition display device. Second, it is possible to increases the sizes of openings in a mask for forming intermediate layers. Third, it is possible to easily make a fine-pitch mask, and manufacture a high-definition display device by using the mask.

Claims

1. An organic light-emitting display device comprising:

   pixels to emit light in a first direction, comprising a first electrode, (131) a second electrode (132), and an intermediate layer disposed between the first and second electrodes, wherein,

   each pixel is divided into first, second and third sub-pixels arranged in a row in this order,

   each sub-pixel is a different colour chosen from red, green, and blue, the intermediate layer comprises a first portion that covers the first and second sub-pixels and a second portion that covers the second and third sub-pixels, and

   the thickness of the intermediate layer for the first sub-pixel is the thickness of the first portion, the thickness of the intermediate layer for the second sub-pixel is the thickness of the first and second portions, and the thickness of the intermediate layer for the third sub-pixel is the thickness of the second portion,

   further wherein the intermediate layer is at least one of a hole transport layer (142), an election transport layer (143), or a hole injection layer (141), and the second sub-pixel is a red sub-pixel.

2. A device according to claim 1, wherein in each of the pixels the intermediate layer is formed as one piece.

3. A device according to any preceding claim, wherein the red, green, and blue sub pixels respectively comprise red, green, and blue emission layers disposed in the intermediate layer,
   wherein the thickness of the intermediate layer is at a maximum in the red sub-pixels.

4. A device according to any preceding claim, wherein the sub-pixels of adjacent pixels are symmetrically disposed according to color, about a boundary between the adjacent pixels.

5. A device according to claim 4, wherein the intermediate layer is formed as one or more pieces that each extends across the boundary, so as to be disposed at least two of the adjacent pixels.

6. A device according to any preceding claim, wherein the intermediate layer comprises:

   hole transport layers (142) having thicknesses that vary according to the sub-pixels.

7. A device according to any preceding claim, wherein the intermediate layer comprises:

   hole injection layers (141) disposed on the first electrode in each pixel, having thicknesses that vary according to the sub-pixels.

8. A device according to any preceding claim, wherein the intermediate layer comprises:

   hole injection layers (141) having thicknesses that vary according to the sub-pixels; and hole transport layers (142) formed on the hole injection layers (141), having thicknesses that vary according to the sub-pixels.

9. A device according to any preceding claim, wherein the intermediate layer comprises electron transport layers (143) having thicknesses that vary according to the sub-pixels.

10. A method of manufacturing an organic light-emitting display device having a plurality of pixels each pixel being divided into first, second and third sub-pixels in a row in this order, each sub-pixel being a different colour chosen from red, green, and blue, the method comprising:

forming first electrodes (131) on a surface of a substrate (102);
forming emission layers (111R, 111G, 111B) and an intermediate layer on the first electrodes (131), such that the intermediate layer comprises a first portion that covers the first and second sub-pixels and a second portion that covers the second and third sub-pixels, and the thickness of the intermediate layer for the first sub-pixel is the thickness of the first portion, the thickness of the intermediate layer for the second sub-pixel is the thickness of the first and second portions, and the thickness of the intermediate layer for the third sub-pixel is the thickness of the second portion; and
forming a second electrode (132) on the intermediate layer,
wherein the intermediate layer is at least one of a hole transport layer (142), an election transport layer (143), or a hole injection layer (141), and the second sub-pixel is a red sub-pixel.

11. A method according to claim 10, wherein the forming of the intermediate layer comprises:

forming a first portion of the intermediate layer in a first region; and
forming a second portion of the intermediate layer in a second region that overlaps the first region.

12. A method according to Claim 11, wherein the forming of the emission layer comprises forming a red emission layer where the first region and the second region overlap.

13. A method according to one of Claims 10 to 12, wherein the forming of the intermediate layer comprises:

forming the first portion of the intermediate layer across adjacent red and green sub-pixels; and
forming the second portion of the intermediate layer across adjacent blue and red sub-pixels, such that the first and second portions are joined together.

14. A method according to Claim 13, wherein the forming of the first portion of the intermediate layer comprises: using a first mask having openings that correspond to each of the first portions, to pattern the first portion.

15. A method according to Claim 14, wherein the forming of the second portion of the intermediate layer comprises using a second mask having openings that correspond to each of the second portions, to pattern the second portion.

16. A method according to one of Claims 10 to 15, wherein the forming of the intermediate layer comprises, in each of the pixels, forming the intermediate layer as one piece.

17. A method according to one of Claims 10 to 16, wherein the forming of the emission layers and the intermediate layer comprises forming the emission layers (111 R, 111 G, 111 B)within the intermediate layer.

18. A method according to one of Claims 10 to 17, wherein the forming of the intermediate layer comprises:

forming a hole injection layer (141) on the first electrodes; and
forming hole transport layers (142) on the hole injection layer (141), such that the thicknesses of the hole transport layers vary according to the sub-pixels.

19. A method according to one of Claims 10 to 18, wherein the forming of the intermediate layer comprises:

forming hole injection layers (141) on the first electrode, such that the thicknesses of the hole injection layers (141) of vary according to the sub-pixels; and
forming a hole transport layer on the hole injection layers.

20. A method according to one of Claims 10 to 19, wherein the forming of the intermediate layer comprises:

forming hole injection layers (141) on the first electrodes (131), such that the thicknesses of the hole injection layers (141) vary according to the sub-pixels; and
forming hole transport layers on the hole injection layers (141), such that the thicknesses of the hole transport layers (142) vary according to the sub-pixels.

21. A method according to Claims 10 to 20, wherein the forming of the emission layer and the intermediate layer comprises:

forming a first portion of the intermediate layer on the first electrodes (131);
forming the emission layers on the first portion;
forming a second portion of the intermediate layer on the emission layers, such that the thickness of the second portion varies according to the sub-pixels.

22. A method according to Claim 21, wherein the second portion is an electron transport layer (143).

23. A device according to one of Claims 1 to 9, wherein the green or blue sub-pixels of adjacent pixels are disposed at a boundary between the adjacent pixels.

24. A device according to one of Claims 1 to 9 or Claim 23, wherein the thickness of the intermediate layer increases from the blue sub-pixel, to the green sub-pixel, to the red sub-pixel.

Patentansprüche

1. Organische lichtemittierende Anzeigevorrichtung, die aufweist:

Pixel, um Licht in einer ersten Richtung zu emittieren, wobei sie eine erste Elektrode (131), eine zweite Elektrode (132) und eine Zwischenschicht aufweist, die zwischen der ersten und der zweiten Elektrode angeordnet ist, wobei ein jedes Pixel in ein erstes, zweites und drittes Subpixel unterteilt ist, die in einer Reihe in dieser Reihenfolge angeordnet sind,
wobei ein jedes Subpixel eine unterschiedliche Farbe aufweist, ausgewählt unter Rot, Grün und Blau,
wobei die Zwischenschicht einen ersten Abschnitt, der das erste und zweite Subpixel bedeckt, und einen zweiten Abschnitt aufweist, der das zweite und dritte Subpixel bedeckt, und wobei die Dicke der Zwischenschicht für das erste Subpixel die Dicke des ersten Abschnittes, die Dicke der Zwischenschicht für das zweite Subpixel die Dicke des ersten und zweiten Abschnittes und die Dicke der Zwischenschicht für das dritte Subpixel die Dicke des zweiten Abschnittes ist,
wobei außerdem die Zwischenschicht mindestens eine von einer Lochtransportschicht (142), einer Elektronentransportschicht (143) oder einer Lochinjektionsschicht (141) ist, und wobei das zweite Subpixel ein rotes Subpixel ist.

2. Vorrichtung nach Anspruch 1, wobei in einem jeden der Pixel die Zwischenschicht als ein Teil ausgebildet ist.

3. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der das rote, grüne und blaue Subpixel jeweils eine rote, grüne und blaue Emissionsschicht aufweisen, die in der Zwischenschicht angeordnet sind,
wobei die Dicke der Zwischenschicht in den roten Subpixel ein Maximum aufweist.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Subpixel der benachbarten Pixel symmetrisch entsprechend der Farbe um eine Grenze zwischen den benachbarten Pixeln angeordnet sind.

5. Vorrichtung nach Anspruch 4, bei der die Zwischenschicht als ein oder mehrere Teile ausgebildet ist, die sich jeweils über die Grenze erstrecken, um so in mindestens zwei der benachbarten Pixeln angeordnet zu werden.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Zwischenschicht aufweist:

Lochtransportschichten (142) mit Dicken, die entsprechend der Subpixel variierten.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Zwischenschicht aufweist:

Lochinjektionsschichten (141), die auf der ersten Elektrode in jedem Pixel angeordnet sind, die Dicken aufweisen, die entsprechend der Subpixel variieren.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Zwischenschicht aufweist:

Lochinjektionsschichten (141) mit Dicken, die entsprechend der Subpixel variierten, und
Lochtransportschichten (142), die auf den Lochinjektionsschichten (141) ausgebildet sind, die Dicken aufweisen, die entsprechend der Subpixel variieren.

9. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der die Zwischenschicht Elektronentransportschichten (143) aufweist, die Dicken aufweisen, die entsprechend der Subpixel variieren.

10. Verfahren zur Herstellung einer organischen lichtemittierenden Anzeigevorrichtung mit einer Vielzahl von Pixeln, wobei jedes Pixel in ein erstes, zweites und drittes Subpixel in einer Reihe in dieser Reihenfolge unterteilt ist, wobei ein jedes Subpixel eine unterschiedliche Farbe aufweist, ausgewählt unter Rot, Grün und Blau, wobei das Verfahren die folgenden Schritte aufweist:

Bilden von ersten Elektroden (131) auf einer Oberfläche eines Substrates (102);
Bilden von Emissionsschichten (111R, 111G, 111B) und einer Zwischenschicht auf den ersten Elektroden (131), so dass die Zwischenschicht einen ersten Abschnitt, der das erste und zweite Subpixel bedeckt, und einen zweiten Abschnitt aufweist, der das zweite und dritte Subpixel bedeckt, und wobei die Dicke der Zwischenschicht für das erste Subpixel die Dicke des ersten Abschnittes, die Dicke der Zwischenschicht für das zweite Subpixel die Dicke des ersten und des zweiten Abschnittes und die Dicke der Zwischenschicht für das dritte Subpixel die Dicke des zweiten Abschnittes ist; und
Bilden einer zweiten Elektrode (132) auf der Zwischenschicht,
wobei die Zwischenschicht mindestens eine von einer Lochtransportschicht (142), einer Elektronentransportschicht (143) oder einer Lochinjektionsschicht (141) ist, und wobei das zweite Subpixel ein rotes Subpixel ist.

11. Verfahren nach Anspruch 10, bei dem das Bilden der Zwischenschicht die folgenden Schritte aufweist:

Bilden eines ersten Abschnittes der Zwischenschicht in einem ersten Bereich; und
Bilden eines zweiten Abschnittes der Zwischenschicht in einem zweiten Bereich, der den ersten Bereich überlappt.

12. Verfahren nach Anspruch 11, bei dem das Bilden der Emissionsschicht den Schritt des Bildens einer roten Emissionsschicht dort aufweist, wo sich der erste Bereich und der zweite Bereich überlappen.

13. Verfahren nach einem der Ansprüche 10 bis 12, bei dem das Bilden der Zwischenschicht die folgenden Schritte aufweist:

Bilden des ersten Abschnittes der Zwischenschicht über den benachbarten roten und grünen Subpixeln; und
Bilden des zweiten Abschnittes der Zwischenschicht über den benachbarten blauen und roten Subpixeln, so dass der erste und der zweite Abschnitt miteinander verbunden werden.

14. Verfahren nach Anspruch 13, bei dem das Bilden des ersten Abschnittes der Zwischenschicht den Schritt des Verwendens einer ersten Maske mit Öffnungen aufweist, die einem jeden der ersten Abschnitte entsprechen, um den ersten Abschnitt zu strukturieren.

15. Verfahren nach Anspruch 14, bei dem das Bilden des zweiten Abschnittes der Zwischenschicht den Schritt des Verwendens einer zweiten Maske mit Öffnungen aufweist, die einem jeden der zweiten Abschnitte entsprechen, um den zweiten Abschnitt zu strukturieren.

16. Verfahren nach einem der Ansprüche 10 bis 15, bei dem das Bilden der Zwischenschicht in einem jeden der Pixel den Schritt des Bildens der Zwischenschicht als ein Teil aufweist.

17. Verfahren nach einem der Ansprüche 10 bis 16, bei dem das Bilden der Emissionsschichten und der Zwischenschicht den Schritt des Bildens der Emissionsschichten (111R, 111G, 111B) innerhalb der Zwischenschicht aufweist.

18. Verfahren nach einem der Ansprüche 10 bis 17, bei dem das Bilden der Zwischenschicht die folgenden Schritte aufweist:

Bilden einer Lochinjektionsschicht (141) auf den ersten Elektroden; und
Bilden von Lochtransportschichten (142) auf der Lochinjektionsschicht (141), so dass die Dicken der Lochtransportschichten entsprechend der Subpixel variieren.

19. Verfahren nach einem der Ansprüche 10 bis 18, bei dem das Bilden der Zwischenschicht die folgenden Schritte aufweist:

Bilden von Lochinjektionsschichten (141) auf der ersten Elektrode, so dass die Dicken der Lochinjektionsschichten (141) entsprechend der Subpixel variierten, und
Bilden einer Lochtransportschicht auf den Lochinjektionsschichten.

20. Verfahren nach einem der Ansprüche 10 bis 19, bei dem das Bilden der Zwischenschicht die folgenden Schritte aufweist:

Bilden von Lochinjektionsschichten (141) auf den ersten Elektroden (131), so dass die Dicken der Lochinjektionsschichten (141) entsprechend der Subpixel variierten, und
Bilden von Lochtransportschichten auf den Lochinjektionsschichten (141), so dass die Dicken der Lochtransportschichten (142) entsprechend der Subpixel variieren.

21. Verfahren nach den Ansprüchen 10 bis 20, bei dem das Bilden der Emissionsschicht und der Zwischenschicht die folgenden Schritte aufweist:

Bilden eines ersten Abschnittes der Zwischenschicht auf den ersten Elektroden (131);
Bilden der Emissionsschichten auf dem ersten Abschnitt;
Bilden eines zweiten Abschnittes der Zwischenschicht auf den Emissionsschichten, so dass die Dicke des zweiten Abschnittes entsprechend der Subpixel variiert.

22. Verfahren nach Anspruch 21, bei dem der zweite Abschnitt eine Elektronentransportschicht (143) ist.

23. Vorrichtung nach einem der Ansprüche 1 bis 9, bei der die grünen oder blauen Subpixel von benachbarten Pixeln an einer Grenze zwischen den benachbarten Pixeln angeordnet sind.

24. Vorrichtung nach einem der Ansprüche 1 bis 9 oder Anspruch 23, bei der die Dicke der Zwischenschicht vom blauen Subpixel zum grünen Subpixel bis zum roten Subpixel zunimmt.

Revendications

1. Appareil à affichage électroluminescent organique, comprenant :

des pixels pour émettre la lumière dans une première direction, comprenant une première électrode (131), une deuxième électrode (132) et une couche intermédiaire agencée entre les première et deuxième électrodes, dans lequel :

chaque pixel est divisé en des premier, deuxième et troisième sous-pixels agencés dans cet ordre dans une rangée ;
chaque sous-pixel est d'une couleur différente, choisie parmi le rouge, le vert et le bleu ;
la couche intermédiaire comprend une première partie recouvrant les premier et deuxième sous-pixels et une deuxième partie recouvrant les deuxième et troisième sous-pixels ; et
l'épaisseur de la couche intermédiaire pour le premier sous-pixel correspond à l'épaisseur de la première partie, l'épaisseur de la couche intermédiaire pour le deuxième sous-pixel correspond à l'épaisseur des première et deuxième parties, et l'épaisseur de la couche intermédiaire pour le troisième sous-pixel correspond à l'épaisseur de la deuxième partie ;

dans lequel la couche intermédiaire est en outre constituée par au moins une couche, une couche de transport de trous (142), une couche de transport d'électrons (143) ou une couche d'injection de trous (141), le deuxième sous-pixel étant un sous-pixel rouge.

2. Appareil selon la revendication 1, dans lequel, dans chacun des pixels, la couche intermédiaire est formée sous forme d'une seule pièce.

3. Appareil selon l'une quelconque des revendications précédentes, dans lequel les sous-pixels rouges, verts et bleus comprennent respectivement des couches d'émission rouges, vertes et bleues agencées dans la couche intermédiaire ;
dans lequel l'épaisseur de la couche intermédiaire est maximale dans les sous-pixels rouges.

4. Appareil selon l'une quelconque des revendications précédentes, dans lequel les sous-pixels de pixels adjacents sont agencés de manière symétrique en fonction de la couleur autour d'une limite entre les pixels adjacents.

5. Appareil selon la revendication 4, dans lequel la couche intermédiaire est formée sous forme d'une ou de plusieurs pièces, s'étendant chacune à travers la limite, de sorte à être agencée sur au moins deux des pixels adjacents.

6. Appareil selon l'une quelconque des revendications précédentes, dans lequel la couche intermédiaire comprend :

des couches de transport de trous (142) ayant des épaisseurs variant en fonction des sous-pixels.

7. Appareil selon l'une quelconque des revendications précédentes, dans lequel la couche intermédiaire comprend :

des couches d'injection de trous (141) agencées sur la première électrode dans chaque pixel, ayant des épaisseurs variant en fonction des sous pixels.

8. Appareil selon l'une quelconque des revendications précédentes, dans lequel la couche intermédiaire comprend :

des couches d'injection de trous (141) ayant des épaisseurs variant en fonction des sous-pixels ; et
des couches de transport de trous (142) formées dans les couches d'injection de trous (141), ayant des épaisseurs variant en fonction des sous-pixels.

9. Appareil selon l'une quelconque des revendications précédentes, dans lequel la couche intermédiaire comprend des couches de transport d'électrons (143) ayant des épaisseurs variant en fonction des sous-pixels.

10. Procédé de fabrication d'un appareil à affichage électroluminescent organique, comportant plusieurs pixels, chaque pixel étant divisé en des premier, deuxième et troisième sous-pixels agencés dans cet ordre dans une rangée, chaque sous-pixel ayant une couleur différente choisie parmi le rouge, le vert et le bleu, le procédé comprenant les étapes ci-dessous :

formation de premières électrodes (131) sur une surface d'un substrat (102) ;
formation de couches d'émission (111R, 111G, 111B) et d'une couche intermédiaire sur les premières électrodes (131), de sorte que la couche intermédiaire comprend une première partie recouvrant les premier et deuxième sous-pixels, et une deuxième partie recouvrant les deuxième et troisième sous-pixels, l'épaisseur de la couche intermédiaire pour le premier sous-pixel correspondant à l'épaisseur de la première partie, l'épaisseur de la couche intermédiaire pour le deuxième sous-pixel correspondant à l'épaisseur des première et deuxième parties, et l'épaisseur de la couche intermédiaire pour le troisième sous-pixel correspondant à l'épaisseur de la deuxième partie ; et
formation d'une deuxième électrode (132) sur la couche intermédiaire ;
dans lequel la couche intermédiaire est constituée par au moins une couche, une couche de transport de trous (142), une couche de transport d'électrons (143) ou une couche d'injection de trous (141), le deuxième sous-pixel étant un sous-pixel rouge.

11. Procédé selon la revendication 10, dans lequel la formation de la couche intermédiaire comprend les étapes ci-dessous :

formation d'une première partie de la couche intermédiaire dans une première région ; et
formation d'une deuxième partie de la couche intermédiaire dans une deuxième région chevauchant la première région.

12. Procédé selon la revendication 11, dans lequel la formation de la couche d'émission comprend l'étape de formation d'une couche à émission de lumière rouge au niveau du point de chevauchement de la première région et de la deuxième région.

13. Procédé selon l'une des revendications 10 à 12, dans lequel la formation de la couche intermédiaire comprend les étapes ci-dessous :

formation de la première partie de la couche intermédiaire à travers des sous-pixels rouge et vert adjacents ; et
formation de la deuxième partie de la couche intermédiaire à travers des sous-pixels bleu et rouge adjacents, de sorte que les première et deuxième parties sont reliées.

14. Procédé selon la revendication 13, dans lequel la formation de la première partie de la couche intermédiaire comprend l'étape d'utilisation d'un premier masque comportant des ouvertures correspondant à chacune des premières parties, pour former un motif sur la première partie.

15. Procédé selon la revendication 14, dans lequel la formation de la deuxième partie de la couche intermédiaire comprend l'étape d'utilisation d'un deuxième masque comportant des ouvertures correspondant à chacune des deuxièmes parties, pour former un motif sur la deuxième partie.

16. Procédé selon l'une des revendications 10 à 15, dans lequel la formation de la couche intermédiaire comprend l'étape de formation de la couche intermédiaire sous forme d'une seule pièce dans chacun des pixels.

17. Procédé selon l'une des revendications 10 à 16, dans lequel la formation des couches d'émission et de la couche intermédiaire comprend l'étape de formation des couches d'émission (111R, 111 G, 111 B) dans la couche intermédiaire.

18. Procédé selon l'une des revendications 10 à 17, dans lequel la formation de la couche intermédiaire comprend les étapes ci-dessous :

formation d'une couche d'injection de trous (141) sur les premières électrodes ; et
formation de couches de transport de trous (142) sur la couche d'injection de trous (141), de sorte que les épaisseurs des couches de transport de trous varient en fonction des sous-pixels.

19. Procédé selon l'une des revendications 10 à 18, dans lequel la formation de la couche intermédiaire comprend les étapes ci-dessous :

formation de couches d'injection de trous (141) sur la première électrode, de sorte que les épaisseurs des couches d'injection de trous (141) varient en fonction des sous-pixels ; et
formation d'une couche de transport de trous sur les couches d'injection de trous.

20. Procédé selon l'une des revendications 10 à 19, dans lequel la formation de la couche intermédiaire comprend les étapes ci-dessous :

formation de couches d'injection de trous (141) sur les premières électrodes (131), de sorte que les épaisseurs des couches d'injection de trous (141) varient en fonction des sous-pixels ; et
formation de couches de transport de trous sur les couches d'injection de trous (141), de sorte que les épaisseurs des couches de transport de trous (142) varient en fonction des sous-pixels.

21. Procédé selon les revendications 10 à 20, dans lequel la formation de la couche d'émission et de la couche intermédiaire comprend les étapes ci-dessous :

formation d'une première partie de la couche intermédiaire sur les premières électrodes (131) ;
formation des couches d'émission sur la première partie ;
formation d'une deuxième partie de la couche intermédiaire sur les couches d'émission, de sorte que l'épaisseur de la deuxième partie varie en fonction des sous-pixels.

22. Procédé selon la revendication 21, dans lequel la deuxième partie est une couche de transport d'électrons (143).

23. Appareil selon l'une des revendications 1 à 9, dans lequel les sous-pixels verts ou bleus de pixels adjacents sont agencés au niveau d'une limite entre les pixels adjacents.

24. Appareil selon l'une des revendications 1 à 9 ou 23, dans lequel l'épaisseur de la couche intermédiaire est accrue du sous-pixel bleu vers le sous-pixel vert et vers le sous-pixel rouge.

FIG. 1A (PRIOR ART)

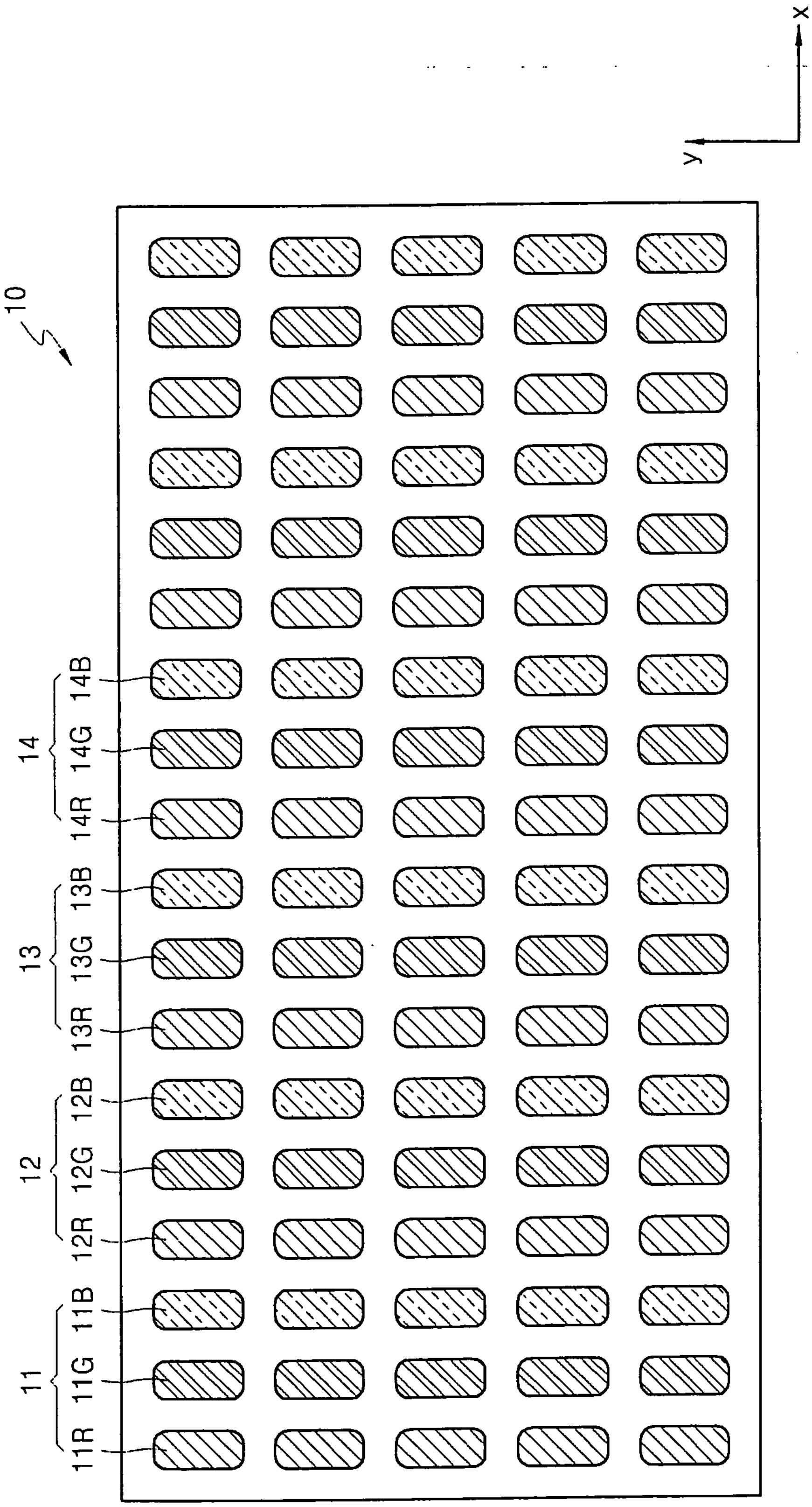


FIG. 1B (PRIOR ART)

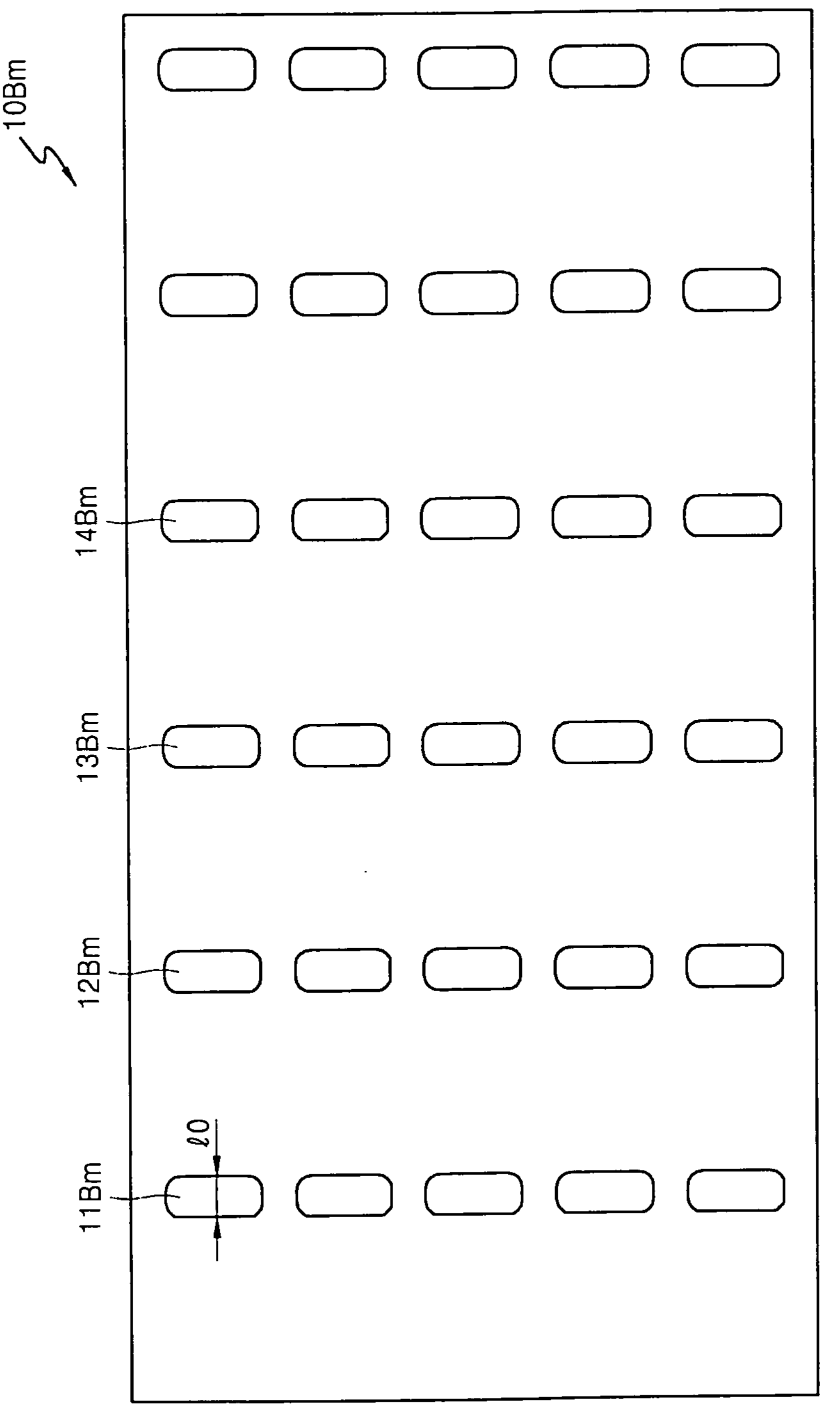


FIG. 2

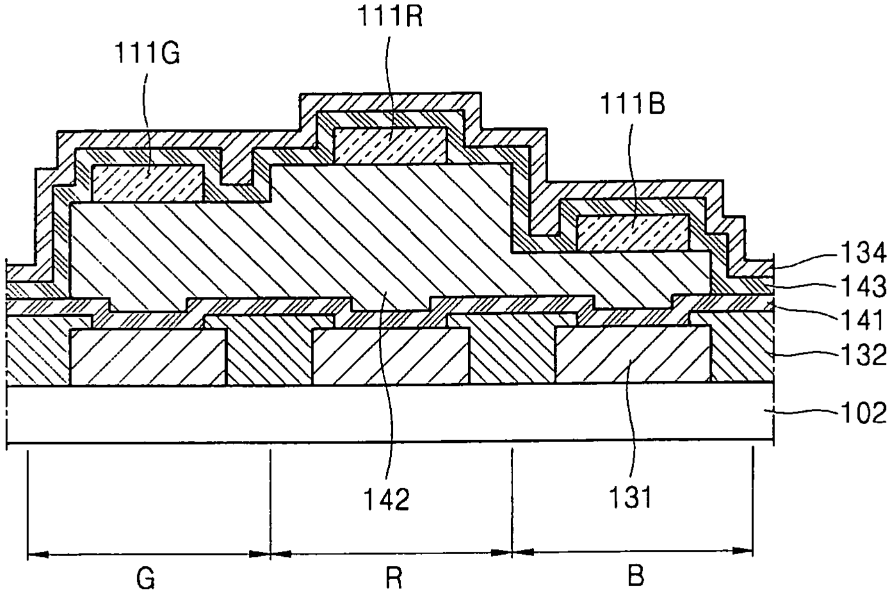


FIG. 3A

FIG. 3B

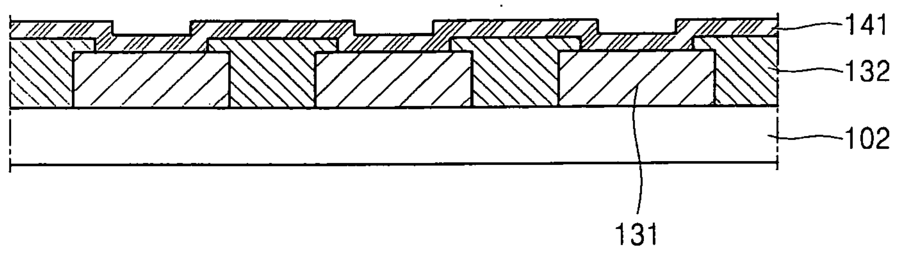


FIG. 3C

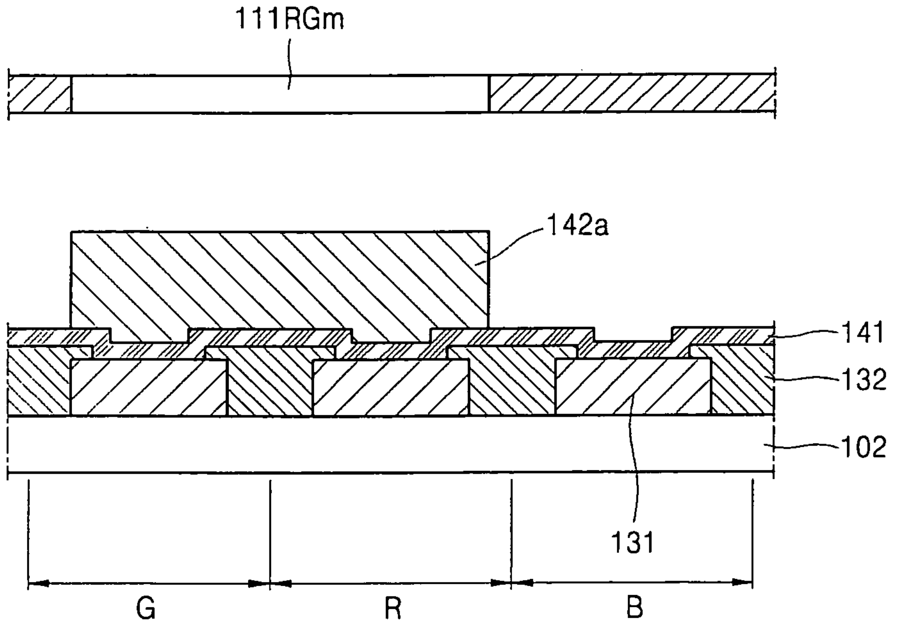


FIG. 3D

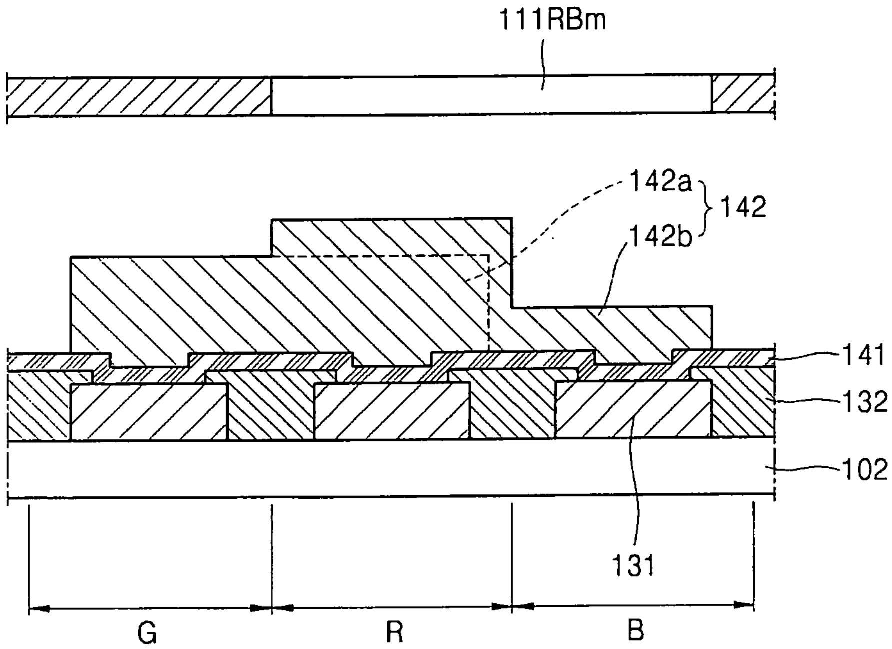

111RBm
142a
142
142b
141
132
102
131
G
R
B

FIG. 3E

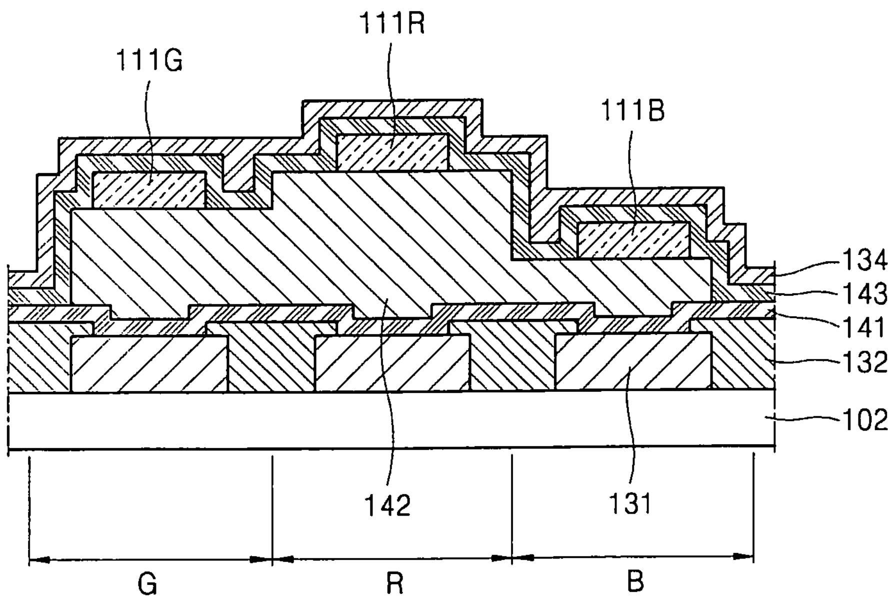

111R
111G
111B
134
143
141
132
102
142
131
G
R
B

FIG. 4

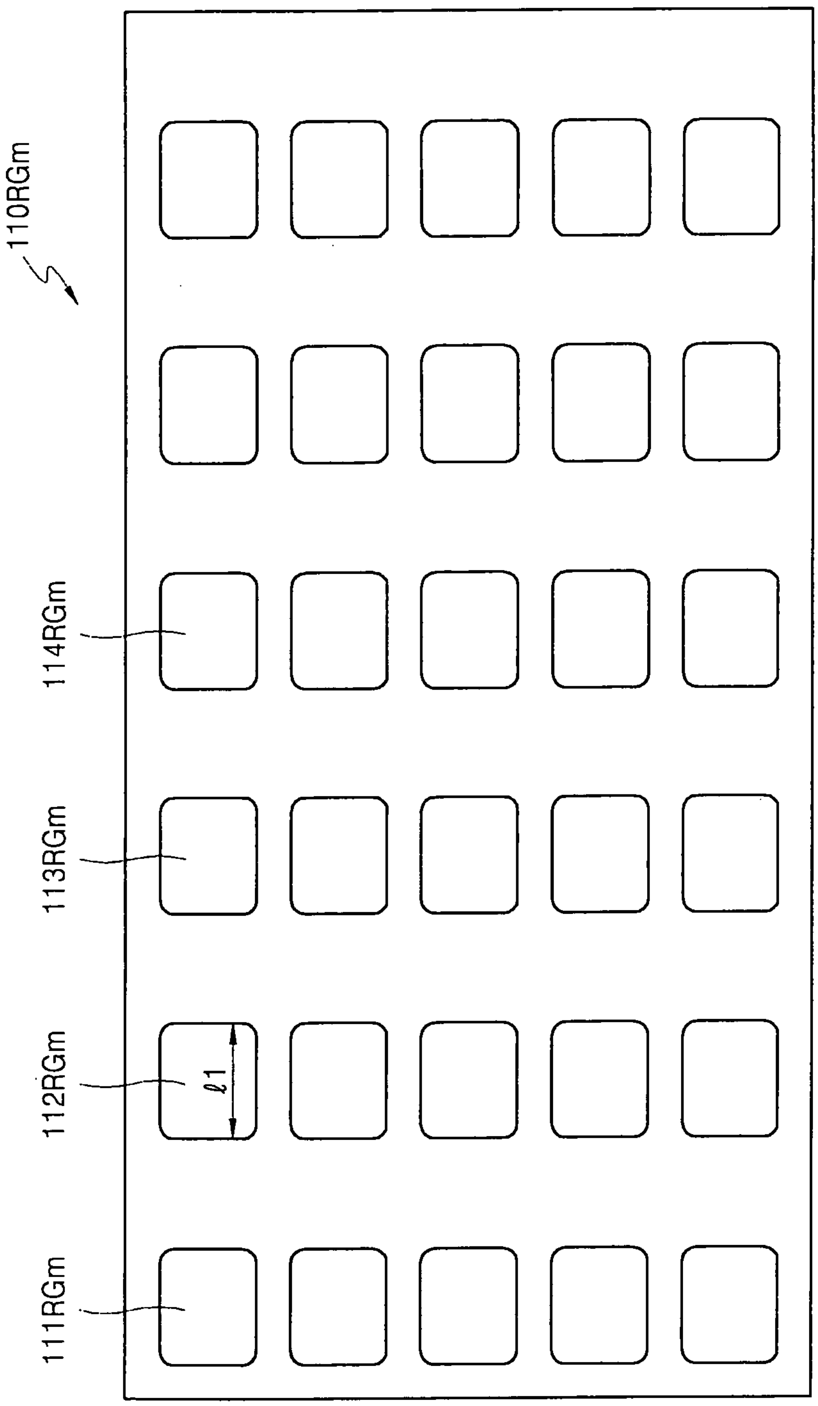


FIG. 5

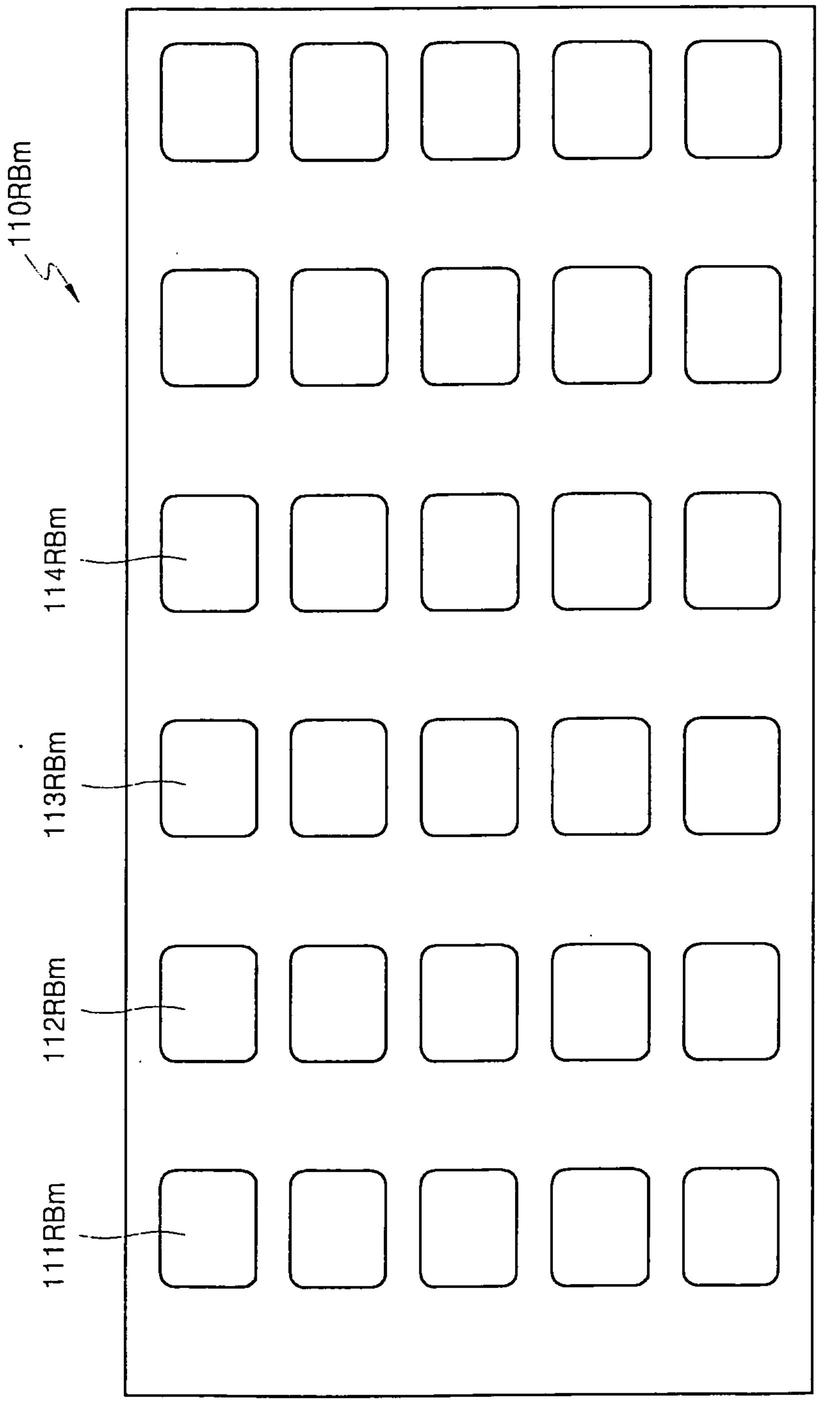


FIG. 6

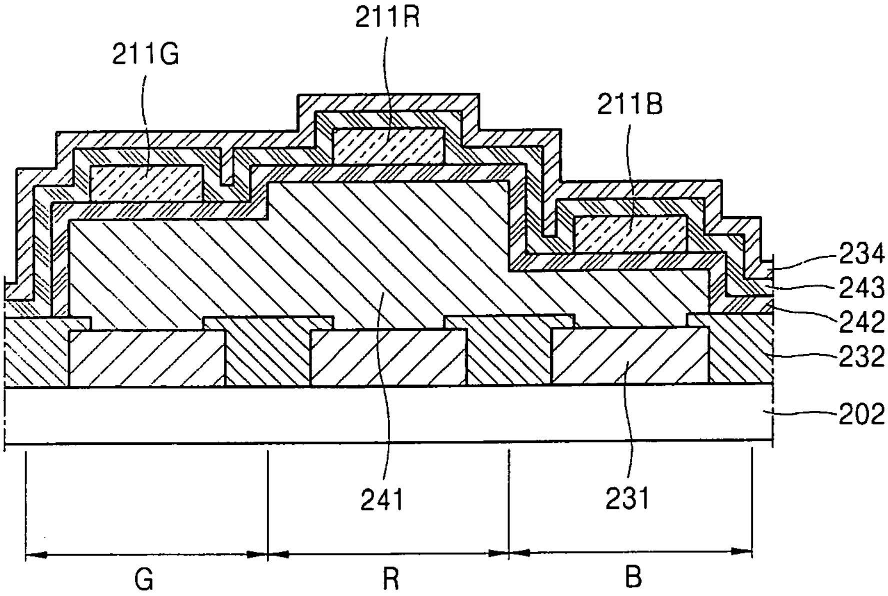


FIG. 7A

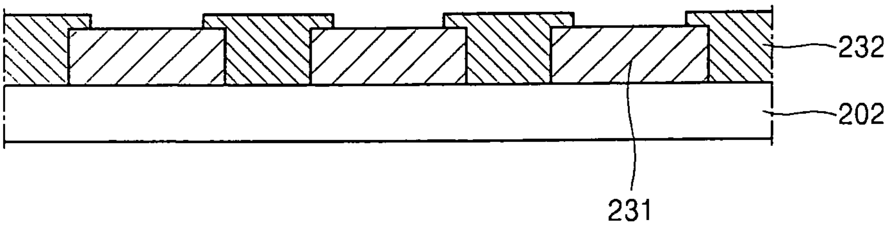


FIG. 7B

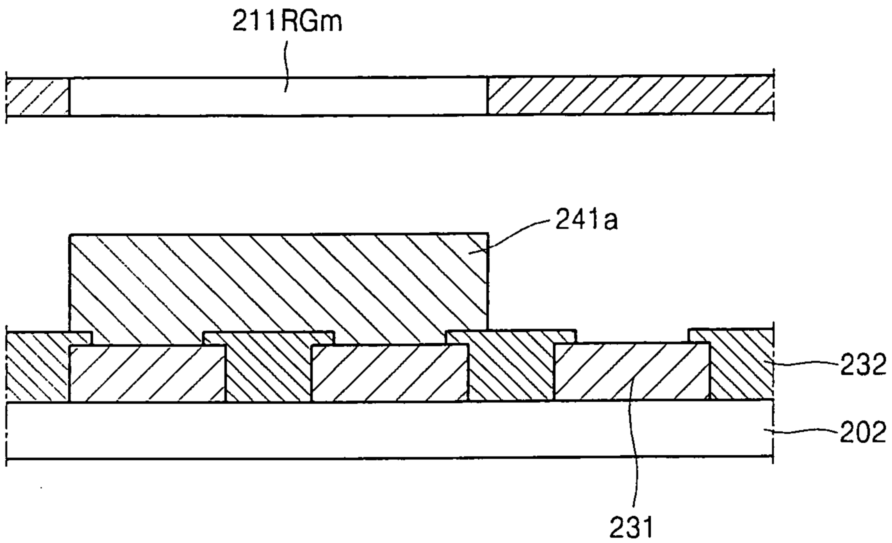


FIG. 7C

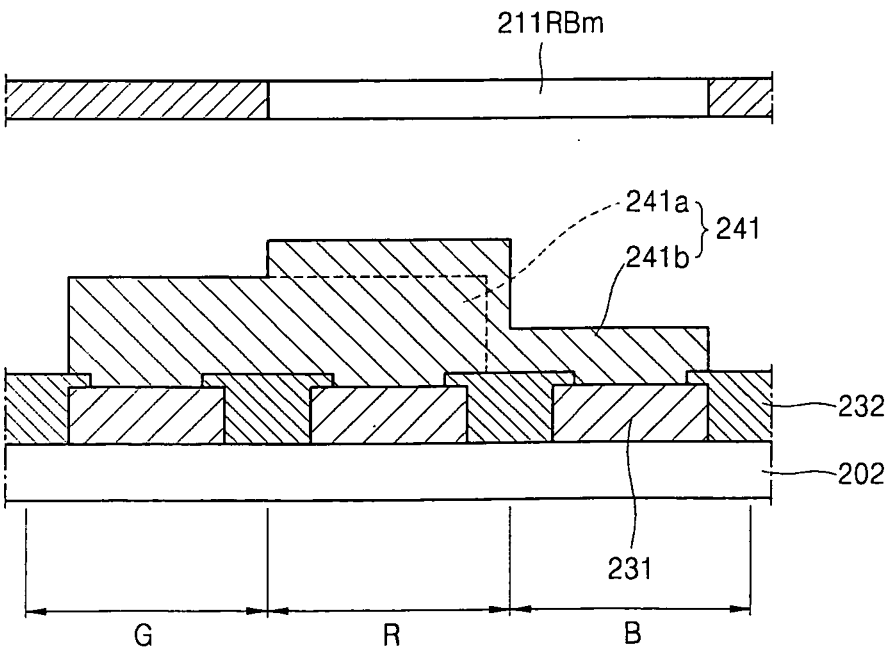


FIG. 7D

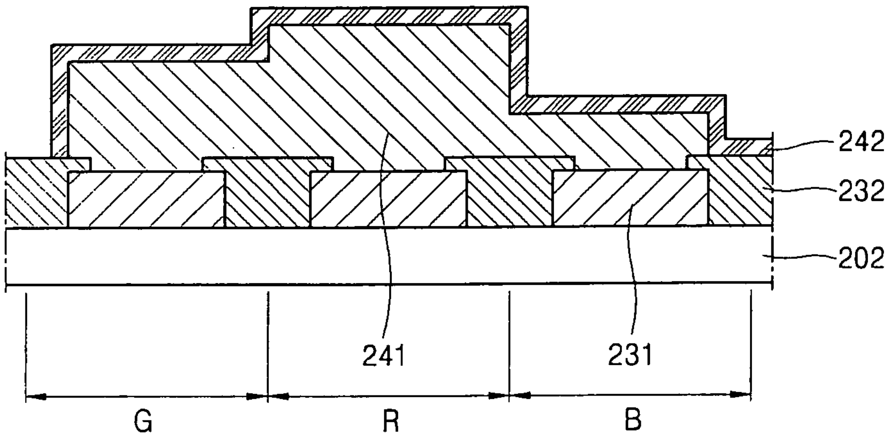

242
232
202
241
231
G
R
B

FIG. 7E

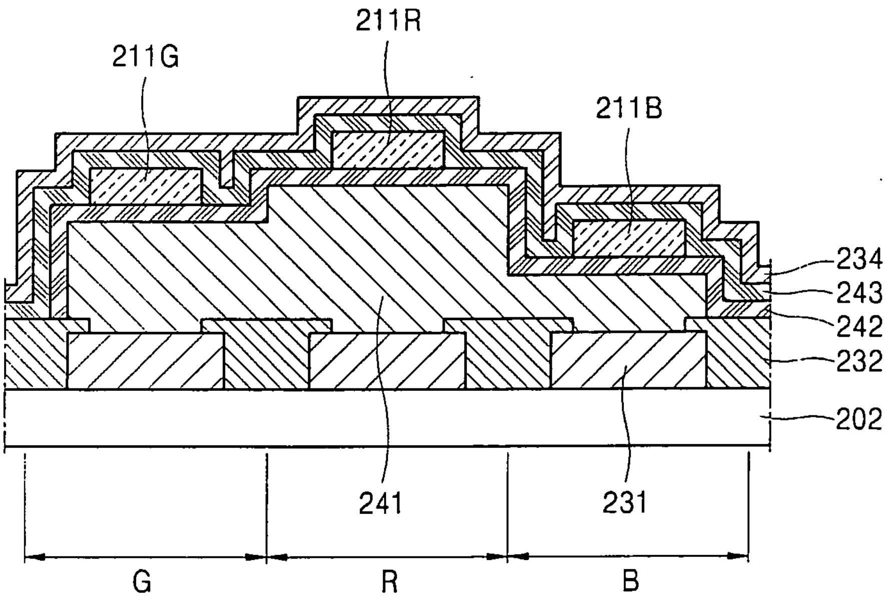

211R
211G
211B
234
243
242
232
202
241
231
G
R
B

FIG. 8

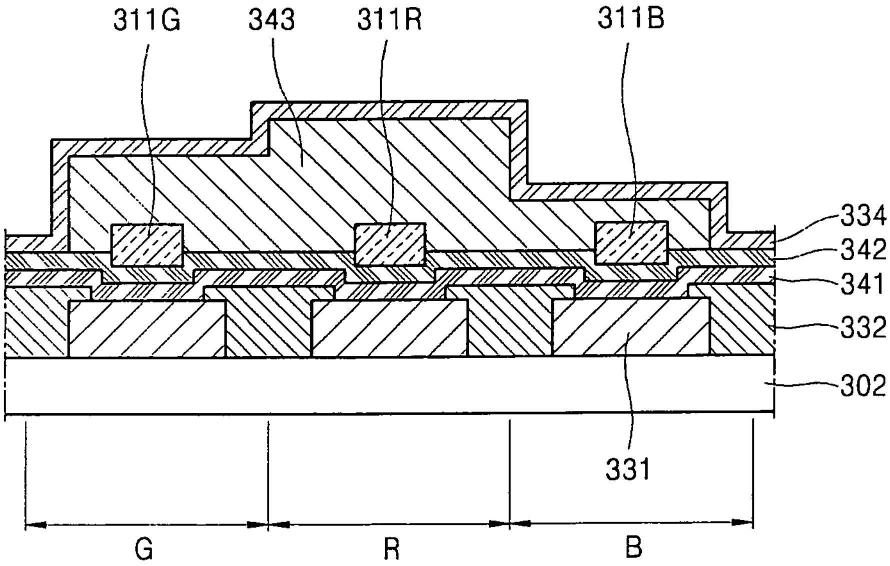


FIG. 9A

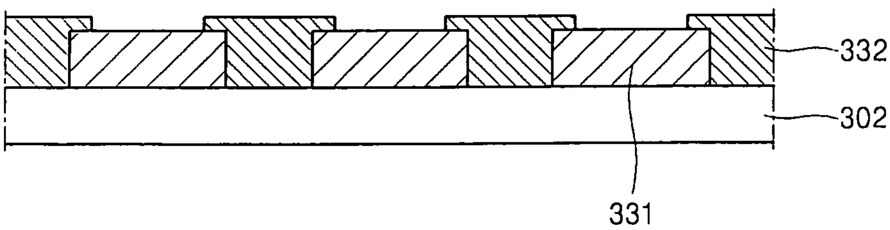


FIG. 9B

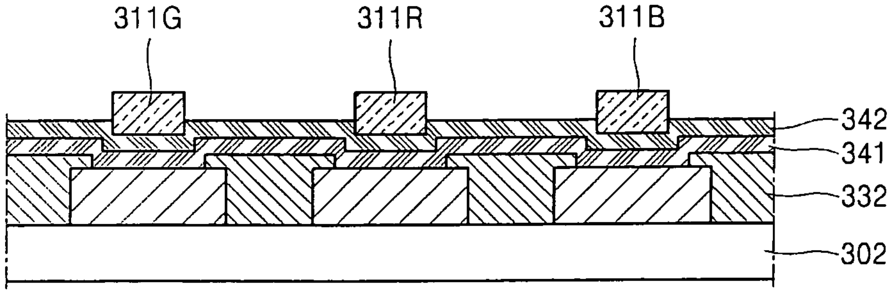

311G
311R
311B
342
341
332
302

FIG. 9C

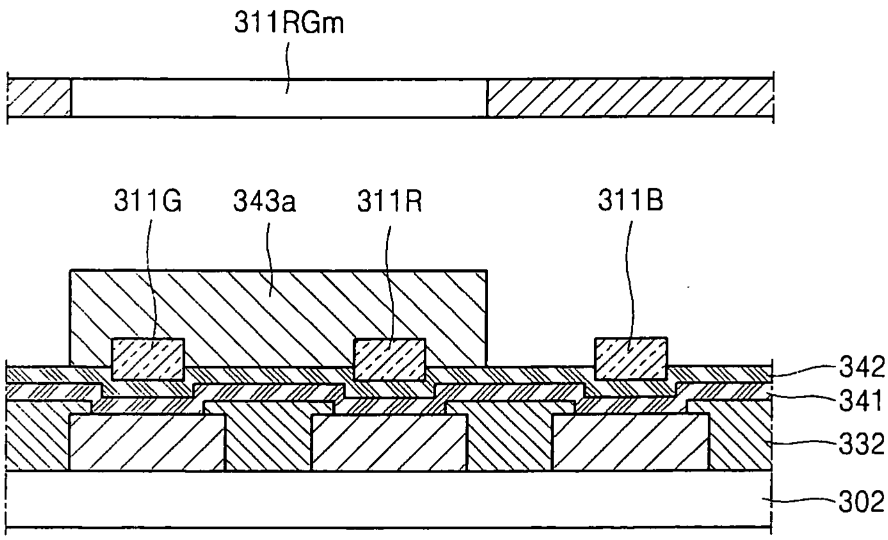

311RGm
311G
343a
311R
311B
342
341
332
302

FIG. 9D

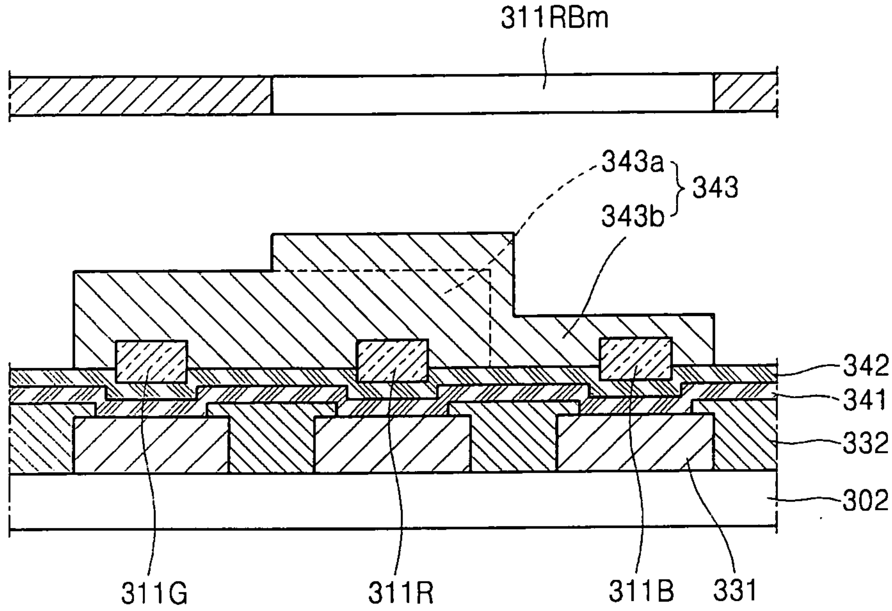

311RBm
343a
343
343b
342
341
332
302
311G
311R
311B
331

FIG. 9E

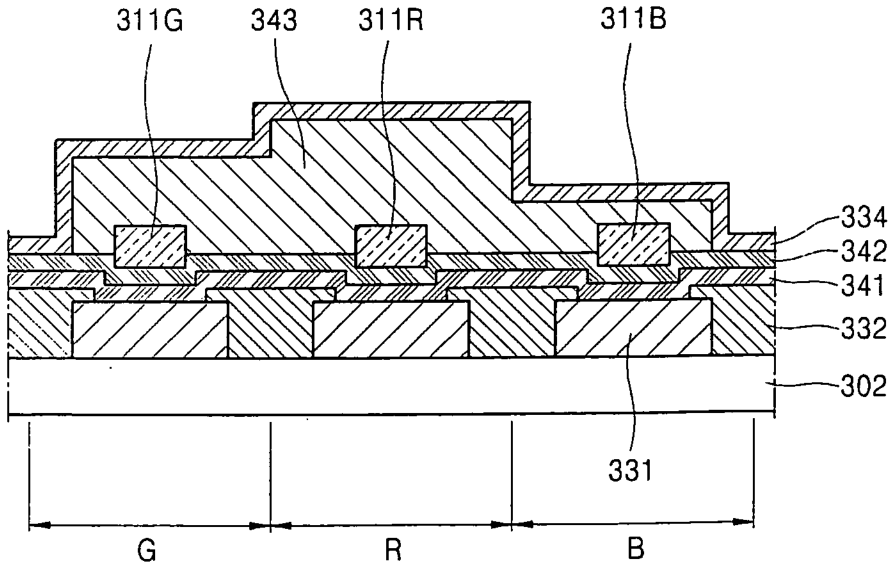

311G
343
311R
311B
334
342
341
332
302
331
G
R
B

FIG. 10A

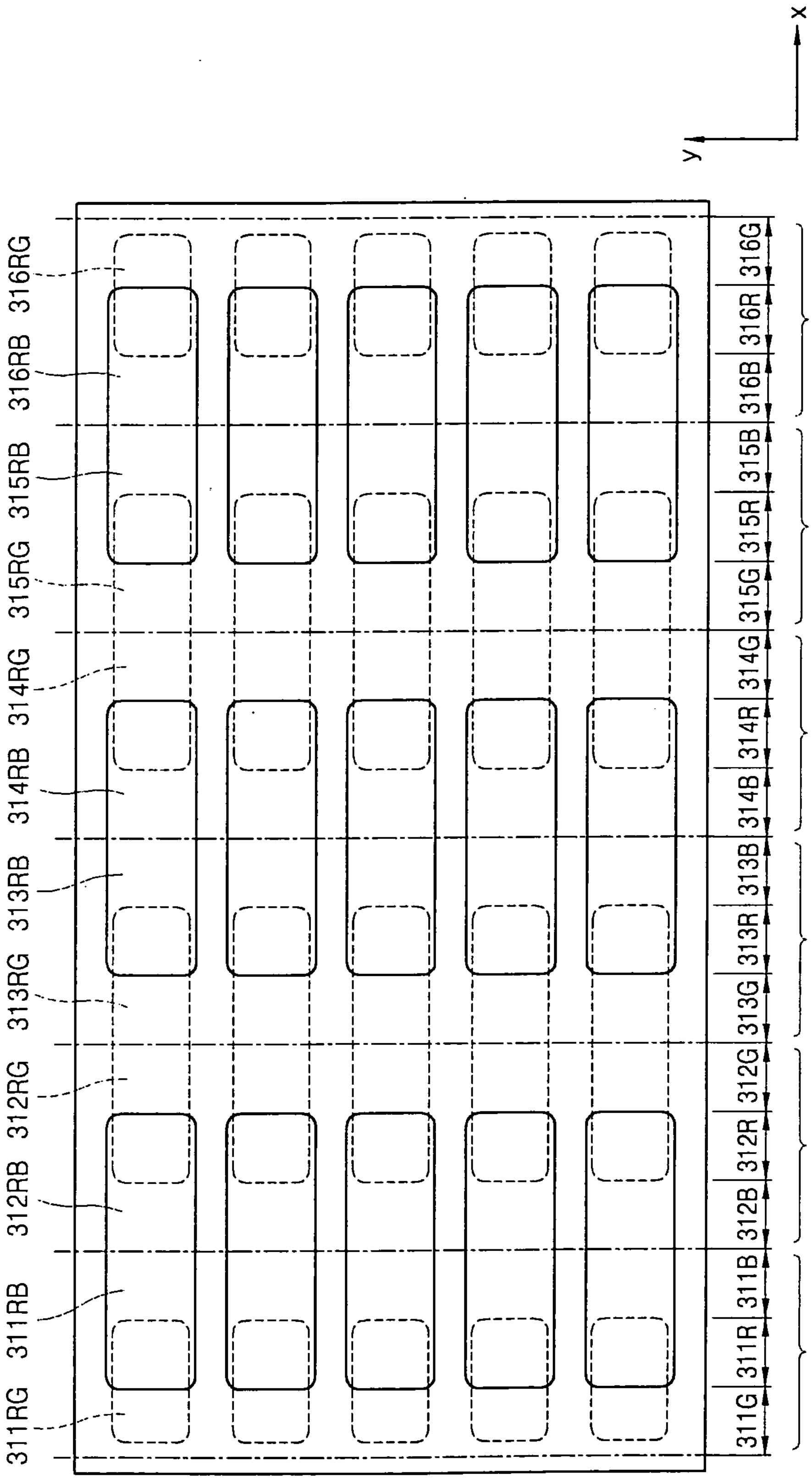

x
y
311RG
311RB
312RB
312RG
313RG
313RB
314RB
314RG
315RG
315RB
316RB
316RG
311G
311R
311B
312B
312R
312G
313G
313R
313B
314B
314R
314G
315G
315R
315B
316B
316R
316G
311
312
313
314
315
316

FIG. 10B

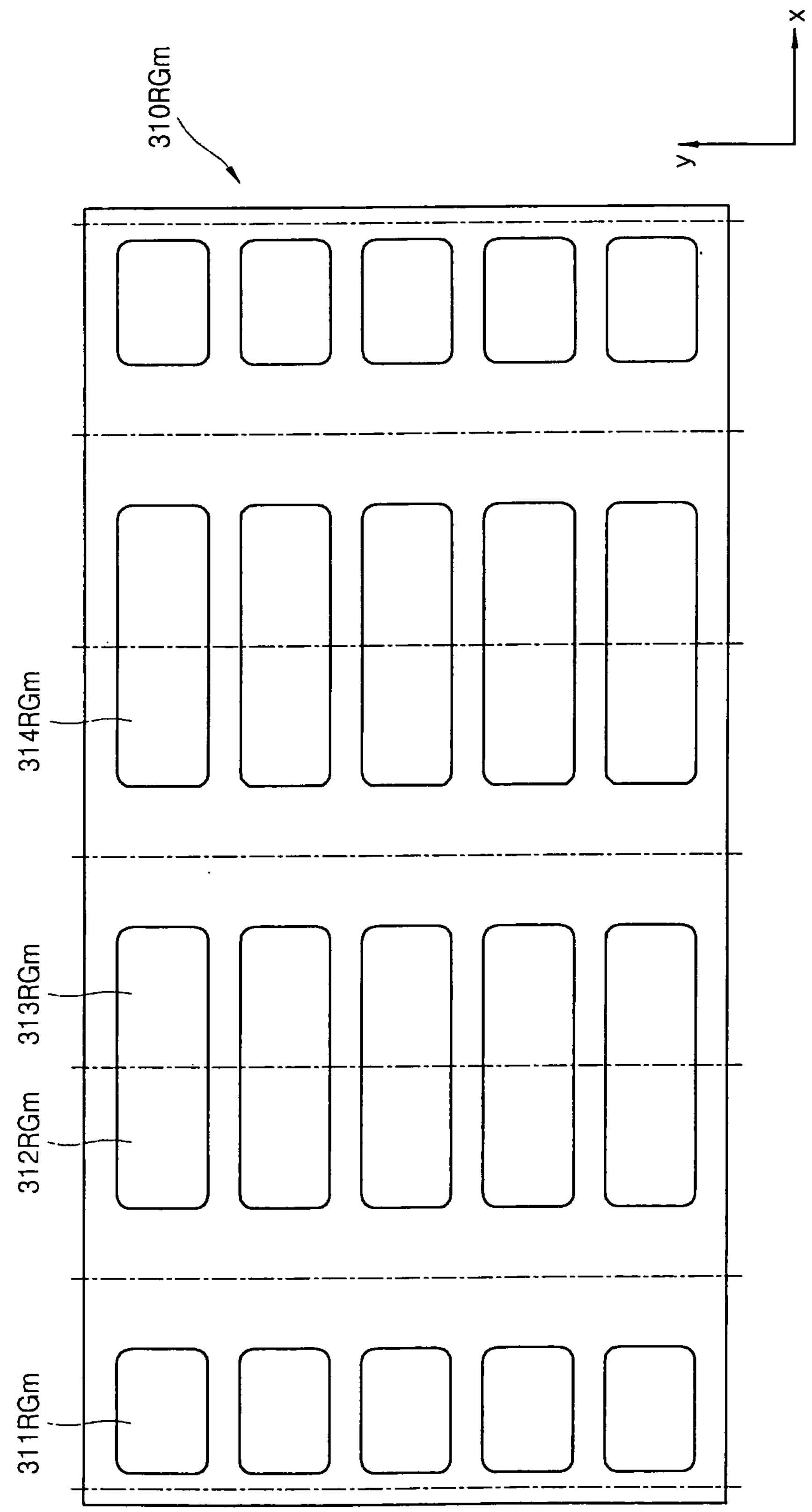


FIG. 10C

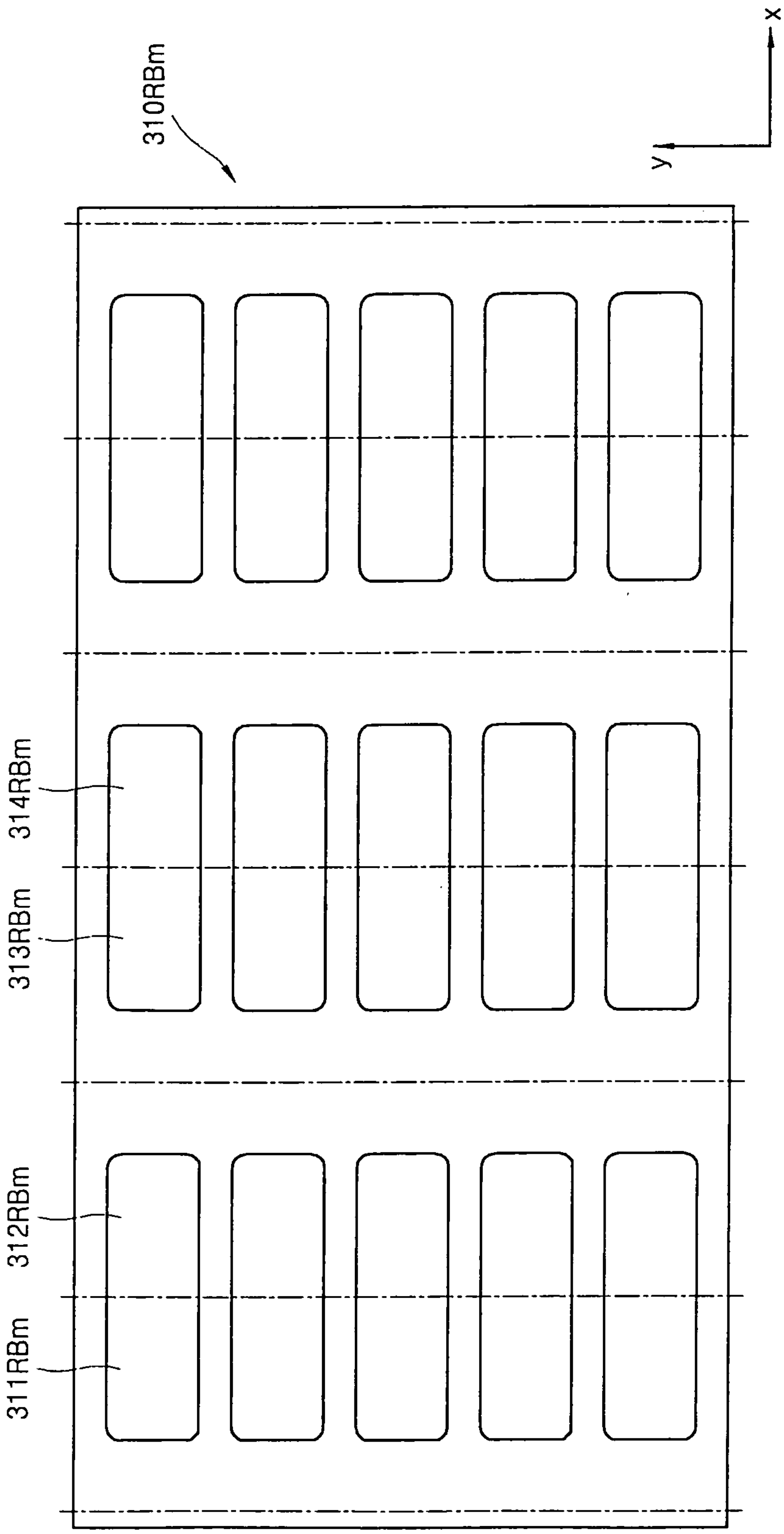


FIG. 11

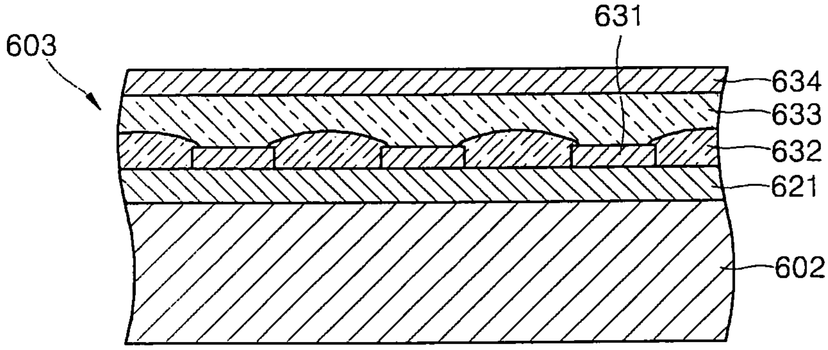
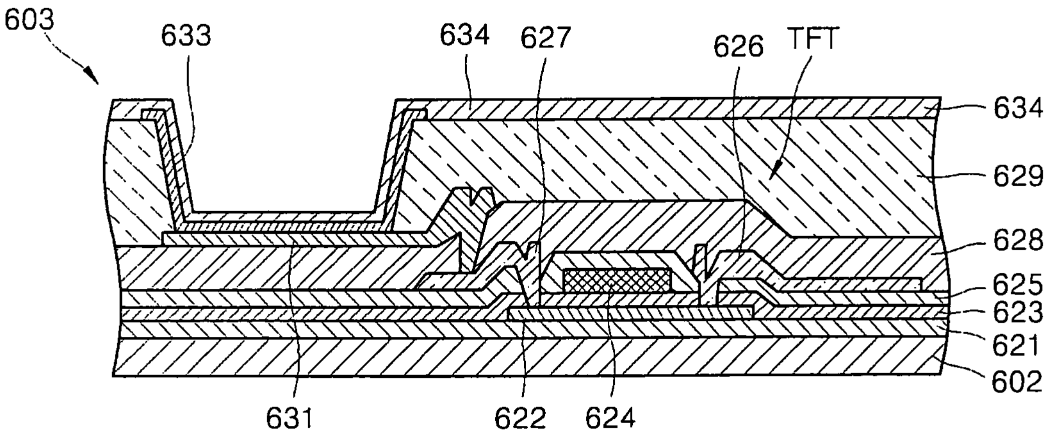

603
631
634
633
632
621
602

FIG. 12


603
633
634
627
626
TFT
634
629
628
625
623
621
602
631
622
624

REFERENCES CITED IN THE DESCRIPTION

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- US 20070296334 A **[0010]**
- EP 1052708 A **[0011]**
- JP 2004207126 B **[0012]**
- US 20070046195 A **[0013]**

专利名称(译)	有机发光显示装置及其制造方法
公开(公告)号	EP2101356B1	公开(公告)日	2016-03-09
申请号	EP2009250716	申请日	2009-03-13
[标]申请(专利权)人(译)	三星显示有限公司
申请(专利权)人(译)	三星移动显示器有限公司.
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.
[标]发明人	SONG MYUNG WON
发明人	SONG, MYUNG-WON
IPC分类号	H01L27/32 H01L51/52
CPC分类号	H01L51/5265 H01L27/3211 H01L51/0011 H01L51/5048 H01L2251/558
优先权	1020080023413 2008-03-13 KR
其他公开文献	EP2101356A1
外部链接	Espacenet

摘要(译)

一种有机发光显示装置及其制造方法，所述有机发光显示装置包括像素（R，G，B），所述像素包括相对的第一电极（131）和第二电极（134），以及中间层（142）设置在第一电极（131）和第二电极（134）之间。像素被分成红色，绿色和蓝色子像素。中间层（142）具有根据子像素（R，G，B）而变化的厚度。

FIG. 1A (PRIOR ART)