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(54) **ORGANIC ELECTRO-LUMINESCENT DISPLAY DEVICE**

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(57) **ABSTRACT**

An organic electro-luminescent display device is characterized in being provided with a substrate which is formed from an insulation material, a plurality of pixels which are arranged in a matrix shape in a display region of the substrate, and an organic layer which is formed spanning an adjacent pixel out of the plurality of pixels and includes a luminous layer, where the organic layer includes an anisotropic layer with greater electrical conductivity in a perpendicular direction with respect to the substrate than the electrical conductivity in a direction along the substrate.

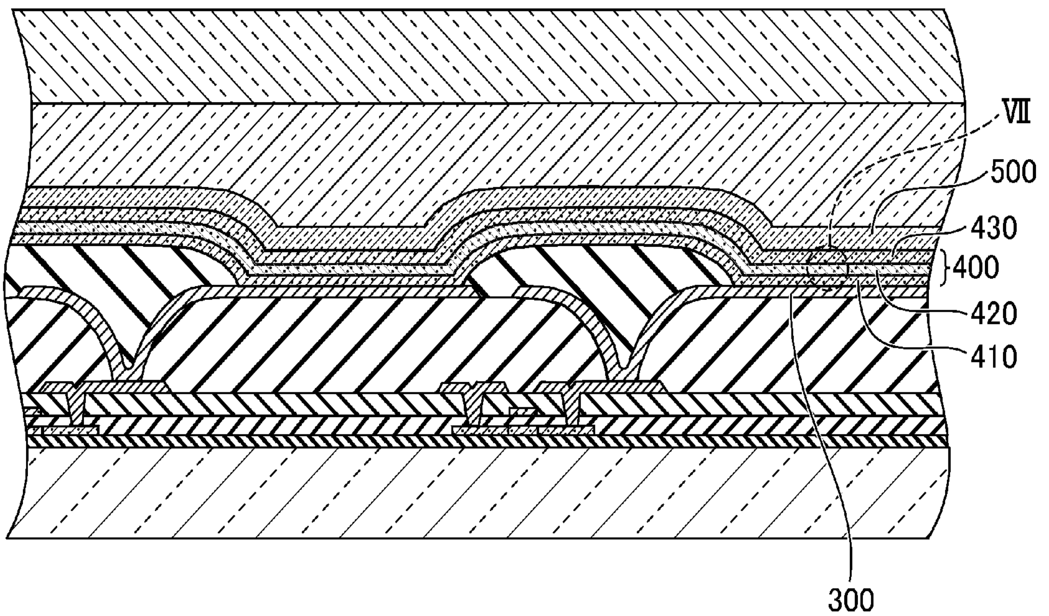


FIG.1

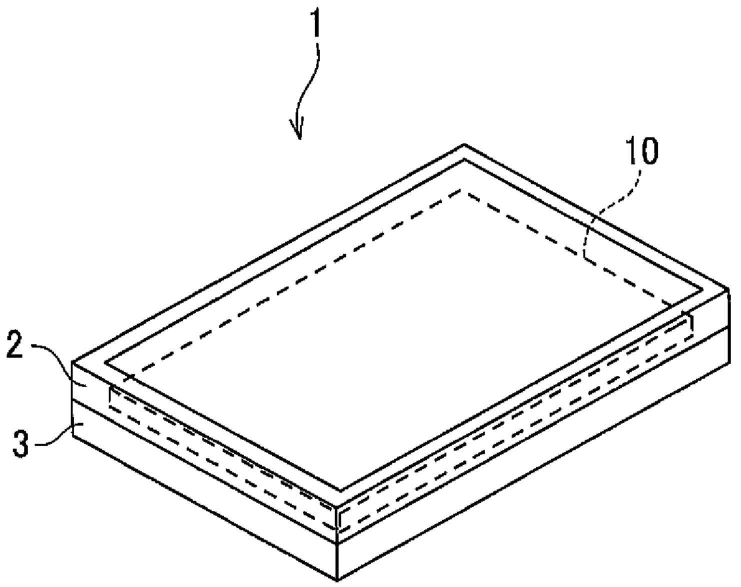


FIG.2

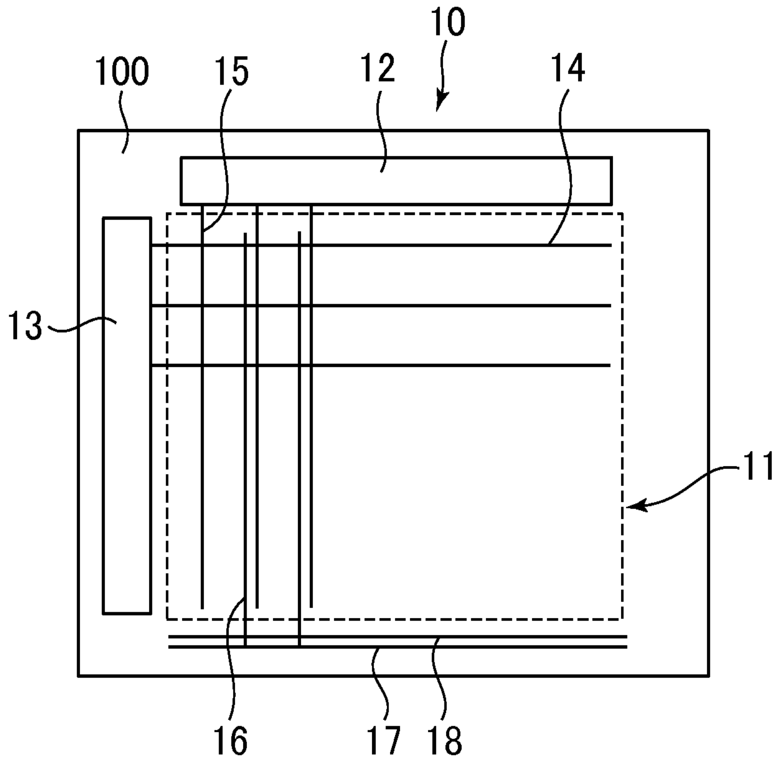


FIG.3

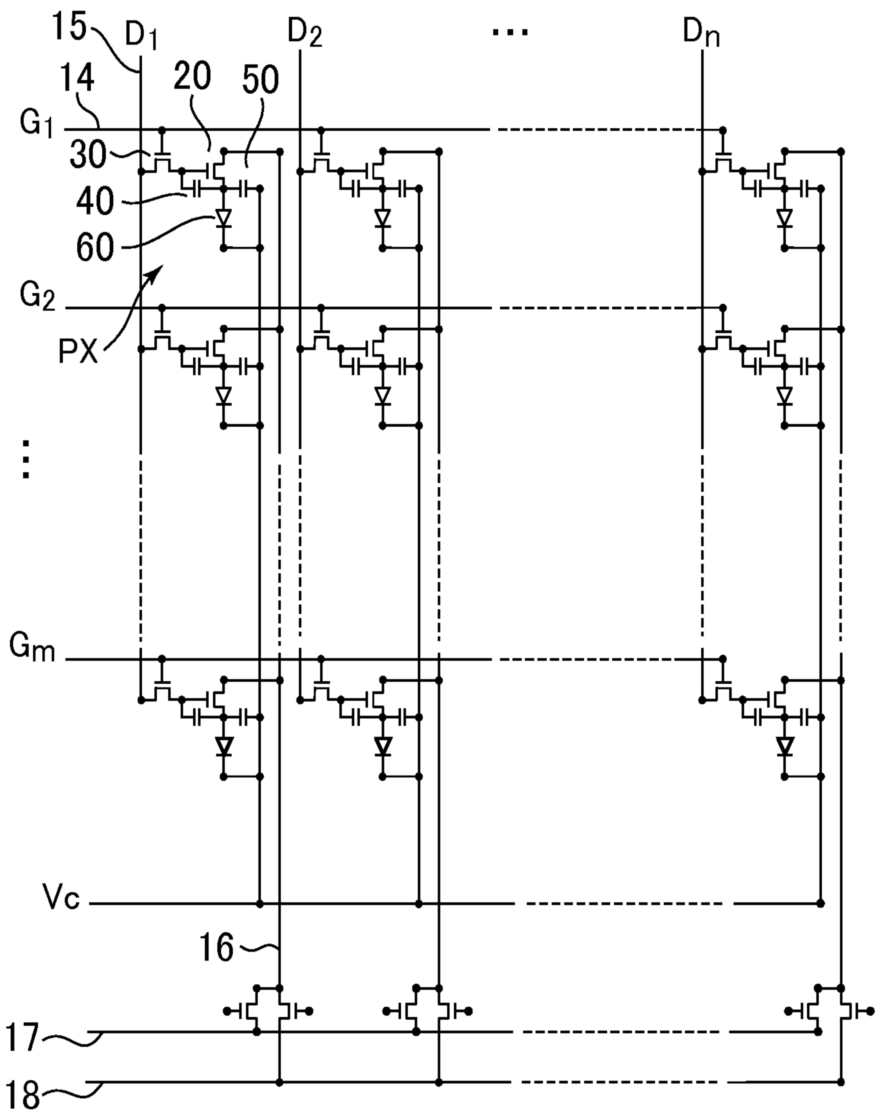


FIG.4

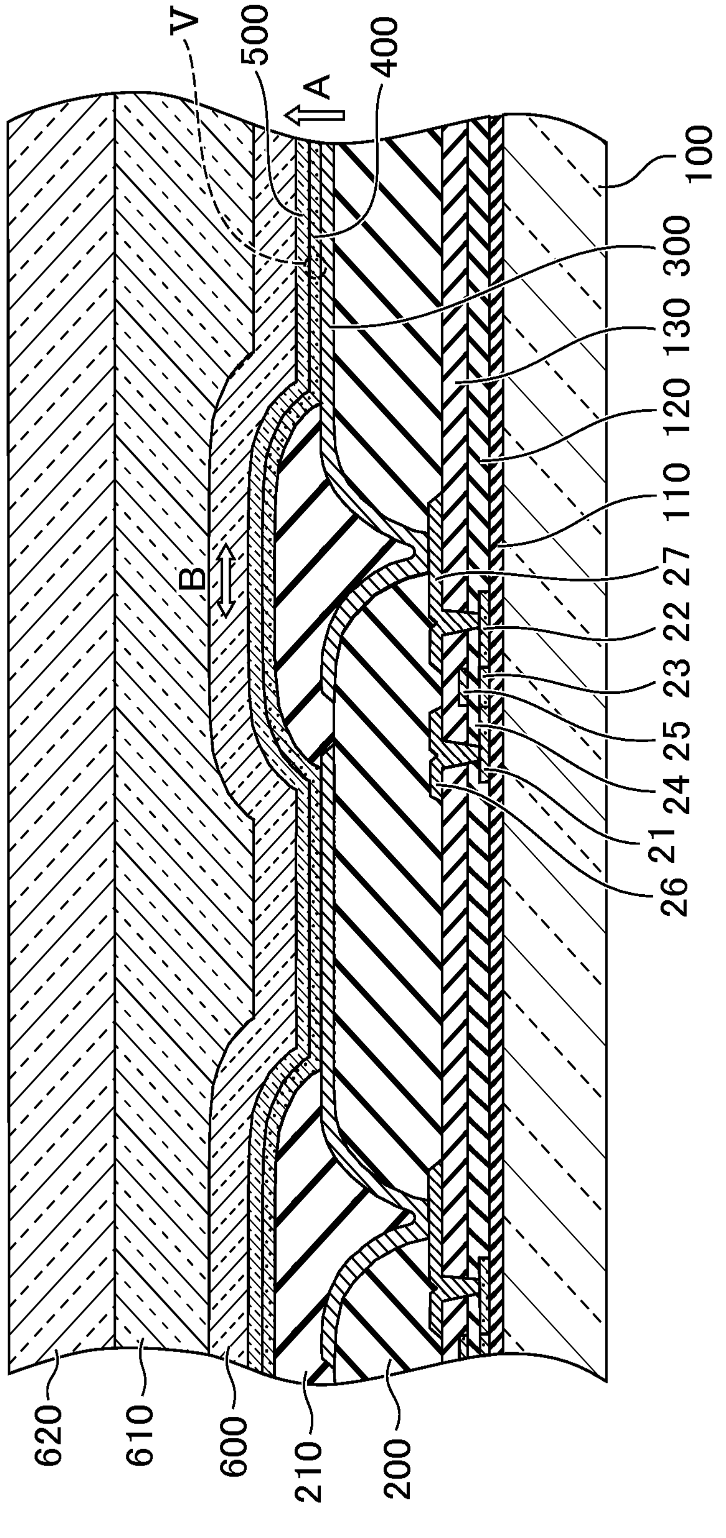

V
500
A
400
100
300
130
120
110
27
22
23
25
24
21
26
B
620
610
600
210
200

FIG.5

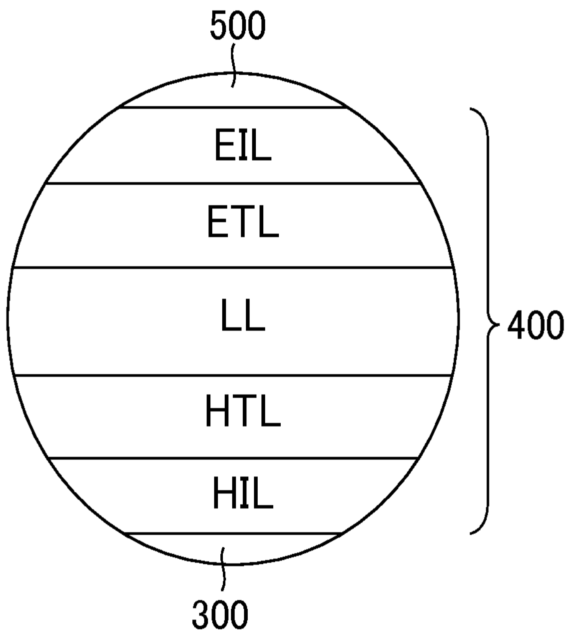


FIG.6

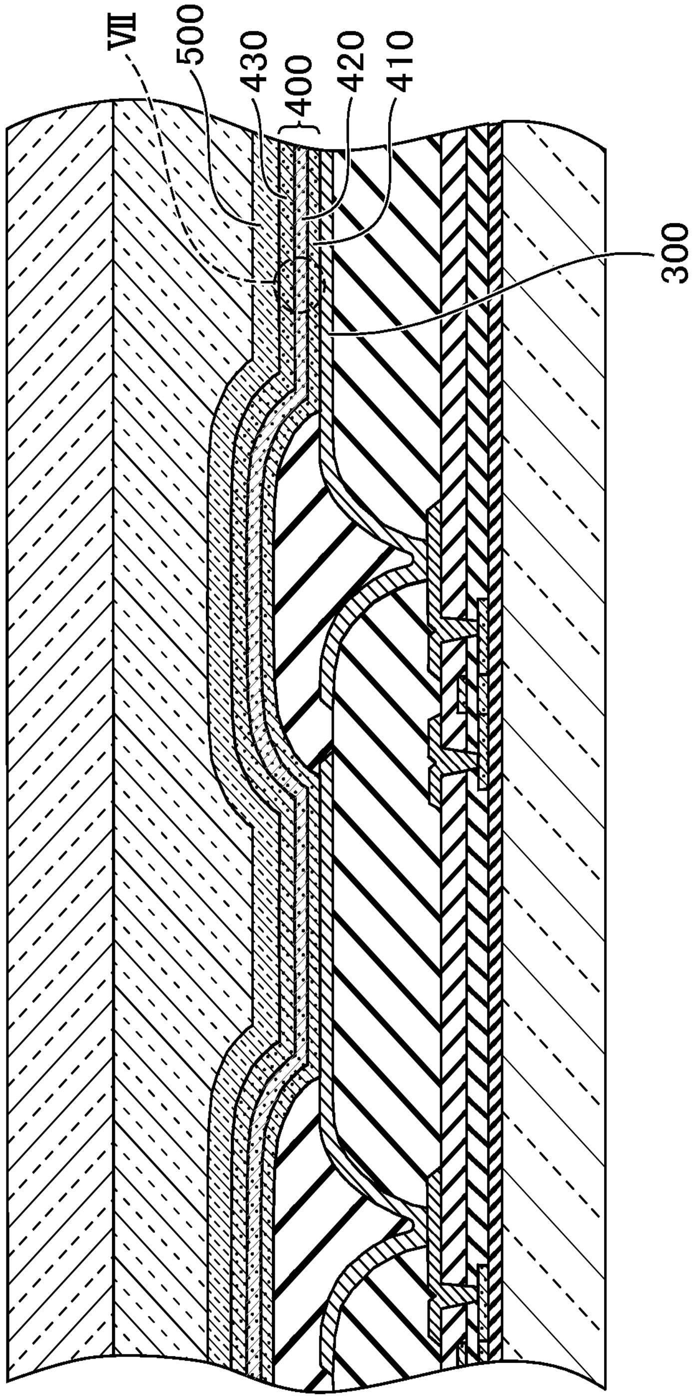


FIG.7

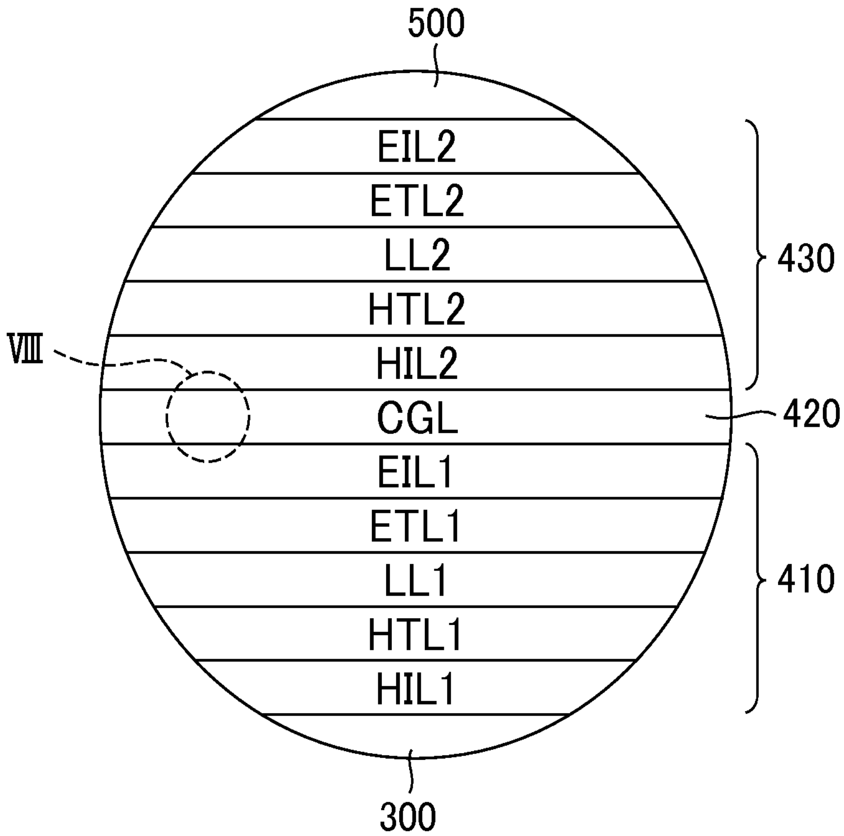
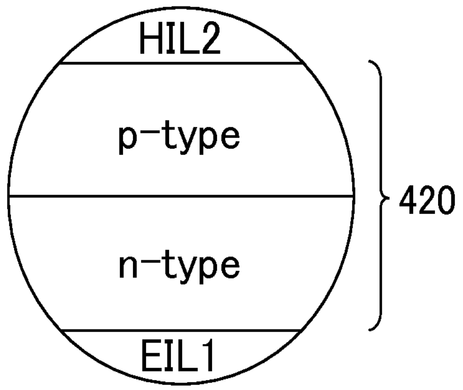

500
EIL2
ETL2
LL2
HTL2
HIL2
430
VIII
CGL
420
EIL1
ETL1
LL1
HTL1
HIL1
410
300

FIG.8



# ORGANIC ELECTRO-LUMINESCENT DISPLAY DEVICE

## CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority from Japanese application JP2014-078983 filed on Apr. 7, 2014, the content of which is hereby incorporated by reference into this application.

## BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an organic electro-luminescent display device.

[0004] 2. Description of the Related Art

[0005] In recent years, an image display device (referred to below as an "organic electro-luminescent display device") has been practically applied which uses a self-luminous element referred to as an organic light emitting diode (OLED). Since the organic electro-luminescent display device uses a self-luminous element, compared with liquid crystal display apparatuses in the related art, not only are visibility and response speed superior, but it is also possible to further reduce the thickness since an auxiliary illumination device such as a back light is not necessary.

[0006] Pixels of the organic electro-luminescent display device contain organic light-emitting diodes, and the organic light-emitting diodes have a configuration where positive electrodes and negative electrodes interpose an organic layer which includes a luminous layer. Here, there are cases where the organic layer is formed spanning a plurality of the pixels of the organic electro-luminescent display device. In that case, adjacent pixels are divided into banks by being formed with an insulation material, and each pixel selectively emits light by each pixel being formed with at least one of a positive electrode or a negative electrode.

[0007] JP 2005-267990 A describes an organic light-emitting element which has a single-color light-emitting unit and a multi-color light-emitting unit which are interposed by an upper electrode and a lower electrode, and a charge-generating layer which is interposed by a plurality of light-emitting units, where the light-emission efficiency of the single-color light-emitting unit is equal to or less than the light-emission efficiency of the multi-color light-emitting unit.

[0008] In addition, JP 2009-520241 A describes an OLED display which is provided with color pixels of four colors, and is provided with driving means which adjusts the luminance of the pixels of each color to set the sum of the peak luminance of pixels determined to be in the color region so as to be smaller than the display peak luminance.

## SUMMARY OF THE INVENTION

[0009] In the case where the organic layer is formed spanning a plurality of pixels, when current flows to the organic light-emitting diode in order to cause a certain pixel to emit light, there are cases where the current flows out to adjacent pixels along the organic layer causing unintentional light emission to the adjacent pixels.

[0010] Therefore, an advantage of some aspects of the invention is to provide an organic electro-luminescent display device which suppresses unintentional light emission to pixels even in a case where the organic layer is formed spanning a plurality of pixels.

[0011] An organic electro-luminescent display device of the invention is characterized in being provided with a substrate which is formed from an insulation material, a plurality of pixels which are arranged in a matrix shape in a display region of the substrate, and an organic layer which is formed spanning an adjacent pixel out of the plurality of pixels and includes a luminous layer, where the organic layer includes an anisotropic layer with greater electrical conductivity in a perpendicular direction with respect to the substrate than the electrical conductivity in a direction along the substrate.

[0012] In addition, in the organic electro-luminescent display device of the invention, the anisotropic layer may be one or a plurality of layers which are included in the organic layer out of an electron injection layer, an electron transfer layer, a hole transfer layer, and a hole injection layer.

[0013] In addition, in the organic electro-luminescent display device of the invention, the anisotropic layer may be a p-type organic semiconductor layer, and may be one or a plurality of layers out of the hole transfer layer and the hole injection layer.

[0014] In addition, in the organic electro-luminescent display device of the invention, the anisotropic layer may be an n-type organic semiconductor layer, or may be one or a plurality of layers out of the electron injection layer and the electron transfer layer.

[0015] In addition, in the organic electro-luminescent display device of the invention, the organic layer includes a plurality of luminous layers and a charge-generating layer, and the plurality of luminous layers are arranged so as to interpose the charge-generating layer, and the anisotropic layer may be one or a plurality of layers out of the layers which are included in the organic layer.

[0016] In addition, in the organic electro-luminescent display device of the invention, the charge-generating layer is formed by layering a p-type organic semiconductor layer and an n-type organic semiconductor layer, and the anisotropic layer may be at least one of the p-type organic semiconductor layer and the n-type organic semiconductor layer.

[0017] In addition, in the organic electro-luminescent display device of the invention, the anisotropic layer may include at least one of bis-(1,2,5-thiadiazole)-p-quinone bis (1,3-dithiol), a perylene tetracarboxylic diimide compound, perylene-3,4,9,10-tetracarboxylic dianhydride, and hexaazatrinaphthylene.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. **1** is a perspective diagram of an organic electro-luminescent display device according to a first embodiment of the invention.

[0019] FIG. **2** is a wiring diagram of an organic electro-luminescent panel according to the first embodiment of the invention.

[0020] FIG. **3** is a circuit diagram of the organic electro-luminescent panel according to the first embodiment of the invention.

[0021] FIG. **4** is a cross sectional diagram of a pixel portion of the organic electro-luminescent panel according to the first embodiment of the invention.

[0022] FIG. **5** is an enlarged view of an organic layer in the first embodiment of the invention.

[0023] FIG. **6** is a cross sectional diagram of a pixel portion of an organic electro-luminescent panel according to a second embodiment of the invention.

**[0024]** FIG. **7** is an enlarged view of an organic layer in the second embodiment of the invention.

**[0025]** FIG. **8** is an enlarged view of a charge-generating layer in the second embodiment of the invention.

## DETAILED DESCRIPTION OF THE INVENTION

**[0026]** Each embodiment of the invention will be described below with reference to the drawings. Here, the disclosure is merely an example, and naturally any embodiment which can be easily conceived of by a person skilled in the art by appropriately modifying maintaining the gist of the invention is included within the scope of the invention. In addition, in order to make the explanation clearer, there are cases where width, thickness, form, or the like of the drawings is represented schematically compared to the actual aspect, but is merely an example and does not limit the interpretation of the invention. In addition, in the specification and each of the drawings, the same reference numerals are given for the same components as prior described in relation to the previously mentioned drawings, and detailed description is omitted as appropriate.

### First Embodiment

**[0027]** FIG. **1** is a perspective diagram illustrating an organic electro-luminescent display device **1** according to a first embodiment of the invention. The organic electro-luminescent display device **1** is configured from an upper frame **2**, a lower frame **3**, and an organic electro-luminescent panel **10** which is fixed so as to be interposed by the upper frame **2** and the lower frame **3**. Here, according to necessity, the organic electro-luminescent display device may be configured by a single organic electro-luminescent panel without the upper frame **2** and the lower frame **3**.

**[0028]** FIG. **2** is a wiring diagram of the organic electro-luminescent panel **10** according to the first embodiment of the invention. The organic electro-luminescent panel **10** controls each of the pixels in a display region **11** on a substrate **100** which is formed from an insulation material such as glass using a data driving circuit **12** and a scanning driving circuit **13**, and displays an image. Here, the data driving circuit **12** is an integrated circuit (IC) which generates and transmits a data signal which is sent to each pixel, and the scanning driving circuit **13** is an IC which generates and transmits a gate signal to a thin film transistor (TFT) which is provided on the pixel. Here, in FIG. **2** the data driving circuit **12** and the scanning driving circuit **13** are described as being formed in two locations, but may be built-in to one IC, and may be formed using a circuit which is directly wired onto the substrate.

**[0029]** A scanning line **14** which conveys a signal from the scanning driving circuit **13** is connected to a gate electrode of a switch transistor **30** as shown in the following drawing. In addition, a data line **15** which conveys a signal from the data driving circuit **12** is connected to a source or a drain electrode of the switch transistor **30**. In a potential wiring **16**, a potential for emitting light to an organic light-emitting diode **60** is imparted and a source or a drain electrode of a driver transistor **20** is connected. A first potential supply wiring **17** and a second potential supply wiring **18** are connected to a potential supply source and are connected to the potential wiring **16** via a transistor.

**[0030]** FIG. **3** is a circuit diagram of the organic electro-luminescent panel **10** according to the first embodiment of the invention. In the display region **11** of the organic electro-luminescent panel **10**, n data lines **15** are formed from D**1** to Dn and m scanning lines **14** are formed from G**1** to Gm. A plurality of pixels PX are arranged in a matrix shape in the extension direction of the scanning lines **14** and the extension direction of the data lines **15**. For example, the pixel PX is formed in a portion which is enclosed by G**1**, G**2**, D**1**, and D**2**.

**[0031]** The first scanning line G**1** is connected to a gate electrode of the switch transistor **30**, and when a signal from the scanning driving circuit **13** is applied, the switch transistor **30** is switched to the on state. Therefore, when a signal from the data driving circuit **12** is applied to the first data line D**1**, charge is accumulated in a storage capacitor **40**, a voltage is applied to the gate electrode of the driver transistor **20**, and the driver transistor **20** is switched to the on state. Here, even if the switch transistor **30** is in the off state, the driver transistor **20** is in the on state for a certain period due to the charge which accumulates in the storage capacitor **40**. A positive electrode of the organic light-emitting diode **60** is connected to the potential wiring **16** through a source or drain of the driver transistor **20**, and since a negative electrode of the organic light-emitting diode **60** is fixed at a reference potential Vc, current flows to the organic light-emitting diode **60** according to the gate voltage of the driver transistor **20**, and the organic light-emitting diode **60** emits light. In addition, an additional capacitor **50** is formed between the positive electrode and the negative electrode of the organic light-emitting diode **60**. The additional capacitor **50** exhibits an effect where voltage which is written to the storage capacitor **40** is stable and contributes to the stable operation of the organic light-emitting diode **60**.

**[0032]** Here, the wiring diagram of FIG. **2** and the circuit diagram of FIG. **3** are examples, and other wiring and circuit configurations may be adopted.

**[0033]** FIG. **4** is a cross sectional diagram of a pixel portion of the organic electro-luminescent panel **10** according to the first embodiment of the invention. FIG. **4** shows a connection state of the driver transistor **20** and the organic light-emitting diode **60** in two adjacent pixels. A panel substrate **100** made from glass or the like is arranged on the lowermost layer, on top of that a first base film **110** made from SiNx or the like is formed, and on top of that a second base film **120** made from SiOx or the like is formed. On top of the second base film **120** a drain electrode layer **21**, a source electrode layer **22**, and a channel layer **23** of the driver transistor **20** are formed. Then, after a gate insulation film **24** is formed so as to cover the drain electrode layer **21**, the source electrode layer **22**, the channel layer **23**, and the second base film **120**, a gate electrode layer **25** is formed on top of the channel layer **23**. Here, in the present embodiment, layers consisting of the drain electrode layer **21**, the source electrode layer **22**, and the channel layer **23** are formed with polycrystalline silicon. Here, the channel layer **23** may be formed with amorphous silicon or the like.

**[0034]** A first inter-layer insulation film **130** is layered so as to cover the gate electrode layer **25** and the gate insulation film **24**, and through holes are formed which respectively reach the drain electrode layer **21** and the source electrode layer **22**. A drain electrode **26** and a source electrode **27** are formed in the respective through holes, and a second inter-layer insulation film **200** is layered so as to cover the drain electrode **26**, the source electrode **27**, and the first inter-layer insulation film **130**. In the second inter-layer insulation film **200**, a through hole is formed which reaches the source electrode **27** of the driver transistor **20** which controls each of the pixels. After this, a lower electrode **300** is formed from a conductive material such as a metal material so as to cover the second inter-layer insulation film **200** where a through hole is provided and to be electrically connected to the source electrode **27** at the bottom of the through hole. The lower electrode **300** is formed in each of the pixels and the lower electrode **300** of the adjacent pixels is electrically insulated.

**[0035]** A pixel separation film **210** (bank) is formed using an insulation material on the lower electrode **300** and an organic layer **400** is formed on the pixel separation film **210** and the lower electrode **300**. The organic layer **400** is formed spanning the adjacent pixels and includes at least a luminous layer. Here, a region where the lower electrode **300** and the organic layer **400** come into contact is a light-emitting region, and the pixel separation film **210** defines an outer edge of the light-emitting region. Here, the organic layer **400** may be formed on each different color pixel or formed spanning adjacent same color pixels. An upper electrode **500** is formed spanning adjacent pixels using a transparent electrode such as indium tin oxide (ITO), indium zinc oxide (IZO), and zinc oxide (ZnO) on the organic layer **400**. The upper electrode **500** may be formed spanning all of the pixels PX which are arranged in a matrix shape.

**[0036]** According to necessity, a transparent sealing layer **600** is formed on the upper electrode **500**. The sealing layer **600** is desirable in order to prevent infiltration of water and air into the organic layer **400**, and is desirably formed from a material with high gas barrier characteristics. In detail, the sealing layer **600** may be formed using a dense inorganic material such as SiN, or a layered film of inorganic material and organic material. Furthermore, a transparent sealing member **620** is arranged with respect to visible light above the sealing layer **600**, and closes and seals a frame portion of the organic electro-luminescent panel **10** using a sealing material. It is desirable for the sealing member **620** to also be a member with high gas barrier characteristics. In detail, it is possible to use a glass substrate or a plastic substrate where a process is executed for high gas barrier characteristics. A filler **610** made from a resin material or an inert gas such as nitrogen may seal a gap between the sealing member **620** and the sealing layer **600**, and the filler **610** may be a transparent substance through which it is difficult to release water which leads to deterioration of the organic layer **400**.

**[0037]** In the organic electro-luminescent display device **1** according to the present embodiment, a material where white light emission is obtained is adopted as the organic layer **400**, sub-pixels of three source colors are realized by arranging color filters which correspond to the three source colors (red, green, and blue) on the sealing member **620**, and full color display is performed. Here, the color filter may be provided in a region which superimposes the light-emitting region of the pixel, and a black matrix may be provided outside of that region. In addition, sub-pixels of white other than red, green, and blue may be provided.

**[0038]** As described above, in the organic electro-luminescent display device **1**, the switch transistor **30** is switched on by a scanning signal and a data signal is sent, and pixels are caused to selectively emit light by switching the driver transistor **20** on. Here, for example, when the driver transistor **20** of the pixel on the right side in FIG. **4** is set to the on state, the lower electrode **300** on the right side is connected to the first potential supply wiring **17** and the second potential supply wiring **18**, and a potential difference (a voltage) is generated between the lower electrode **300** and the upper electrode **500** which is maintained at the reference potential Vc. As a result, holes are injected from the side of the lower electrode **300** which is a positive electrode to the organic layer **400**, and electrons are injected from the side of the upper electrode **500** which is a negative electrode to the organic layer **400**. The electrons and holes which are injected reach the luminous layer of the respective organic layers **400**, recombination of the electrons and holes occurs, and light with a predetermined wavelength is generated. The light which is generated in the luminous layer is released to the upper electrode **500** side, passes through the color filters, and then is visually recognized by a user.

**[0039]** Here, as shown in FIG. **4**, in a case where the organic layer **400** spans adjacent pixels, there is a concern that not only does current flow in the direction perpendicular to the substrate **100** (the direction of the arrow A), but current also flows in the direction along the substrate **100** (the direction of the arrow B). When current flows in the direction B along the organic layer **400**, current flows to the luminous layer of the adjacent pixels, and unintentional light emission to the adjacent pixels is caused. In the case of the above example, regardless of the lower electrode **300** at the right side in FIG. **4** being selected, there is a concern that light is emitted to the pixels at the left side along with the pixels at the right side.

**[0040]** In the present embodiment, out of the layers which are included in the organic layer **400**, unintentional light emission to the adjacent pixels of all the layers or some of the layers is suppressed by forming an anisotropic layer which has anisotropy with electrical conductivity. The anisotropic layer is a layer with greater electrical conductivity in the A direction which is perpendicular with respect to the substrate **100** than the electrical conductivity in the B direction which is along the substrate **100**. In other words, the anisotropic layer is a layer with greater electrical conductivity in the layering direction of the layer than the electrical conductivity in the extension direction of the layer.

**[0041]** FIG. **5** is an enlarged view of the organic layer **400** in the first embodiment of the invention. FIG. **5** is an enlarged view of a portion of a circle V which is drawn with a dotted line in FIG. **4**. The organic layer **400** has a structure where a hole injection layer (HIL), a hole transfer layer (HTL), a luminous layer (LL), an electron transfer layer (ETL), and an electron injection layer (EIL) are layered from the lower electrode **300** side in that order. Here, the hole injection layer (HIL) and the hole transfer layer (HTL) are formed with a p-type organic semiconductor, and the electron injection layer (EIL) and the electron transfer layer (ETL) are formed with an n-type organic semiconductor. The luminous layer (LL) is made up of a guest molecule which is a luminous molecule and a host molecule which holds the guest molecule. Here, the guest molecule is selected so as to obtain a desired luminous color. The host molecule may be formed with either the p-type organic semiconductor or the n-type organic semiconductor.

**[0042]** In the present embodiment, all of or some of the layers out of the hole injection layer (HIL), the hole transfer layer (HTL), the luminous layer (LL), the electron transfer layer (ETL), and the electron injection layer (EIL) may be anisotropic layers. For example, in a case where the electron injection layer (EIL) is an anisotropic layer, movement of the electrons which relates to the extension direction B of the electron injection layer (EIL) is suppressed more than movement of the electrons which relates to the layering direction A of the electron injection layer (EIL), electrons are suppressed from flowing out to adjacent pixels, and unintentional light emission is suppressed. Naturally, the layers which configure the organic layer **400** other than the electron injection layer (EIL) may be anisotropic layers. In addition, the effect where unintentional light emission of adjacent pixels is suppressed is exhibited best in a case where all of the layers which configure the organic layer **400** are anisotropic layers.

**[0043]** In a case where the hole injection layer (HIL) and the hole transfer layer (HTL) are anisotropic layers, it is preferable to use a p-type organic semiconductor layer which has anisotropy with electrical conductivity. Bis-(1,2,5-thiadiazole)-p-quinone bis(1,3-dithiol) (referred to below as BTQBT) is given as an example of the p-type organic semiconductor layer. In addition, either of a perylene tetracarboxylic diimide compound (referred to below as PTCDI) or hexaazatrinaphthylene (referred to below as HATNA) may be used. In a case where the hole injection layer (HIL) is an anisotropic layer, it is preferable to adopt a material with a value close to the work function of the lower electrode **300**.

**[0044]** In a case where the electron transfer layer (ETL) and the electron injection layer (EIL) are anisotropic layers, it is preferable to use an n-type organic semiconductor which has anisotropy with electrical conductivity. In detail, it is preferable to use perylene-3,4,9,10-tetracarboxylic dianhydride (referred to below as PTCDA), or PTCDI. In addition, HATNA may be used.

**[0045]** In a case where the luminous layer (LL) is an anisotropic layer, it is possible to use any one of BTQBT, PTCDI, HATNA, and PTCDA as the host molecule.

**[0046]** There are cases where the material which forms the anisotropic layer has a planar portion with respect to the molecule structure. In that case, anisotropy with electrical conductivity is realized by aligning the planar portion parallel to the substrate **100**. That is, due to n electrons being distributed in a direction which is orthogonal to the planar portion of the molecule structure, the direction perpendicular to the substrate **100** has relatively high electrical conductivity where n orbital overlap is high and the direction along the substrate **100** has relatively low electrical conductivity where n orbital overlap is low.

**[0047]** Here, it is possible to use a material which has anisotropy with electrical conductivity other than the examples above as the material which forms the anisotropic layer.

Second Embodiment

**[0048]** FIG. **6** is a cross sectional diagram of the pixel portion of the organic electro-luminescent panel **10** according to the second embodiment of the invention. The organic electro-luminescent panel **10** according to the second embodiment is different compared to the organic electro-luminescent panel **10** according to the first embodiment in the configuration of the organic layer **400**, and is the same in the other configuration. The organic layer **400** in the second embodiment of the invention has a configuration where a first organic layer **410**, a charge-generating layer **420**, and a second organic layer **430** are layered. The organic light-emitting diode **60** according to the present embodiment is a so-called tandem-type organic light-emitting diode **60**, the first organic layer **410** and the second organic layer **430** each include a luminous layer, and the charge-generating layer **420** is arranged so as to be interposed by two luminous layers. Here, the two luminous layers may have luminous colors which are each different.

**[0049]** In the present embodiment, unintentional light emission to adjacent pixels is suppressed by a layer which includes any one of the first organic layer **410**, the charge-generating layer **420**, and the second organic layer **430** forming the anisotropic layer which has anisotropy with electrical conductivity. The anisotropic layer is preferably formed with the aforementioned materials, and is a layer with greater electrical conductivity in the direction which is perpendicular with respect to the substrate **100** than the electrical conductivity in the direction which is along the substrate **100**.

**[0050]** FIG. **7** is an enlarged view of the organic layer **400** in the second embodiment of the invention. FIG. **7** is an enlarged view of a portion of a circle VII which is drawn with a dotted line in FIG. **6**. The organic layer **400** in the present embodiment is formed where a first hole injection layer (HIL**1**), a first hole transfer layer (HTL**1**), a first luminous layer (LL**1**), a first electron transfer layer (ETL**1**), and a first electron injection layer (EIL**1**), a charge-generating layer (CGL), a second hole injection layer (HIL**2**), a second hole transfer layer (HTL**2**), a second luminous layer (LL**2**), a second electron transfer layer (ETL**2**), and a second electron injection layer (EIL**2**) are layered from the lower electrode **300** side in that order. Here, all or some out of these layers may be anisotropic layers.

**[0051]** For example, it is possible to efficiently suppress a carrier along the charge-generating layer (CGL) from flowing out to adjacent pixels by the charge-generating layer (CGL) being an anisotropic layer in a case where electrical conductivity is high compared to another layer which configures the organic layer **400**, and unintentional light emission to adjacent pixels is suppressed. Naturally, unintentional light emission to adjacent pixels is further suppressed by other layers being anisotropic layers while the charge-generating layer (CGL) is an anisotropic layer.

**[0052]** In detail, in a case where any of the first hole injection layer (HIL**1**), the first hole transfer layer (HTL**1**), the second hole injection layer (HIL**2**), and the second hole transfer layer (HTL**2**) is an anisotropic layer, it is preferable to use any one or a combination of BTQBT, PTCDI, and HATNA.

**[0053]** In addition, in a case where any of the first electron transfer layer (ETL**1**), the first electron injection layer (EIL**1**), the second electron transfer layer (ETL**2**), and the second electron injection layer (EIL**2**) is an anisotropic layer, it is preferable to use PTCDA.

**[0054]** In a case where either of the first luminous layer (LL**1**) and the second luminous layer (LL**2**) is an anisotropic layer, it is possible to use BTQBT, PTCDI, HATNA, and PTCDA as the host molecule.

**[0055]** FIG. **8** is an enlarged view of the charge-generating layer **420** in the second embodiment of the invention. FIG. **8** is an enlarged view of a portion of a circle VIII which is drawn with a dotted line in FIG. **7**. The charge-generating layer **420** of the present embodiment is formed where an n-type organic semiconductor layer (n-type) and a p-type organic semiconductor layer (p-type) are layered from the first electron injection layer (EIL**1**) side in that order. Here, the n-type organic semiconductor layer (n-type) supplies electrons to the first electron injection layer (EIL**1**) and the p-type organic semiconductor layer (p-type) supplies holes to the second hole injection layer (HIL**2**).

**[0056]** In a case where the charge-generating layer **420** is an anisotropic layer, the anisotropic layer includes, for example, PTCDA, PTCDI, BTQBT, and HATNA. Particularly in a case where the n-type organic semiconductor layer (n-type) which configures the charge-generating layer **420** is an anisotropic layer, it is preferable, for example, to form the n-type organic semiconductor layer (n-type) using either of PTCDA or PTCDI.

**[0057]** In addition, in a case where the p-type organic semiconductor layer (p-type) which configures the charge-generating layer **420** is an anisotropic layer, it is preferable, for example, to form the p-type organic semiconductor layer (p-type) using BTQBT.

**[0058]** Both the n-type organic semiconductor layer (n-type) and the p-type organic semiconductor layer (p-type) which are included in the charge-generating layer **420** may be anisotropic layers, in that case it is possible to suppress both the electrons and holes from flowing out to the adjacent pixels, and it is possible to more reliably suppress unintentional light emission to the adjacent pixels.

**[0059]** In the present embodiment, a case of the tandem-type organic light-emitting diode **60** which has the first organic layer **410**, the charge-generating layer **420**, and the second organic layer **430** is indicated, but even in a case of the tandem-type organic light-emitting diode **60** which has three or more organic layers and two or more charge-generating layers, it is possible to suppress unintentional light emission to the adjacent pixels by applying the invention. In that case, it is possible to efficiently suppress the carrier from flowing out to adjacent pixels by a plurality of the charge-generating layers where comparative electrical conductivity is high being anisotropic layers.

**[0060]** The entirety of the organic electro-luminescent display device which is obtained by a person skilled in the art executing appropriate design changes based on the organic electro-luminescent display device **1** described above as the embodiment of the invention is limited to being included in the gist of the invention, and belongs in the scope of the invention.

**[0061]** In the category of the concept of the invention, a person skilled in the art could conceive of each type of modification example and correction example, and it is understood that these modification examples and correction examples belong to the scope of the invention. For example, with respect to each of the embodiments described above, a person skilled in the art could add, remove, or perform design changes to configuration elements, add or omit processes, or perform modifications of conditions limited to providing the gist of the invention and included in the scope of the invention.

**[0062]** In addition, the invention in the present embodiment is obvious from the description in the other actions and effects which are produced by the aspects described above or it is understood that a person skilled in the art could appropriately conceive of actions and effects naturally produced by the invention.

**[0063]** While there have been described what are at present considered to be certain embodiments of the invention, it will be understood that various modifications may be made thereto, and it is intended that the appended claims cover all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

**1**. An organic electro-luminescent display device comprising:

a substrate which is formed from an insulation material;

a plurality of pixels which are arranged in a matrix shape in a display region of the substrate; and

an organic layer which is formed spanning an adjacent pixel out of the plurality of pixels and includes a luminous layer,

wherein the organic layer includes an anisotropic layer with greater electrical conductivity in a perpendicular direction with respect to the substrate than the electrical conductivity in a direction along the substrate.

**2**. The organic electro-luminescent display device according to claim **1**,

wherein the anisotropic layer is one or a plurality of layers which are included in the organic layer out of an electron injection layer, an electron transfer layer, a hole transfer layer, and a hole injection layer.

**3**. The organic electro-luminescent display device according to claim **2**,

wherein the anisotropic layer is a p-type organic semiconductor layer, and is one or a plurality of layers out of the hole transfer layer and the hole injection layer.

**4**. The organic electro-luminescent display device according to claim **2**,

wherein the anisotropic layer is an n-type organic semiconductor layer, and is one or a plurality of layers out of the electron injection layer and the electron transfer layer.

**5**. The organic electro-luminescent display device according to claim **1**,

wherein the organic layer includes a plurality of luminous layers and a charge-generating layer, and the plurality of luminous layers are arranged so as to interpose the charge-generating layer, and the anisotropic layer is one or a plurality of layers out of the layers which are included in the organic layer.

**6**. The organic electro-luminescent display device according to claim **5**,

wherein the charge-generating layer is formed by layering a p-type organic semiconductor layer and an n-type organic semiconductor layer, and the anisotropic layer is at least one of the p-type organic semiconductor layer and the n-type organic semiconductor layer.

**7**. The organic electro-luminescent display device according claim **1**,

wherein the anisotropic layer includes at least one of bis-(1,2,5-thiadiazole)-p-quinone bis(1,3-dithiol), a perylene tetracarboxylic diimide compound, perylene-3,4,9,10-tetracarboxylic dianhydride, and hexaazatrinaphthylene.

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摘要(译)

一种有机电致发光显示装置，其特征在于，具有由绝缘材料形成的基板，在基板的显示区域中以矩阵形状排列的多个像素，以及形成的有机层跨越所述多个像素中的相邻像素包括发光层，其中所述有机层包括各向异性层，所述各向异性层相对于所述基板在垂直方向上具有比沿着所述基板的方向上的导电性更大的导电率。