US 20140335639A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2014/0335639 A1**

(43) **Pub. Date: Nov. 13, 2014**

**Takashige**

(54) **METHOD FOR PRODUCING ORGANIC EL DISPLAY PANEL**

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(21) Appl. No.: **14/362,683**

(22) PCT Filed: **Dec. 14, 2012**

(86) PCT No.: **PCT/JP2012/008029**

§ 371 (c)(1),
(2), (4) Date: **Jun. 4, 2014**

(30) **Foreign Application Priority Data**

Dec. 15, 2011 (JP) ................................ 2011-274414

**Publication Classification**

(51) **Int. Cl.**
***H01L 51/00*** (2006.01)
***H01L 51/50*** (2006.01)

(52) **U.S. Cl.**
CPC ........ ***H01L 51/0004*** (2013.01); ***H01L 51/5036*** (2013.01); *H01L 2227/323* (2013.01)
USPC ........................................................... **438/46**

(57) **ABSTRACT**

A manufacturing method of an organic EL display panel includes: preparing G, R, and B inks that each include a solvent and respectively include G, R, and B organic light-emitting materials differing from each other in terms of light-emitting wavelength; applying the G ink to G subpixel regions on a substrate; applying the R ink to R subpixel regions; and applying the B ink to B subpixel regions. The R and B subpixel regions are each adjacent to a corresponding one of the G subpixel regions on both sides thereof. The G ink has a lower viscosity than the R and B inks. After application of the G ink is started, application of the R and B inks is started.

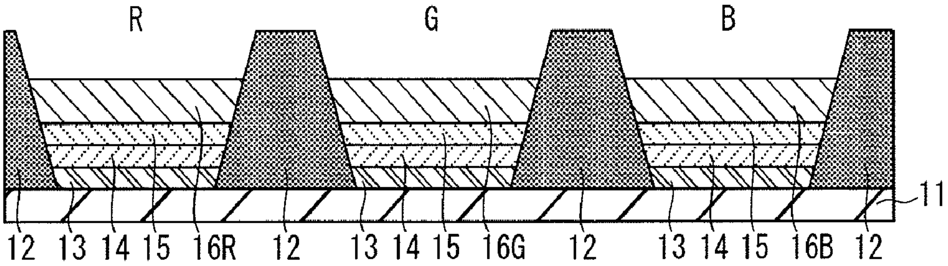


FIG. 1

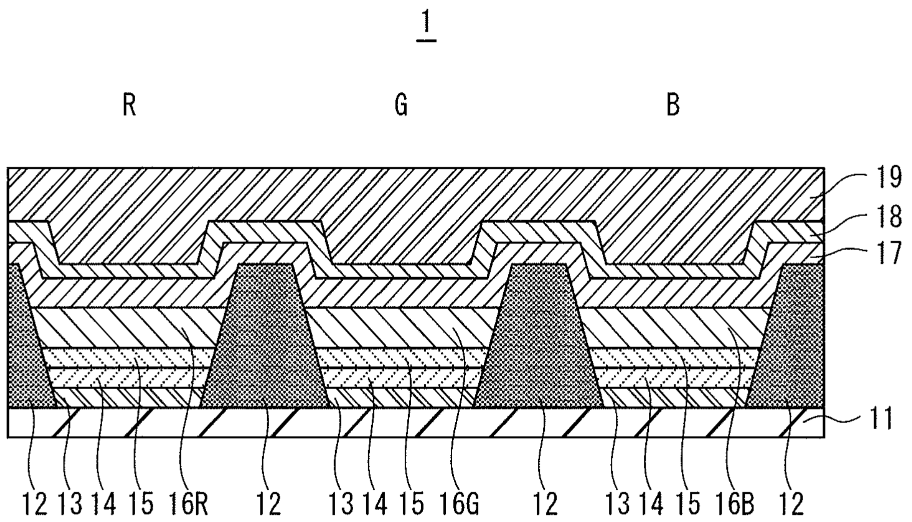


FIG. 2

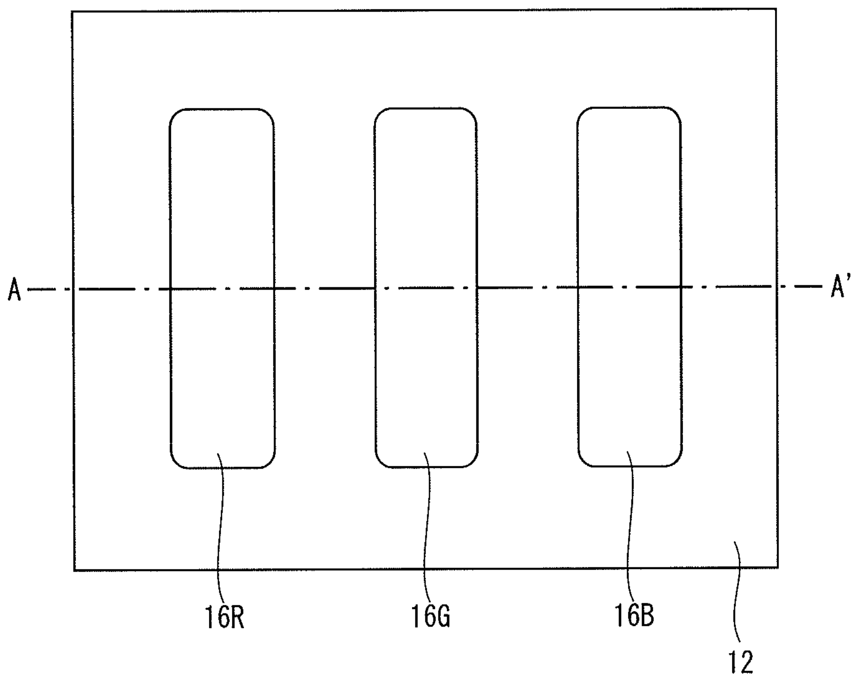


FIG. 3A

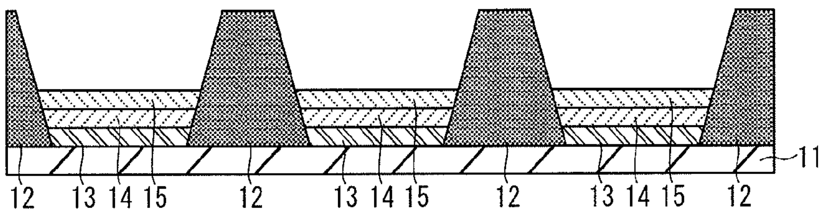



FIG. 3B

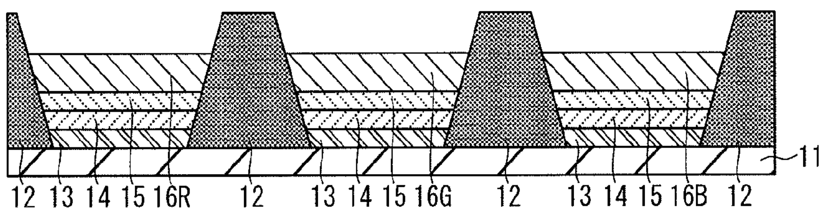



FIG. 3C

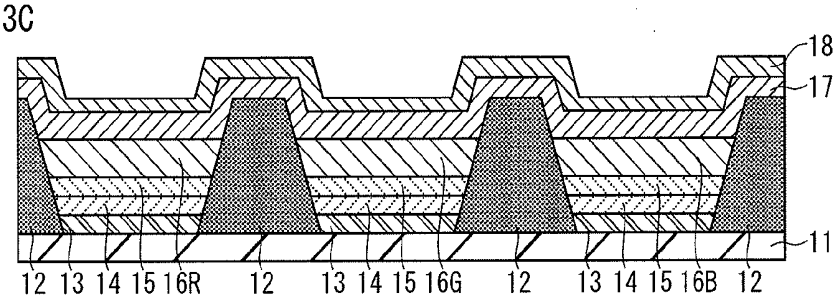



FIG. 3D

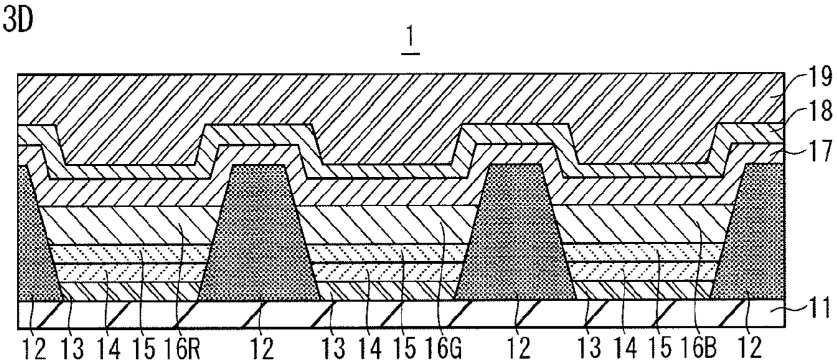


FIG. 4A

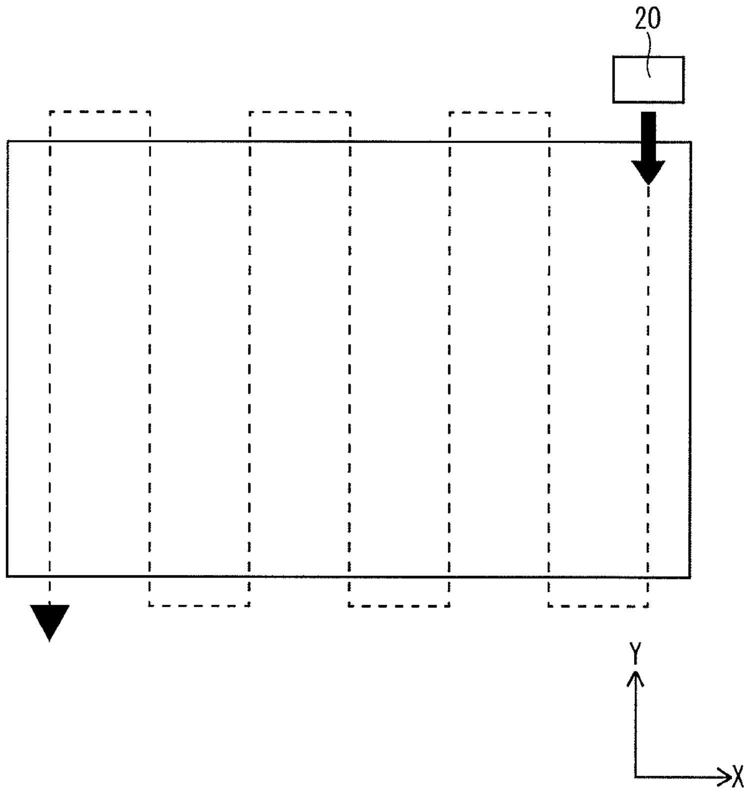



FIG. 4B

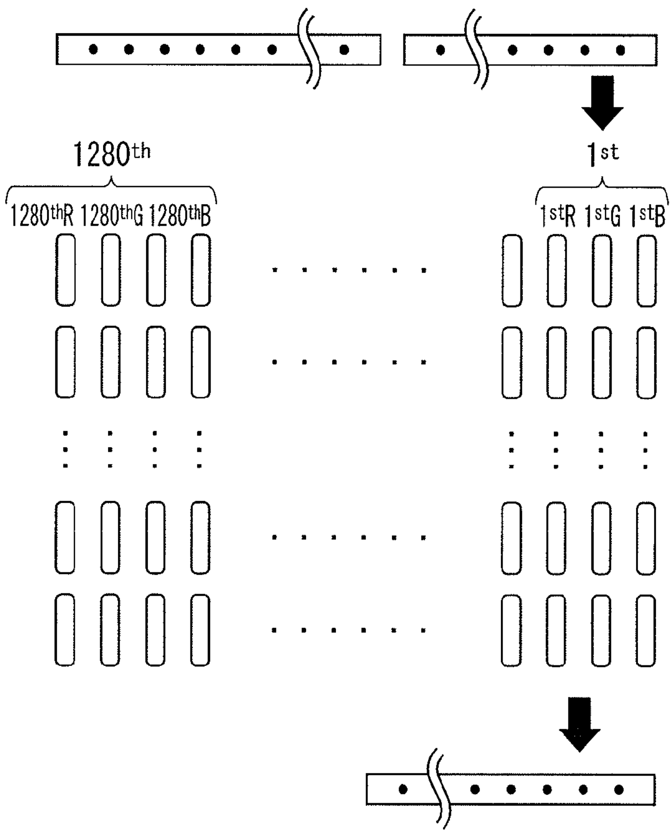


FIG. 5A

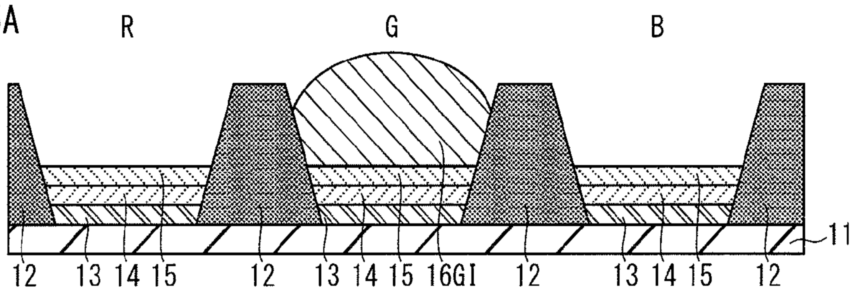



FIG. 5B

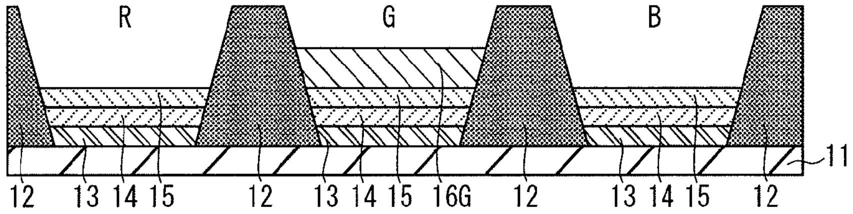



FIG. 5C

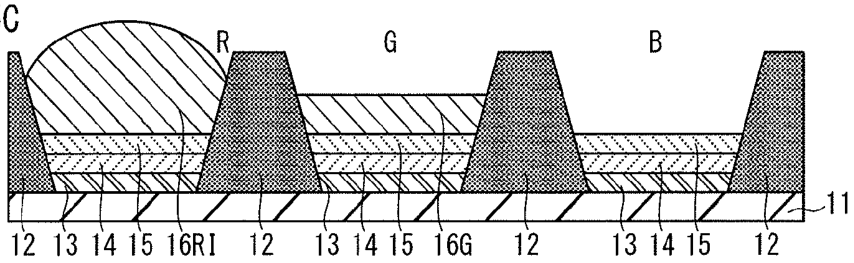



FIG. 5D

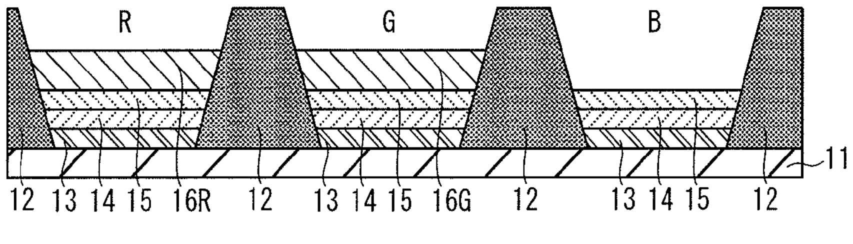



FIG. 5E

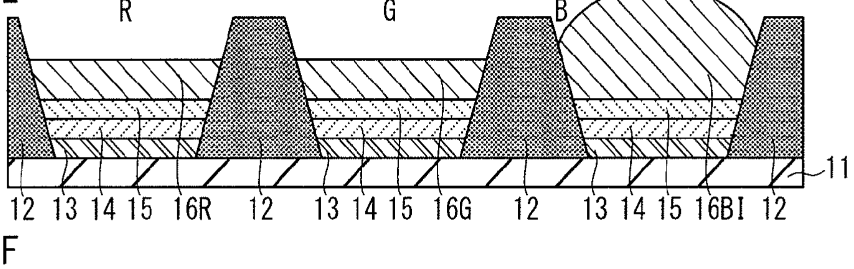



FIG. 5F

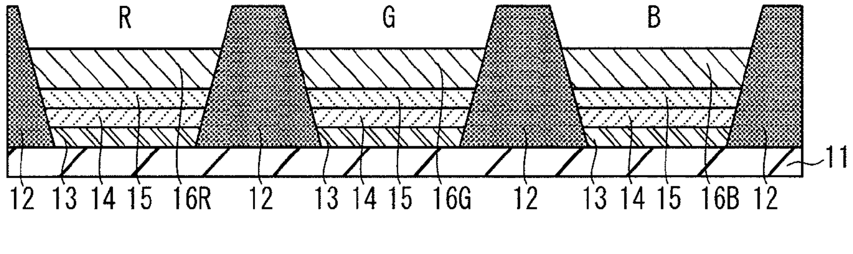


FIG. 6A

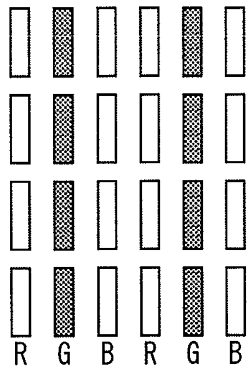



FIG. 6B

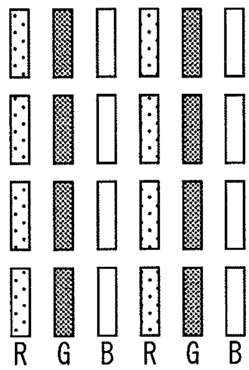



FIG. 6C

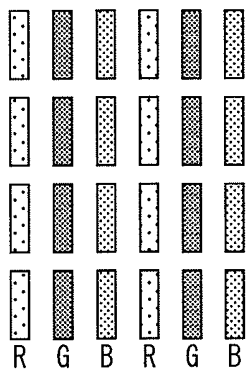


FIG. 7

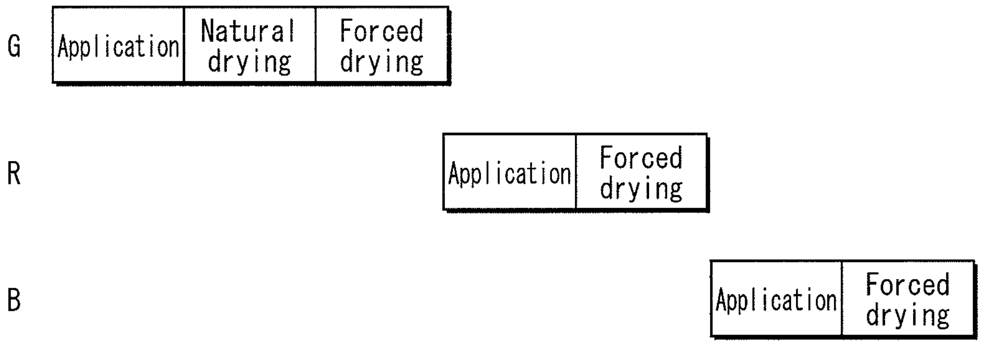

G
Application
Natural drying
Forced drying
R
Application
Forced drying
B
Application
Forced drying

FIG. 8A

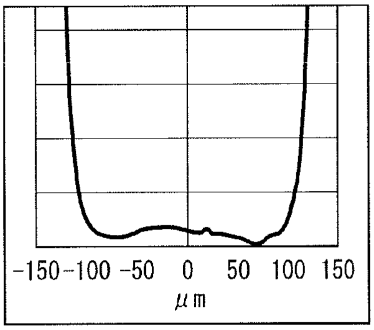



FIG. 8D

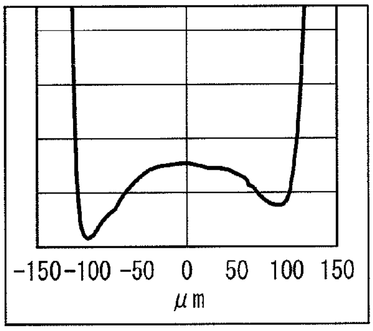



FIG. 8B

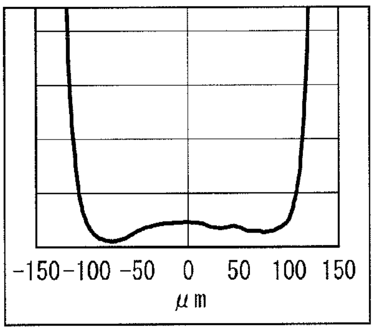



FIG. 8E

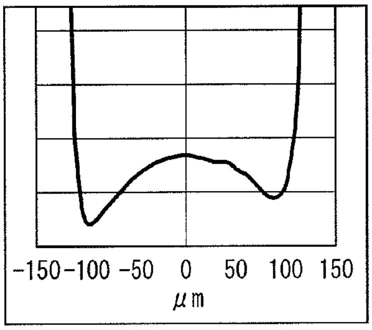



FIG. 8C

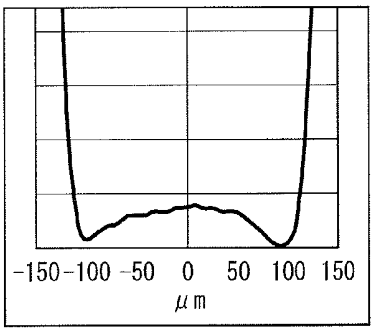



FIG. 8F

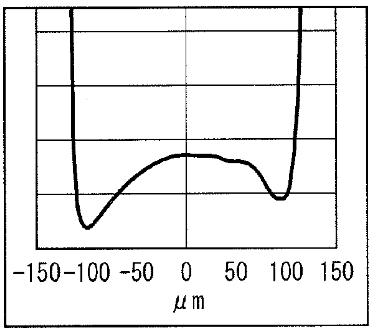


FIG. 9A

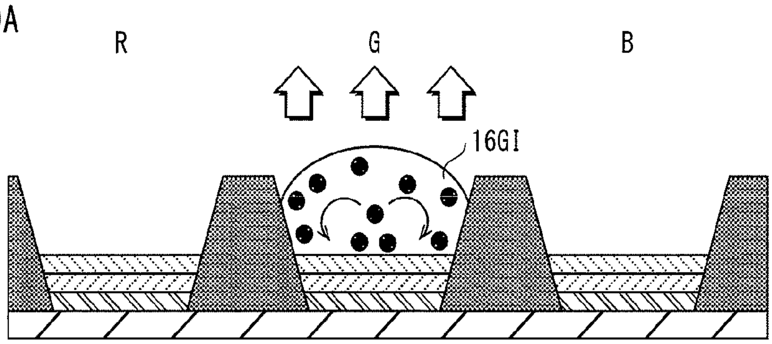



FIG. 9B

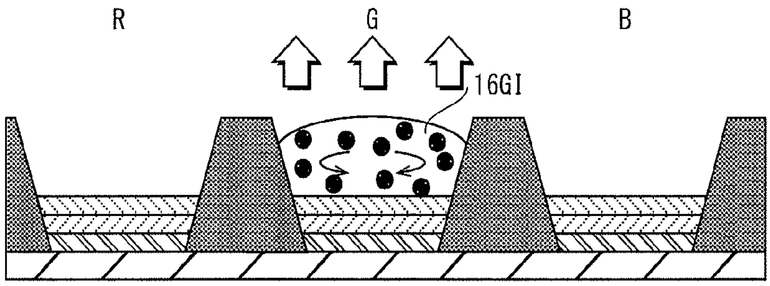



FIG. 9C

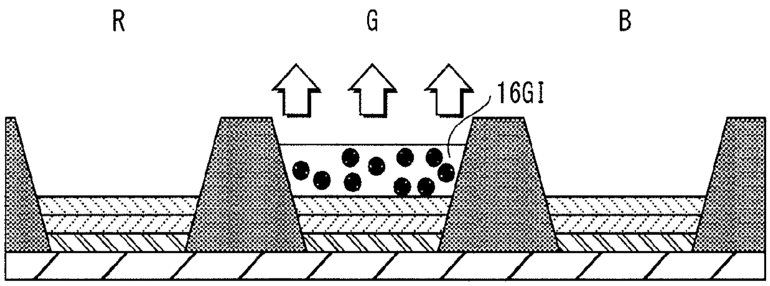



FIG. 9D

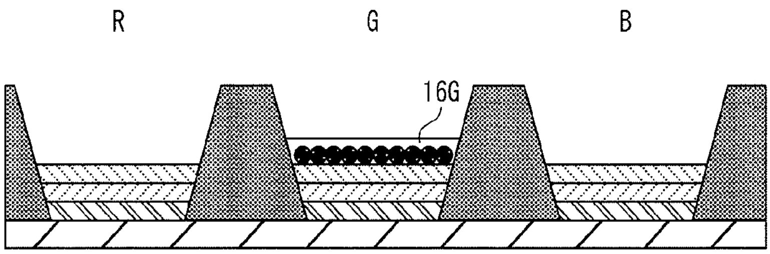


FIG. 10A

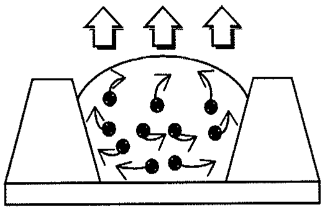


FIG. 10B

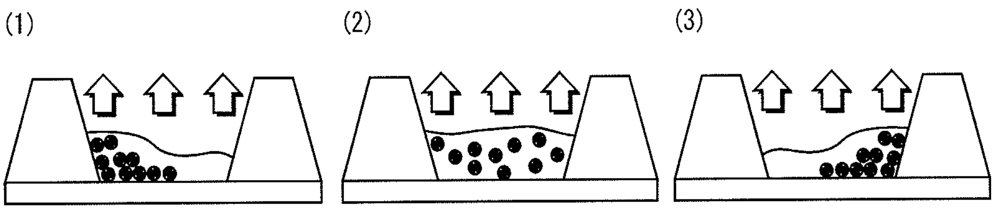



FIG. 10C

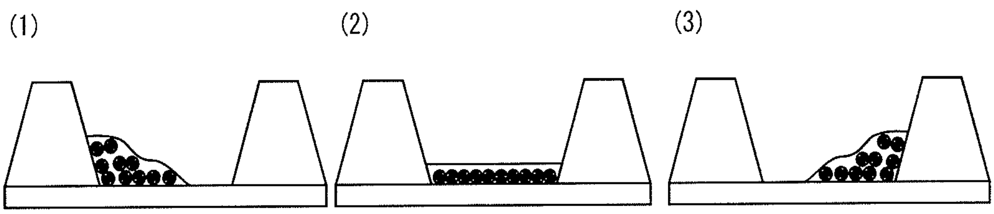


FIG. 11A

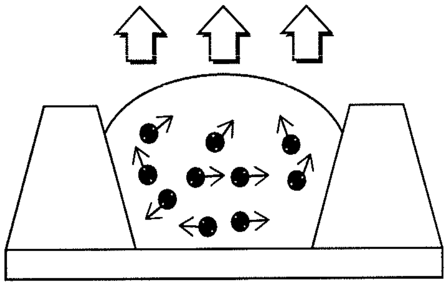


FIG. 11B

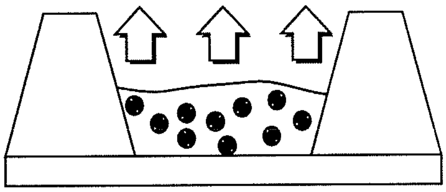


FIG. 11C

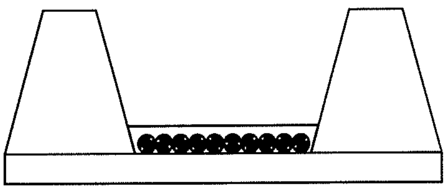


FIG. 12A

FIG. 12B

FIG. 12C

FIG. 12D

FIG. 12E

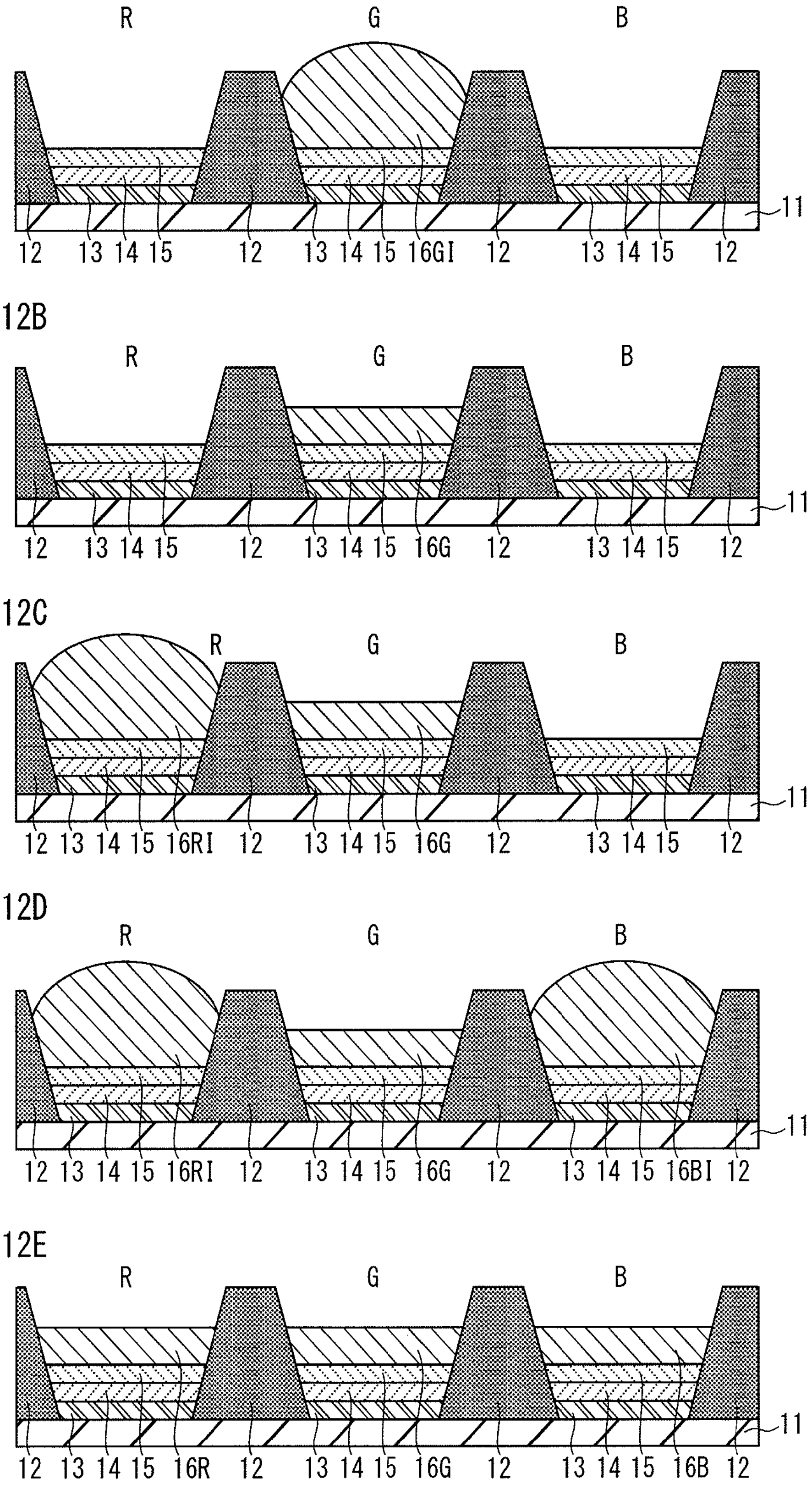


FIG. 13A

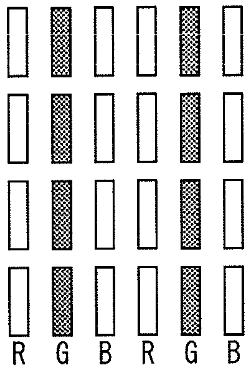



FIG. 13B

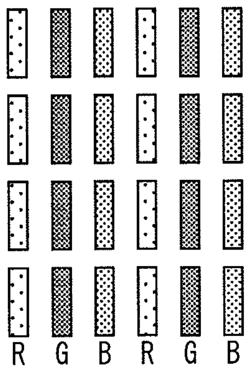


FIG. 14

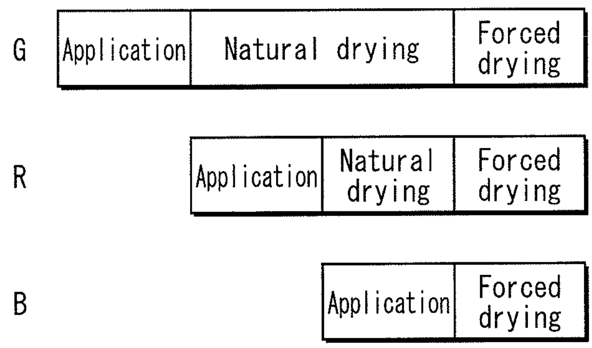

G
Application
Natural drying
Forced drying
R
Application
Natural drying
Forced drying
B
Application
Forced drying

FIG. 15A

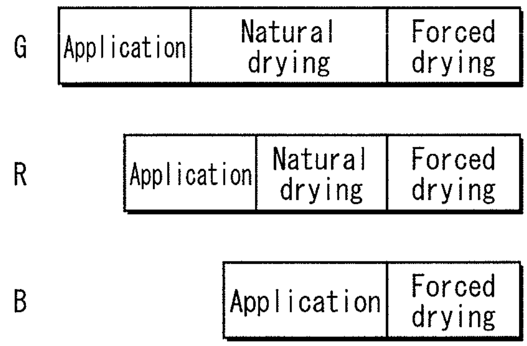



FIG. 15B

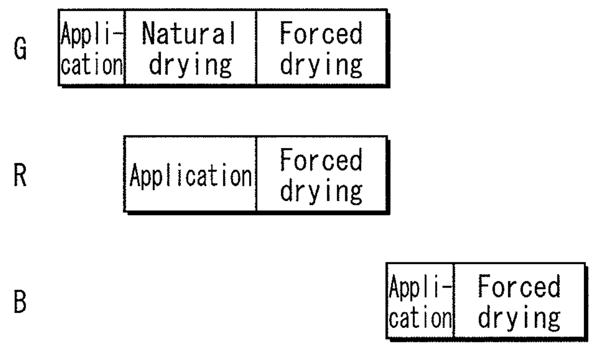


FIG. 16

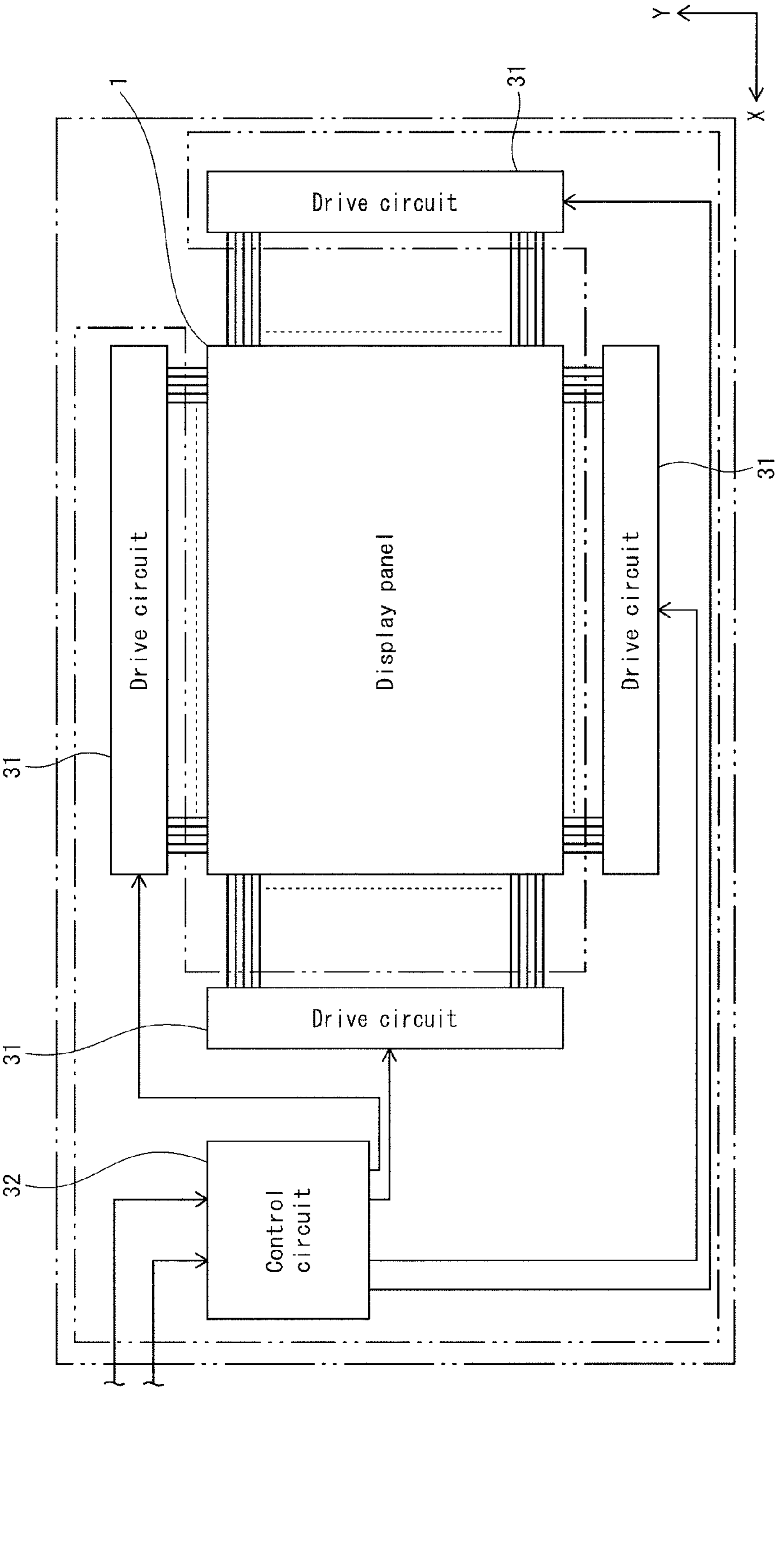
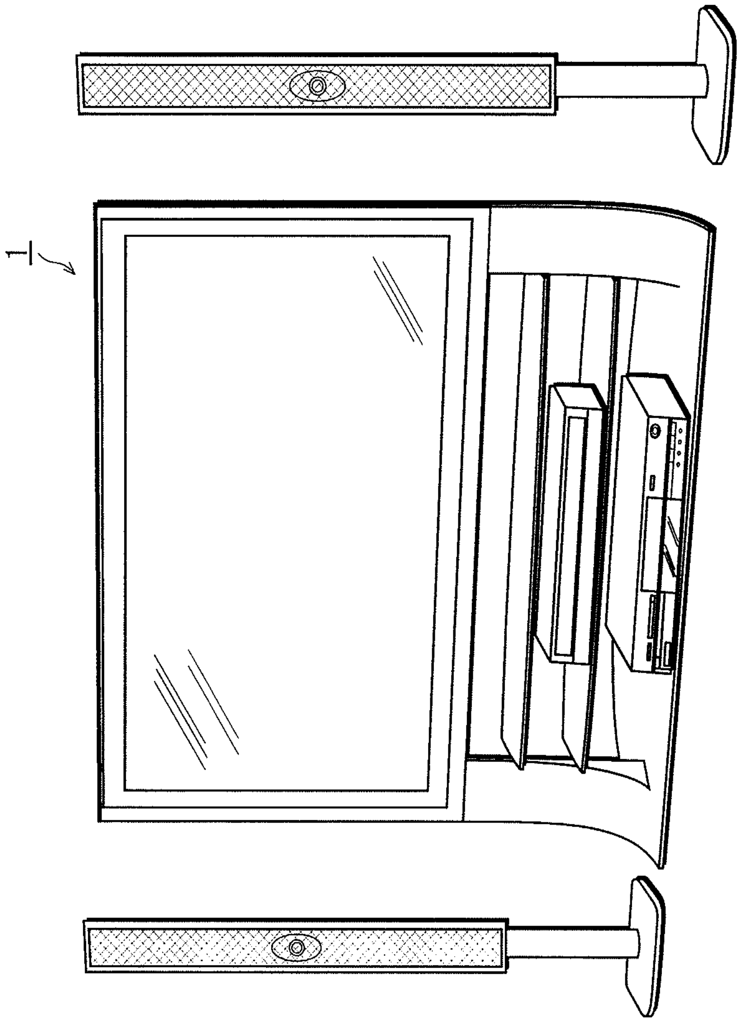

Y
X
1
31
Drive circuit
31
Drive circuit
Display panel
Drive circuit
31
Drive circuit
31
32
Control
circuit

FIG. 17



# METHOD FOR PRODUCING ORGANIC EL DISPLAY PANEL

## TECHNICAL FIELD

**[0001]** The present invention relates to a manufacturing method of an organic EL display panel including a forming process of a light-emitting layer by a printing method such as an ink jet method.

## BACKGROUND ART

**[0002]** Recently, researches and developments have been promoted on organic electroluminescence elements (hereinafter, referred to just as organic EL elements) which are current-driven light-emitting elements and rely on electroluminescence phenomenon of organic fluorescent materials. Also, as display devices employing organic EL elements, there have been widely used organic EL display panels having a configuration in which organic EL elements are arranged on a substrate. Organic EL elements included in an organic EL display panel are configured from a TFT (thin film transistor) substrate, anodes made of metal such as Al, light-emitting layers made of an organic light-emitting material, and a cathode made of a transparent material such as ITO (Indium Tin Oxide) that are laminated in respective orders. Also, the organic EL elements each further include a hole injection layer, a hole transport layer, an electron injection layer, an electron transport layer, a sealing layer, and so on as necessary.

**[0003]** Light emitting layers included in an organic EL display panel are formed by a vacuum evaporation method, or a printing method according to which an organic material ink, which results from dissolving a tiny amount of an organic light-emitting material in a solvent, is applied by an ink jet. The printing method allows formation of light-emitting layers with use of a manufacturing device simplifier than the vacuum evaporation method. Also, a large size organic EL display panel is formed by the printing method with use of a manufacturing device that is simplifier than in the vacuum evaporation method, and accordingly is of more advantage than the vacuum evaporation method in terms of manufacturing cost for example.

**[0004]** According to a conventional method of forming light-emitting layers by the printing method with use of an ink jet, a barrier rib (referred to also a as bank) that is made of a material including a liquid repellent component is formed on a substrate, and an organic material ink, which results from dissolving a tiny amount of an organic light-emitting material in a solvent, is applied to each of subpixel regions surrounded by the barrier rib (see Patent Literatures 1 and 2). The adjacent light-emitting layers differ from each other in terms of luminescent color of R (Red), G (Green), and B (Blue) colors. Also, the light-emitting layers differ in terms of material for each luminescent color.

## CITATION LIST

### Patent Literature

**[0005]** [Patent Literature 1]

**[0006]** Japanese Patent Application Publication No. 2002-222695

**[0007]** [Patent Literature 2]

**[0008]** Japanese Patent Application Publication No. 2011-18632

## SUMMARY OF INVENTION

### Technical Problem

**[0009]** However, the present inventors demonstrated by experiments that formation of an organic EL display panel by the printing method results in light-emitting layers having cross-sectional shapes that vary between subpixel regions, and this might cause uneven luminance.

**[0010]** The present invention aims to suppress uneven luminance in an organic EL display panel that is manufactured by the printing method.

### Solution to Problem

**[0011]** One aspect of the present invention provides a manufacturing method of an organic EL display panel comprising: preparing a first ink including a first organic light-emitting material and a solvent; preparing a second ink including a second organic light-emitting material and a solvent, the second organic light-emitting material differing from the first organic light-emitting material in terms of light-emitting wavelength; preparing a third ink including a third organic light-emitting material and a solvent, the third organic light-emitting material differing from the first organic light-emitting material and the second organic light-emitting material in terms of light-emitting wavelength; applying the first ink to first subpixel regions on a substrate; and applying the second ink to second subpixel regions that are each adjacent to a corresponding one of the first subpixel regions; and applying the third ink to third subpixel regions that are each adjacent to a corresponding one of the first subpixel regions on an opposite side of the first subpixel region relative to a corresponding one of the second subpixel regions, wherein the first ink has a lower viscosity than the second ink and the third ink, and after application of the first ink is started, application of the second ink and the third ink is started.

### Advantageous Effects of Invention

**[0012]** According to the manufacturing method of the organic EL display panel relating to the above aspect, it is possible to suppress an influence exercised by difference in concentration of solvent atmosphere during a time period from when application of the first ink, which has a low viscosity, is started to when drying of the first ink is completed. The difference in concentration of solvent atmosphere occurs between respective solvents which are evaporated from the second and third subpixel regions, which are adjacent to each of the first subpixel regions on the both sides thereof, and is hereinafter referred to for example as difference in solvent atmosphere on the both sides. This is because no organic material ink exists in the second and third subpixel regions which are adjacent to each of the first subpixel regions at the start time of application of the first ink, and accordingly the difference in solvent atmosphere on the both sides of each of the first subpixel regions is suppressed. Since the difference in solvent atmosphere on the both sides of the first subpixel region is suppressed, it is also possible to suppress variation in the difference in solvent atmosphere on the both sides between the first subpixel regions which are positioned in different positions in the organic EL display panel, compared with the case where an organic material ink has been already applied to only one of the second and third subpixel regions, which are adjacent to the first subpixel region on the both sides thereof, at the start time of application of the first ink.

[0013] By the way, during a time period between start of application of the first ink and completion of drying of the first ink, an evaporation speed of the solvent included in the first ink differs within the first subpixel region due to the difference in solvent atmosphere on the both sides of the first subpixel region. The difference in evaporation speed causes convection current. Accordingly, in the case where variation occurs in the difference in solvent atmosphere on the both sides between the first subpixel regions which are positioned in different positions in the organic EL display panel, difference might occur in convection current of the solvent included in the first ink between the first subpixel regions. The difference in convection current of the solvent included in the first ink causes difference in distribution of solute included in the first ink between the first subpixel regions, which are positioned in different positions in the organic EL display panel. As a result, difference might occur in shape between light-emitting layers resulting from applying the first ink.

[0014] Therefore, according to the manufacturing method of the organic EL display panel relating to the above one aspect, by suppressing variation in the difference in solvent atmosphere on the both sides between the first subpixel regions which are positioned in different positions, it is possible to suppress variation in shape of light-emitting layers which are formed by applying the first ink and are positioned in different positions.

## BRIEF DESCRIPTION OF DRAWINGS

[0015] FIG. **1** is a cross-sectional view showing an organic EL display panel relating to Embodiment 1.

[0016] FIG. **2** is a top view showing the organic EL display panel shown in FIG. **1** from which an electron injection layer, a cathode, and a sealing layer are removed.

[0017] FIG. **3**A to FIG. **3**D are cross-sectional views showing a manufacturing process of the organic EL display panel shown in FIG. **1**.

[0018] FIG. **4**A shows operations of an ink jet head at the time of manufacturing of the organic EL display panel shown in FIG. **1**, and FIG. **4**B is a top view showing the organic EL display panel **1** shown in FIG. **1** at the time of manufacturing thereof.

[0019] FIG. **5**A to FIG. **5**F are cross-sectional views showing the details of a process of forming light-emitting layers in the manufacturing process shown in FIG. **3**A to FIG. **3**D.

[0020] FIG. **6**A to FIG. **6**C are top views showing the process of forming light-emitting layers shown in FIG. **5**A to FIG. **5**F.

[0021] FIG. **7** is a time chart showing the process of forming light-emitting layers shown in FIG. **5**A to FIG. **5**F.

[0022] FIG. **8**A to FIG. **8**C each show a shape of an upper surface of a different light-emitting layer in a conventional organic EL display panel, and FIG. **8**D and FIG. **8**F each show a shape of an upper surface of a different light-emitting layer in the organic EL display panel shown in FIG. **1**.

[0023] FIG. **9**A to FIG. **9**D explain the manufacturing process of the organic EL display panel shown in FIG. **1**.

[0024] FIG. **10**A to FIG. **10**C explain a manufacturing process with use of an organic material ink having a low viscosity.

[0025] FIG. **11**A to FIG. **11**C explain a manufacturing process with use of an organic material ink having a high viscosity.

[0026] FIG. **12**A to FIG. **12**E are cross-sectional views showing the details of a process of forming light-emitting layers in the manufacturing process shown in FIG. **3**A to FIG. **3**D.

[0027] FIG. **13**A and FIG. **13**B are top views showing the process of forming light-emitting layers shown in FIG. **12**A to FIG. **12**E.

[0028] FIG. **14** is a time chart showing the process of forming light-emitting layers shown in FIG. **12**A to FIG. **12**E.

[0029] FIG. **15**A and FIG. **15**B are time charts showing a manufacturing process of an organic EL display panel relating to Modification.

[0030] FIG. **16** is a schematic block diagram showing the outline configuration of the manufacturing process of the organic EL display panel shown in FIG. **1**.

[0031] FIG. **17** is an appearance diagram showing an organic EL display device including the organic EL display panel shown in FIG. **1**.

## DESCRIPTION OF EMBODIMENTS

[0032] [Process by which One Aspect of the Present Invention was Achieved]

[0033] Before concretely describing one aspect of the present invention, the following describes the process by which the aspect of the present invention was achieved.

[0034] In the case where light-emitting layers are formed by an evaporation method, R, G, and B organic light-emitting materials are considered to be evaporated in this order for example. This is because it is considered that, in terms of operating life, R organic EL elements are the longest, followed in order by G and B organic EL elements, and it is advantageous to start forming light-emitting layers with R light-emitting layers, which have the longest operating life. The following describes advantages that formation of light-emitting layers is performed in descending order of length of operating life.

[0035] Manufacturing of organic EL elements is completed for example by forming light-emitting layers on a TFT substrate, and sealing the light-emitting layers by a cathode, a sealing layer, and so on. During a time period between completion of formation of sealing of the light-emitting layers and completion of sealing of the light-emitting layers, the light-emitting layers are subject to deterioration because moisture, oxygen, and so on are easy to reach the light-emitting layers. Accordingly, the longer the time period between completion of formation of the light-emitting layers and completion of sealing of the light-emitting layers is, the more possibility of deterioration of the light-emitting layers increases. By starting formation of light-emitting layers with the R light-emitting layers, which have the longest operating life, light-emitting layers which have shorter operating life have less possibility of deterioration. Accordingly, compared with the case where light-emitting layers which have shorter operating life have more possibility of deterioration, it is possible to suppress an operating life of the entire organic EL display panel.

[0036] By the way, the present inventors tested to manufacture an organic EL display panel by a printing method using an ink jet according to which light-emitting layers are formed by a manufacturing device that is more simplified than in the vacuum evaporation method. However, any research and development have not yet been performed on an application order of organic light-emitting materials in the printing method. For this reason, application of organic light-emitting materials is considered to be performed in the same order as that in the above evaporation method. Accordingly, in the same manner as in the evaporation method, the present inventors tested to apply organic material inks in order of decreasing operating life of the light-emitting layers corresponding to the organic material inks. In other words, the present inventors tested to use R, G, and B organic material inks to form R, G, and B light-emitting layers, by applying the R, G, and B organic material inks in respective orders, and then performing forced drying processing such as bake drying processing, reduced-pressure drying processing, or the like on the R, G, and B organic material inks. However, the present inventors proved that this manufacturing method results in variation in cross-sectional shape of the light-emitting layers between subpixel regions, and might cause uneven luminance.

**[0037]** Furthermore, after checking a relationship between uneven luminance and viscosity of organic material ink which are materials of light-emitting layers, the present inventors proved that a large uneven luminance occurs especially in light-emitting layers which are formed using an organic material ink having a comparatively low viscosity.

**[0038]** There occurs variation in cross-sectional shape of the light-emitting layers, which are formed using an organic material ink having a comparatively low viscosity, because an organic material ink having a low viscosity is larger in liquidity of solvent than an organic material ink having a high viscosity, and is more subject to an influence exercised by solvent atmosphere than the organic material ink having a high viscosity.

**[0039]** The inventors focused on this point, and conceived an idea of determining an application order of organic material inks based on a viscosity of the organic material inks. Then, the present inventors achieved results that it is possible to suppress variation in cross-sectional shape of light-emitting layers between subpixel regions even if the light-emitting layers are formed using an organic material ink having a low viscosity. The one aspect of the present invention was achieved through the process described above.

[Outline of One Aspect of the Present Invention]

**[0040]** One aspect of the present invention provides a manufacturing method of an organic EL display panel comprising: preparing a first ink including a first organic light-emitting material and a solvent; preparing a second ink including a second organic light-emitting material and a solvent, the second organic light-emitting material differing from the first organic light-emitting material in terms of light-emitting wavelength; preparing a third ink including a third organic light-emitting material and a solvent, the third organic light-emitting material differing from the first organic light-emitting material and the second organic light-emitting material in terms of light-emitting wavelength; applying the first ink to first subpixel regions on a substrate; and applying the second ink to second subpixel regions that are each adjacent to a corresponding one of the first subpixel regions; and applying the third ink to third subpixel regions that are each adjacent to a corresponding one of the first subpixel regions on an opposite side of the first subpixel region relative to a corresponding one of the second subpixel regions, wherein the first ink has a lower viscosity than the second ink and the third ink, and after application of the first ink is started, application of the second ink and the third ink is started.

**[0041]** According to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, it is possible to suppress an influence exercised by difference in solvent atmosphere between the second and third subpixel regions adjacent to each of the first sub pixel regions on the both sides thereof during a time period between start of application of the first ink and completion of drying of the first ink, which has a low viscosity.

**[0042]** For example, when application of the first ink having a low viscosity to the first subpixel region is started, there exists no organic material ink in the second and third subpixel regions which are adjacent to the first subpixel region. This suppresses difference in solvent atmosphere which occurs between respective solvents which are dried from the second and third subpixel regions. Since difference in solvent atmosphere between subpixel regions on the both sides of each of the first subpixel regions is suppressed, variation in difference in solvent atmosphere on the both sides between the first subpixel regions which are positioned in different positions in the organic EL display panel is also suppressed. Therefore, according to the above manufacturing method, compared with the case where an ink exists in only one of the second and third subpixel regions, which are adjacent to the first subpixel region, at the start time of application of the first ink, it is possible to suppress difference in solvent atmosphere on the both sides between the first subpixel regions which are positioned in different positions in the organic EL display panel. As a result, it is possible to suppress variation in shape of light-emitting layers which results from applying the first ink and are positioned in different positions in the organic EL display panel.

**[0043]** Also, according to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, after application of the first ink is completed, application of the second ink and the third ink may be started.

**[0044]** Also, the manufacturing method of the organic EL display panel relating to the one aspect of the present invention may further comprise drying the first ink, after the applying the first ink, wherein after drying of the first ink is started, application of the second ink and the third ink may be started.

**[0045]** Also, according to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, drying of the first ink may be performed through natural drying processing and forced drying processing subsequent to the natural drying processing.

**[0046]** Also, according to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, after application of the first ink is started, application of one of the second ink and the third ink may be started earlier than the other, where one of the second organic material and the third organic material, corresponding to the one of the second ink and the third ink, has a longer operating life than the other.

**[0047]** Also, according to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, a natural drying time period of the first ink may be longer than a natural drying time period of each of the second ink and the third ink, the natural drying time period being a time period from when application is completed to when forced drying processing is started.

**[0048]** Also, according to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, drying of the second ink and the third ink may be performed through forced drying processing without performing natural drying processing.

[0049] Also, according to the manufacturing method of the organic EL display panel relating to the one aspect of the present invention, after drying of the first ink is completed, application of the second ink and the third ink may be started.

[0050] Also, the manufacturing method of the organic EL display panel relating to the one aspect of the present invention may further comprise drying the second ink and drying the third ink, after the applying the second ink and the third ink.

[0051] One aspect of the present invention provides a manufacturing method of an organic EL display panel comprising: preparing a first ink including a first organic light-emitting material and a solvent; preparing a second ink including a second organic light-emitting material and a solvent, the second organic light-emitting material differing from the first organic light-emitting material in terms of light-emitting wavelength; preparing a third ink including a third organic light-emitting material and a solvent, the third organic light-emitting material differing from the first organic light-emitting material and the second organic light-emitting material in terms of light-emitting wavelength; applying the first ink to first subpixel regions on a substrate; and applying the second ink to second subpixel regions that are each adjacent to a corresponding one of the first subpixel regions; and applying the third ink to third subpixel regions that are each adjacent to a corresponding one of the first subpixel regions on an opposite side of the first subpixel region relative to a corresponding one of the second subpixel regions, wherein the first ink has a lower viscosity than the second ink and the third ink, and a natural drying time period of the first ink is longer than a natural drying time period of each of the second ink and the third ink, the natural drying time period being a time period from when application is completed to when forced drying processing is started.

## Embodiment 1

### 1. Overall Configuration

[0052] The following describes embodiments in detail with reference to the drawings. FIG. **1** is a cross-sectional view showing an organic EL display panel **1** relating to Embodiment 1. The organic EL display panel **1** includes a TFT (thin film transistor) substrate **11** and a barrier rib layer **12** that is formed on the TFT substrate **11**. The TFT substrate **11** is constituted from a glass substrate, a TFT, a planarizing layer, and so on. In order to light the organic EL display panel **1**, the planarizing layer that is provided between the glass substrate and anodes **13** reduces roughness of the TFT, which is provided on the glass substrate. Note that the TFT and the planarizing layer have known configurations, and accordingly illustration thereof is omitted here. The barrier rib layer **12** has a film thickness of approximately 1 um, and has a forward tapered cross section.

[0053] In a subpixel region that is positioned in each adjacent two portions of the barrier rib layer **12**, the anode **13**, a hole injection layer **14**, an IL layer (interlayer) **15**, and one of light-emitting layers **16**R, **16**G, and **16**B are laminated. The anodes **13** are made of metal such as Al. The light-emitting layers **16**R, **16**G, and **16**B are each made of an organic material, and hereinafter referred to collectively as light-emitting layers **16** when distinction therebetween is unnecessary. Furthermore, an electron injection layer **17**, a cathode **18**, and a sealing layer **19** are laminated in respective orders so as to cover the barrier rib layer **12** and the light-emitting layers **16**. The cathode **18** is made of a transparent material such as ITO. The sealing layer **19** is made of a light transmissive material such as SiN and SiON. The organic EL display panel **1** includes pixels that are each constituted from a combination of three R, G, and B subpixels. Also, the R, G, and B subpixel regions differ in luminescent color because of difference in material between the light-emitting layers **16**R, **16**G, and **16**B.

[0054] FIG. **2** is a top view of the organic EL display panel **1** from which the electron injection layer **17**, the cathode **18**, and the sealing layer **19** are removed, where the barrier rib layer **12** and the light-emitting layers **16** are illustrated. A cross-sectional view taken along line A-A' in FIG. **2** is equivalent to FIG. **1**. Note that only one pixel (three subpixels) of the organic EL display panel **1** is illustrated in FIG. **1** and FIG. **2**. The barrier rib layer **12** surrounds each of the light-emitting layers **16**. Also, respective regions indicated as the light-emitting layers **16**R, **16**G, and **16**B in FIG. **2** each represent a subpixel region. In the case where a general 20-inch organic EL display panel has 1280×768 pixels arranged in equal intervals, subpixel regions each have a size of approximately 64 um×234 urn.

[0055] In the present embodiment, respective light-emitting layers emitting light of the R, G, and B colors are referred to as an R light-emitting layer, a G light-emitting layer, and a B light-emitting layer. Also, respective organic material inks emitting light of the R, G, and B colors are referred to as an R organic material ink RI, a G organic material ink GI, and a B organic material ink BI.

### 2. Manufacturing Process of Organic EL Display Panel **1**

[0056] The following describes a manufacturing process of the organic EL display panel. Firstly, the entire process is described with reference to FIG. **3**A to FIG. **3**D, and then a process of forming light-emitting layers is described in detail with reference to FIG. **4**A to FIG. **7**.

[0057] As shown in FIG. **3**A, a substrate is prepared on which a TFT substrate **11**, a barrier rib layer **12**, anodes **13**, hole injection layers **14**, and IL layers **15** are laminated.

[0058] As shown in FIG. **3**B, an organic material ink, which is a material of light-emitting layers **16**, is applied to each of subpixel regions surrounded by the barrier rib layer **12** by a printing method using an ink jet. The applied organic material ink undergoes natural drying processing, and then undergoes forced drying processing such as reduced-pressure drying processing and bake drying processing. As a result, the light-emitting layers **16** are obtained.

[0059] As shown in FIG. **3**C, an electron injection layer **17** and a cathode **18** are formed so as to cover the barrier rib layer **12** and the light-emitting layers **16**.

[0060] As shown in FIG. **3**D, a sealing layer **19** is formed on the cathode **18**. This completes an organic EL display panel **1**.

[0061] Note that the electron injection layer **17**, the cathode **18**, and the sealing layer **19** are formed by general members and formation techniques that are used in a known art relating to organic light-emitting devices.

[0062] The organic EL display panel **1** is manufactured through the above processes.

### 3. Details of Process of Forming Light-Emitting Layers

(Operations of Ink Jet Head)

**[0063]** The following describes in detail the process of forming the light-emitting layers **16**, especially operations of the ink jet head.

**[0064]** FIG. **4**A shows operations of the ink jet head at the time of manufacturing of the organic EL display panel **1**. FIG. **4**B is a top view showing the organic EL display panel **1** at the time of manufacturing thereof.

**[0065]** In the present embodiment, an ink jet device includes an ink jet head **20** having three types of ink discharging nozzles. As shown in FIG. **4**A, the ink jet device performing scanning by the ink jet head **20** to discharge and apply organic material inks to the subpixel regions from the nozzle while controlling the positional relationship between the nozzles and the substrate. Note that the ink jet head **20** is for example a piezo ink jet head that discharges an ink by deforming piezo elements. Also, a multipath printing method is used according to which an organic material ink is applied by repeating plural times of an operation of scanning in the Y-direction and then moving in the X-direction by the ink jet head **20**.

**[0066]** The following describes the printing method in further detail. The ink jet head **20** has print heads corresponding to the luminescent colors, namely an R print head, a G print head, and a B print head. The R, G, and B print heads each discharge droplets of an organic material ink such that the nozzles one-to-one correspond to the subpixels. The droplets are landed on a desired subpixel region, and the droplets are dried. As a result, light-emitting layers **16** are formed. Here, the R, G, and B print heads used in the present embodiment each have 64 nozzles. The organic material ink is applied to the entire organic EL display panel **1** for each of all the R, G, and B colors by repeating scanning 20 times from the 1st scanning to the 20th scanning while moving the print head to a part where printing has not been yet performed. As a result, the light-emitting layers **16** for the entire organic EL display panel **1** is completed.

**[0067]** Conditions of ink viscosity adjustment and ink dropping on subpixel regions are set as follows: a G organic material ink of 72 pl, which has a comparatively low viscosity of approximately 5 mPas, is dropped for each subpixel; an R organic material ink of 72 pl, which has a viscosity of approximately 15 mPas higher than the G organic material ink, is dropped for each subpixel; and a B organic material ink of 70 pl, which has a viscosity of approximately 12 mPas higher than the G organic material ink, is dropped for each subpixel. An organic solvent having a boiling temperature of approximately 200 degree C. is used as a solvent for all the organic material inks.

(Details of Process of Forming Light-Emitting Layers)

**[0068]** FIG. **5**A to FIG. **5**F are cross-sectional views showing the details of the process of forming light-emitting layers in the manufacturing process shown in FIG. **3**A to FIG. **3**D. FIG. **6**A to FIG. **6**C are top views showing the process of forming light-emitting layers shown in FIG. **5**A to FIG. **5**F.

**[0069]** As shown in FIG. **5**A, a G organic material ink **16**GI is applied to each of G subpixel regions by the ink jet method. No organic material ink exists in an R subpixel region and a B subpixel region which are adjacent to each of the G subpixel regions on both sides thereof, and only all the G subpixel regions on the organic EL display panel **1** are filled with the G organic material ink **16**GI.

**[0070]** Next, as shown in FIG. **5**B, light-emitting layers **16**G are formed. Specifically, after the G organic material ink **16**GI is applied, a stand-by time period is given without performing forced drying processing until the solvent applied to each of all the G subpixel regions on the organic EL display panel **1** is dried by leaving the substrate unattended. Here, giving a stand-by time period without performing forced drying processing such as reduced-pressure drying processing and bake drying processing is referred to as natural drying processing. In the present embodiment, natural drying processing is performed for a stand-by time period of approximately 20 minutes to 30 minutes until the solvent for the G organic material ink is dried. Then, the G organic material ink undergoes reduced-pressure drying processing at 0.5 Pa for 20 minutes, and as a result a G light-emitting layer **16**G is formed in each of the G subpixel regions. The solvent for the G organic material ink **16**GI is completely dried from the G subpixels regions through natural drying processing and reduced-pressure drying processing. Alternatively, forced drying processing may be performed through bake drying processing instead of reduced-pressure drying processing. FIG. **6**A is an overhead view of the state shown in FIG. **5**B.

**[0071]** As shown in FIG. **5**C, after the G light-emitting layers **16**G are formed, an R organic material ink **16**RI is applied to each of R subpixel regions by the ink jet method.

**[0072]** Next, as shown in FIG. **5**D, R light-emitting layers **16**R are formed. Specifically, the organic material ink **16**RI is applied to each of all the R subpixel regions on the organic EL display panel **1**, and then the organic material ink **16**RI undergoes reduced-pressure drying processing at 0.5 Pa for 20 minutes. FIG. **6**B is an overhead view of the state shown in FIG. **5**D.

**[0073]** As shown in FIG. **5**E, after the R light-emitting layers **16**R are formed, a B organic material ink **16**BI is applied to each of B subpixel regions by the ink jet method.

**[0074]** Next, as shown in FIG. **5**F, B light-emitting layers **16**B are formed. Specifically, a B organic material ink **16**BI is applied to each of all the B subpixel regions on the organic EL display panel **1**, and then the B organic material ink **16**BI undergoes reduced-pressure drying processing at 0.5 Pa for 20 minutes. FIG. **6**C is an overhead view of the state shown in FIG. **5**F.

**[0075]** Note that, during a time period between start of application and completion of application of each of the R organic material ink **16**RI and the B organic material ink **16**BI, the ink, which has been applied to the subpixel regions, is spontaneously dried.

**[0076]** Then, the entire organic EL display panel **1** is baked at 130 degrees C. under $N_2$ atmosphere for 10 minutes. This completes formation of the light-emitting layers **16**.

**[0077]** The following describes the above process of forming the light-emitting layers **16** in chronological order. FIG. **7** is a time chart showing the process of forming the light-emitting layers **16**. Processes indicated by letters R, G, and B in FIG. **7** represent processes performed on the R, G, and B subpixel regions, respectively.

**[0078]** Firstly, the G organic material ink **16**GI is applied, undergoes natural drying processing, and then undergoes forced drying processing. As a result, the G light-emitting layers **16**G are formed. Next, the R organic material ink **16**RI is applied, and then undergoes forced drying processing by reduced-pressure drying processing. As a result, the light-emitting layers **16**R are formed. Finally, the B organic material ink **16**BI is applied, and then undergoes forced drying processing by reduced-pressure drying processing. As a result, the B light-emitting layers **16**B are obtained. In this way, no organic material ink exists in R and B subpixel regions which are adjacent to each of the G subpixel regions on both sides thereof during a time period from when application of the G organic material ink **16**GI is started to drying of the G organic material ink **16**GI is completed. Accordingly, at the start time of application of each of the R organic material ink **16**RI and the B organic material ink **16**BI, the G organic material ink **16**GI has been sufficiently dried, and therefore the shape of the light-emitting layers **16**G has been determined.

**[0079]** Note that the G organic material ink **16**GI may be dried by performing only natural drying processing without performing forced drying processing.

**[0080]** In the present embodiment, after drying of the G organic material ink is completed, application of each of the R and B organic material inks is started. Since the G organic material ink has been dried at the start time of application of each of the R and B organic material inks, the shape of the G organic material ink is not influenced by application of the R and B organic material inks. Also, when application of the R or B organic material ink is performed subsequent to application of the G organic material ink, difference in solvent atmosphere is reduced between subpixel regions which are adjacent to each of subpixel regions to which the R or B organic material ink is applied on the both sides thereof. This suppresses variation in shape of the R or B light-emitting layers that are formed using the R or B organic material ink applied subsequent to application of the G organic material ink between the R or B subpixel regions which are positioned in different positions.

**[0081]** Note that the order of application and drying of the R, G, and B organic material inks is not limited to the order described in the present embodiment. Alternatively, before drying of the G organic material ink is completed, application of an organic material ink of other color may be started.

**[0082]** Also, application of the R and B organic material inks may be started simultaneously. Furthermore, only a specific type of organic material ink whose application is completed may undergo forced drying processing. Alternatively, after application of all the types of organic material inks is completed, all the types of organic material inks may collectively undergo forced drying processing.

**[0083]** Moreover, the organic material inks other than the G organic material ink having the lowest viscosity, namely the B and R organic material inks may be applied in descending order of operating life. In the case where the R organic material ink has a longer operating life than the B organic material ink for example, application of the G, R, and B organic material inks is performed in respective orders. This suppresses variation in shape of the G light-emitting layers, and also maintains a further long operating life of the organic EL display panel.

## 5. Effects

### (5-1) Observation Results of Cross-Sectional Shape of Light-Emitting Layers

**[0084]** FIG. **8**A to FIG. **8**C each show a shape of an upper surface of a different G light-emitting layer **16**G of an organic EL display panel **1** relating to a comparative example. FIG. **8**D to FIG. **8**F each show a shape of an upper surface of a different G light-emitting layer **16**G of the organic EL display panel **1** relating to the present embodiment. Specifically, the ink jet head **20** performs an operation of scanning and application 20 times for each of the R organic material ink **16**RI, the G organic material ink **16**GI, and the organic material ink **16**BI (hereinafter, when distinction is unnecessary, these three types of inks are referred to collectively organic material ink **161**). Then, the shape of the upper surface of each of the G light-emitting layers **16**G resulting from drying the organic material ink **161** is evaluated by AFM (Atomic Force Microscope).

**[0085]** In the comparative example in which results shown in FIG. **8**A to FIG. **8**C are obtained, in the case where the R organic material ink is the longest, followed in order by the G and B organic material inks in terms of operating life for example, application of the respective R, G, and B organic material inks **16**RI, **16**GI, and **16**BI is performed in respective orders. Then, the respective R, G, and B organic material inks **16**RI, **16**GI, and **16**BI collectively undergo reduced-pressure drying processing. Application is performed in this order in order to reduce a possibility that if the organic EL display panel **1** is left unattended for a long time period under an atmosphere in which application is completed, an organic material ink of a specific luminescent color deteriorates soon. In other words, since the B light-emitting layer **16**B has the shortest operating life, the shortest time period between application and sealing is set for the B organic material ink **16**BI. This suppresses deterioration of the whole operating life of the light-emitting layers **16**.

**[0086]** In the results in the comparative example shown in FIG. **8**A to FIG. **8**C, there is variation in shape of the upper surfaces of the light-emitting layers **16**G in the three different subpixel regions. Specifically, respective uppermost parts of the upper surfaces of the G light-emitting layers **16**G shown in FIG. **8**A to FIG. **8**C are −20 μm, 0 μm, and 5 μm, respectively. Also, respective lowermost parts of the upper surfaces of the G light-emitting layers **16**G shown in FIG. **8**A to FIG. **8**C are 70 μm, −75 μm, and 95 μm, respectively.

**[0087]** In the results in the present embodiment shown in FIG. **8**D to FIG. **8**F, on the other hand, there is no variation in shape of the upper surfaces of the light-emitting layers **16**G in the three different subpixel regions. Specifically, respective uppermost parts of the upper surfaces of the G light-emitting layers **16**G shown in FIG. **8**D to FIG. **8**F are each 0 μm. Also, respective lowermost parts of the upper surfaces of the G light-emitting layers **16**G shown in FIG. **8**D to FIG. **8**F are each −100 μm. Note that further uniformization of the cross-sectional shape of the light-emitting layers is realized by appropriately selecting a material, water repellency, an inclination angle of lateral surfaces, and so on of the bank.

### (5-2-1) Consideration on Application Order

**[0088]** The following considers in detail the effects of the application order of organic material inks in the present embodiment.

**[0089]** FIG. **9**A to FIG. **9**D show the manufacturing process of the organic EL display panel **1**, and especially explain a process of forming the G light-emitting layers **16**G. Arrows in FIG. **9**A and FIG. **9**B each represent a convection current of a solvent.

**[0090]** As shown in FIG. **9**A, the G organic material ink **16**GI, which includes a solvent in which a solute is distributed, is applied to each of the G subpixel regions. After the G organic material ink **16**GI is applied, the solvent is spontaneously dried. A drying speed of the solvent differs between a central region and a periphery region in the G subpixel region. This difference in drying speed of the solvent causes a convection current where the solute moves in the solvent.

**[0091]** As shown in FIG. **9**B, when the solvent is dried to a certain degree, the convection current is reduced and as a result the solute is difficult to move.

**[0092]** As shown in FIG. **9**C, when the solvent is mostly dried, the convection current stops and as a result the solute stops moving. The distribution of the solute at this time is reflected to the final cross-sectional shape of the G light-emitting layers **16**G.

**[0093]** As shown in FIG. **9**D, after the solvent is completely dried, the G light-emitting layers **16**G are obtained.

**[0094]** Here, if difference occurs in solvent atmosphere between two subpixel regions which are adjacent to a specific subpixel region on both sides thereof, a convection current having a left-right asymmetrical shape is likely to occur in the specific subpixel region. This means that the shape of a light-emitting layer in the specific subpixel region is influenced by the solvent atmosphere on the subpixel regions which are adjacent to the specific subpixel region on the both sides. For this reason, in the case where two subpixel regions on the organic EL display panel **1**, which are positioned in different positions, differ from each other in terms of difference in solvent atmosphere between subpixel regions on the both sides, the organic EL display panel **1** has variation in cross-sectional shape of the light-emitting layers.

**[0095]** Also, the convection current of the solvent occurs differently depending on a viscosity of an organic material ink, in addition to depending on the difference in solvent atmosphere between subpixel regions on the both sides. FIG. **10**A to FIG. **10**C explain a manufacturing process with use of an organic material ink having a low viscosity. FIG. **11**A to FIG. **11**C explain a manufacturing process with use of an organic material ink having a high viscosity. Arrows in FIG. **10**A and FIG. **11**A each represent a convection current of a solvent.

**[0096]** As shown in FIG. **10**A, when an organic material ink having a low viscosity is used, liquidity of a solvent is large. As a result, a convection current is increased, and a solute rapidly moves. As shown in sections (1) to (3) of FIG. **10**B, this results in large variation in distribution of the solute at the time when the convection current stops. Specifically, a subpixel region has a distribution shown in section (1) of FIG. **10**B, another subpixel region has a distribution shown in section (2) of FIG. **10**B, and yet another subpixel region has a distribution shown in section (3) of FIG. **10**B. Accordingly, in the case where an organic material ink having a low viscosity is applied to each of subpixel regions of a specific color, the subpixel region of the specific color is subject to an influence exercised by two subpixel regions that are adjacent to the subpixel region of the specific color on the both sides thereof, as shown in sections (1) to (3) of FIG. **10**C. As a result, a prominent variation occurs in cross-sectional shape of the light-emitting layers **16** between the subpixel regions.

**[0097]** As shown in FIG. **11**A, compared with this, when an organic material ink having a high viscosity is used, liquidity of a solvent is small. As a result, a convection current is increased, and a solute slowly moves. As shown in FIG. **11**B, this results in not so large distribution of the solute at the time when the convection current stops. Accordingly, in the case where an organic material ink having a high viscosity is applied to each of subpixel regions of a specific color, the subpixel region of the specific color is not subject to an influence exercised by two subpixel regions that are adjacent to the subpixel region of the specific color on the both sides thereof, as shown in FIG. **11**C. As a result, a large variation does not occur in cross-sectional shape of the light-emitting layers **16** between the subpixel regions.

**[0098]** In this way, the degree to which each of the subpixel regions is subject to an influence exercised by two subpixel regions which are adjacent to each of the subpixel regions on the both sides differs depending on a viscosity of an organic material ink to be applied. Accordingly, with respect to an organic material ink having the lowest viscosity, it is effective to suppress variation in difference in solvent atmosphere on the both sides between the subpixel regions which are positioned in different positions. In the present embodiment, in order to suppress variation in cross-sectional shape of the light-emitting layers **16**, the application order is adjusted such that at a time when application of an organic material having a low viscosity to each of corresponding subpixel regions is started, no organic material ink exists in two subpixel regions which are adjacent to the subpixel region on the both sides thereof.

**[0099]** For example, the ink application order is adjusted such that, at the start time of application of a first ink having a low viscosity to a first subpixel region, no organic material ink has been yet applied to a second subpixel region and a third subpixel region that are adjacent to the first subpixel region on the both sides thereof. This suppresses a difference in solvent atmosphere between the second subpixel region and the third subpixel region, which are adjacent to the first subpixel region on the both sides, thereby suppressing variation in the difference in solvent atmosphere on the both sides between the first subpixel regions which are positioned in different positions, compared with the case where the organic material ink has been already applied to only one of the second subpixel region and the third subpixel region at the start time of application of the first ink.

**[0100]** Also, the organic EL display panel **1** has a tendency that a central region thereof is less subject to drying of an organic material ink which is applied than an edge region thereof. In the present embodiment, when application of the G organic material ink **16**GI is started, the R organic material ink **16**RI and the B organic material ink **16**BI have not been yet applied. Accordingly, it is possible to further suppress variation in difference in solvent atmosphere on both sides of each of the G subpixel regions between the G subpixel regions, compared with the case where when application of the G organic material ink **16**GI is started, only one of the R organic material ink **16**RI and the B organic material ink **16**BI has been already applied.

**[0101]** Furthermore, since a time period that elapses after start of application of an organic material ink differs depending on the position of subpixel regions, a dry state of the organic material ink also differs. For example, with respect to a subpixel region to which an organic material ink has been applied earlier, spontaneous drying of the organic material ink is progressing. Accordingly, there is a comparatively small difference in solvent atmosphere between the initially applied subpixel region and a subpixel region to which an organic material ink has not been yet applied. Compared with this, with respect to a subpixel region to which the organic material ink has been comparatively recently applied, a large amount of solvent remains in the sub pixel region. Accordingly, there is a comparatively large difference in solvent atmosphere between the comparatively recently applied subpixel region and a subpixel region to which an organic material ink has not been yet applied. In the present embodiment, application of the G organic material ink **16**GI is completed before application of the R organic material ink **16**RI and the B organic material ink **16**BI is started. Also, drying of the G organic material ink **16**GI is completed before application of the R organic material ink **16**RI and the B organic material ink **16**BI is started. Accordingly, it is possible to further suppress difference in solvent atmosphere between subpixel regions on the both sides of each of the G subpixel regions. Note that it is most preferable that there should exist no organic material ink in R and B subpixel regions which are adjacent to each of the G subpixel regions during a time period until drying of a G organic material ink having a low viscosity is completed. However, it is only necessary that there exists no organic material ink in the adjacent R and B subpixel regions only during at least a time period included in the time period until drying of the G organic material having a low viscosity is completed. For example, as long as once application of an organic material ink having the lowest viscosity is started, even if application of organic material inks having a high viscosity is started before application of the organic material ink having the lowest viscosity is completed, it is possible to suppress variation in cross-sectional shape of light-emitting layers between the subpixel regions. This is because the time period until drying of the organic material ink having the lowest viscosity includes at least a partial time period during which there is no organic material ink in subpixel regions which are adjacent to each of subpixel regions to which the organic material ink having the lowest viscosity has been applied.

**[0102]** It is preferable that after application of an organic material ink having the lowest viscosity is completed, application of other organic material inks should be started. This is because in order to increase a time period during which no organic material ink exists in the subpixel regions which are adjacent to each of the subpixel regions to which the organic material ink having the lowest viscosity has been applied. Also, it is further preferable that after application and drying of the organic material ink having the lowest viscosity are complete, application of the other organic material inks should be started.

(5-2-2) Consideration of Drying Method

**[0103]** The following considers an influence on the shape of the light-emitting layer exercised by the drying method of organic material inks in addition to the application order of organic material inks.

**[0104]** In the present embodiment, the G organic material ink **16**GI undergoes natural drying processing until the shape of the G light-emitting layer **16**G has been determined, and then the G organic material ink **16**GI undergoes forced drying processing. Accordingly, at the start time of forced drying processing of the G organic material ink **16**GI, an amount of the solvent has been decreased to a certain degree, and the shape of the G organic material ink **16**GI has been determined.

**[0105]** In the process shown in FIG. **7** compared with this, during a time period between start of application and completion of application, each of the R organic material ink **16**RI and the B organic material ink **16**BI is spontaneously dried. After completion of application, each of the R organic material ink **16**RI and the B organic material ink **16**BI undergoes forced drying processing.

**[0106]** In other words, the G organic material ink **16**GI, which has a low viscosity, is longer than the R organic material ink **16**RI and the B organic material ink **16**BI in terms of natural drying time period after completion of application (a time period between completion of application and start of forced drying processing).

**[0107]** The following describes reasons why there is less variation in shape of light-emitting layers which have undergone natural drying processing for a long natural drying time period. At a time immediately after the G organic material ink **16**GI is applied, variation in shape of the G organic material ink **16**GI sometimes occurs between the G subpixel regions. If this G organic material ink **16**GI undergoes forced drying processing such as reduced-pressure drying processing and heated-air drying processing without undergoing sufficient natural drying processing, organic light-emitting layers **16** might be formed while there is still variation in distribution of solute. Compared with this, by securing a longer natural drying time period for the G organic material ink **16**GI, which is most subject to variation in shape, than the R organic material ink **16**RI and the B organic material ink **16**BI, it is possible to suppress variation in distribution of solute of the applied organic material inks **161**, thereby suppressing variation in cross-sectional shape of the light-emitting layers **16**.

**[0108]** Note that even if the organic material ink having the lowest viscosity is not completely dried by natural drying processing, it is possible to suppress variation in cross-sectional shape of the light-emitting layers **16** by drying the organic material ink having the lowest viscosity for a further long time period. For example, it is preferable to secure a longer natural drying time period for the organic material ink having the lowest viscosity, which is most subject to variation in cross-sectional shape, than respective natural drying time periods for the other two organic material inks.

**[0109]** In the present embodiment, the description has been given on the case where both the features of the application order of organic material inks and the drying method are included. Only with one of the features of the application order of organic material inks and the drying method, it is also possible to prevent variation in distribution of solute of the organic material ink at the time immediately after application from exercising an influence on the final shape of the light-emitting layers. This exhibits an effect of suppressing variation in shape of the light-emitting layers between the subpixel regions.

**[0110]** Note that, in the process shown in FIG. **7**, the R and B organic material inks each start undergoing forced drying processing at the same time as when application thereof is completed. Alternatively, the R and B organic material inks each may undergo forced drying processing after undergoing natural drying processing for a predetermined time period. However, if the natural drying time period is secured for each of the R and B organic material inks, a long takt time occurs. For this reason, it is effective to dry the G organic material ink having the lowest viscosity for a longer drying time period than the R and B organic material inks, as described above.

(5-3) Summary of Effects

**[0111]** In the present embodiment, only the G organic material ink **16**GI is applied to the G subpixel regions while the R organic material ink **16**RI and the B organic material ink

16BI have not been yet applied to the R and B subpixel regions, respectively, which are each adjacent to a corresponding one of the G subpixel regions.

**[0112]** This suppresses the difference in solvent atmosphere between two subpixel regions which are adjacent to each of the G subpixel regions on the both sides thereof, thereby suppressing variation in the difference in solvent atmosphere on the both sides between the G subpixel regions, which are positioned in different positions in the organic EL display panel **1**, compared with the case where an organic material ink has been already applied to only one of the R and B subpixel regions, which are adjacent to each of the G subpixel regions, at the start time of application of the G organic material ink **16**GI.

**[0113]** Accordingly, it is possible to suppress variation in convection current of a solvent during a time period between when application of the G organic material ink **16**GI, which has the lowest viscosity, is started to when drying of the G organic material ink **16**GI is completed, between the G subpixel regions which are positioned in different positions in the organic EL display panel **1**. This suppresses variation in shape of the G light-emitting layers **16**G, which are positioned in different positions in the organic EL display panel **1**.

**[0114]** As a result, uneven luminance is suppressed.

**[0115]** Also, after drying of the G organic material ink **16**GI is completed, application of at least one of the R organic material ink **16**RI and the B organic material ink **16**BI (the R organic material ink **16**RI in the present embodiment) is started. Accordingly, it is possible to suppresses variation in cross-sectional shape of the G light-emitting layers **16**G, compared with the case where before drying of the G organic material ink **16**GI is completed, application of the R organic material ink **16**RI and the B organic material ink **16**BI is started. This is because a light-emitting layer **16**G is formed as follows. The solvent is completely dried from the G organic material ink **16**GI until a convection current of a solvent of the G organic material ink **16**GI is reduced. No organic material ink is applied to the R and B subpixel regions which are adjacent to each of the G subpixel regions until the solvent is completely dried from the G organic material ink **16**GI.

**[0116]** Furthermore, the G organic material ink **16**GI, which has the lowest viscosity, is longer than the R organic material ink **16**RI and the B organic material ink **16**BI in terms of natural drying time period after completion of application (a time period between completion of application and start of forced drying processing). Accordingly, it is possible to form the G light-emitting layers **16**G whose cross-sectional shape is most subject to variation, such that there is further less variation in cross-sectional shape.

**[0117]** Note that by applying the organic material ink in the order described in the present embodiment, it is also possible to further uniformize the film thickness of the light-emitting layers **16** in the subpixel regions.

**[0118]** The variation in film thickness between the subpixel regions is also caused by a material, water repellency, an inclination angle of lateral surfaces, and so on of the barrier rib layer. Accordingly, there is a case where even if there is no difference in solvent atmosphere between two subpixel regions which are adjacent to each of subpixel regions of a specific color on the both side thereof, variation occurs in film thickness of light-emitting layers **16** in the subpixel regions of the specific color. However, it is possible to uniformize the film thickness of the light-emitting layers of the specific color better in the case where a small difference in solvent atmosphere on the both sides occurs than in the case where a large difference in solvent atmosphere on the both sides occurs.

## Embodiment 2

**[0119]** Embodiment 2 differs from the above Embodiment 1 only in terms of the process of forming the light-emitting layers **16**, and is common with Embodiment 1 in terms of configuration of the substrate and use of the ink jet. Accordingly, description on the substrate, the ink jet, and the organic material ink is omitted here.

### 1. Details of Process of Forming Light-Emitting Layers

**[0120]** FIG. **12**A to FIG. **12**E are cross-sectional views showing a process of forming light-emitting layers of the organic EL display panel **1**. FIG. **13**A and FIG. **13**B are top views showing the process of forming light-emitting layers shown in FIG. **12**A to FIG. **12**E.

**[0121]** As shown in FIG. **12**A, a G organic material ink **16**GI is applied to each of G subpixel regions by the ink jet method. No organic material ink exists in an R subpixel region and a B subpixel region which are adjacent to the G subpixel region on both sides thereof, and only all the G subpixel regions on the organic EL display panel **1** are filled with the G organic material ink **16**GI.

**[0122]** Next, as shown in FIG. **12**B, light-emitting layers **16**G are formed. Specifically, a stand-by time period is given to leave the substrate unattended until solvents for all the G subpixel regions on the organic EL display panel **1** have been dried after application of the G organic material ink **16**GI is completed. A stand-by time period for natural drying processing in the present embodiment is approximately 20 minutes to 30 minutes. After the stand-by time period elapses, a G light-emitting layer **16**G which has been dried only by natural drying processing is obtained in each of the G subpixel regions. FIG. **13**A is an overhead view of the state shown in FIG. **12**B.

**[0123]** As shown in FIG. **12**C, after the G light-emitting layers **16**G are formed, an R organic material ink **16**RI is applied to each of R subpixel regions.

**[0124]** Next, as shown in FIG. **12**D, a B organic material ink **16**BI is applied to each of B subpixel regions.

**[0125]** Next, as shown in FIG. **12**E, R light-emitting layers **16**R and B light-emitting layers **16**B are formed. Specifically, an R organic material ink **16**RI and a B organic material ink **16**BI are applied respectively to all the R and B subpixel regions on the organic EL display panel **1**, and then the R organic material ink **16**RI and the B organic material ink **16**BI each undergo reduced-pressure drying processing at 0.5 Pa for 20 minutes. FIG. **13**B is an overhead view of the state shown in FIG. **12**E.

**[0126]** Then, the entire organic EL display panel **1** undergoes bake drying processing (heated-air drying processing) at 130 degrees C. under $N_2$ atmosphere for 10 minutes. As a result, the light-emitting layers **16** are complete.

**[0127]** In FIG. **12**, after drying of the G organic material ink **16**GI by natural drying processing is completed, application of the R organic material ink **16**RI and application of the B organic material ink **16**BI are performed. In order to suppress variation in shape of the G light-emitting layers **16**G between the G subpixel regions, it is preferable to start application of the R organic material ink **16**RI and application of the B organic material ink **16**BI after drying of the G organic material ink **16**GI is completed.

**[0128]** However, even when drying of the G organic material ink **16**GI is not complete, application of the R organic material ink **16**RI and application of the B organic material ink **16**BI may be started. While application of the R organic material ink **16**RI and application of the B organic material ink **16**BI are performed, the G organic material ink is spontaneously dried. Then, the organic EL display panel **1** undergoes forced drying processing when an amount of the solvent for the G organic material becomes small.

**[0129]** FIG. **14** is a time chart showing the manufacturing process of the organic EL display panel **1**.

**[0130]** As shown in FIG. **14**, the G organic material ink **16**GI is firstly applied. Then, the R organic material ink **16**RI and the B organic material ink **16**BI are applied before forced drying processing of the G organic material ink **16**GI is started. Then, forced drying processing by bake drying processing is performed on the G organic material ink **16**GI, the R organic material ink **16**RI and the B organic material ink **16**BI, thereby to obtain the G light-emitting layers **16**G, the R light-emitting layers **16**R and the B light-emitting layers **16**B, respectively. The G organic material ink **16**GI is longer than the R organic material ink **16**RI and the B light-emitting layers **16**BI in terms of natural drying time period. Note that the R organic material ink **16**RI and the B organic material ink **16**BI, which have a high viscosity, are less subject to variation in shape due to difference in solvent atmosphere on the both sides. Accordingly, it is effective to employ the ink application order and the drying method relating to the present embodiment since the G organic material ink **16**GI has the lowest viscosity.

2. Effects

**[0131]** In this process of forming light-emitting layers, the R organic material ink **16**RI, the G organic material ink **16**GI, and the B organic material ink **16**BI simultaneously undergo forced drying processing by bake drying processing, thereby further reducing the manufacturing time period compared with that in Embodiment 1.

**[0132]** Because of having a high viscosity, the R organic material ink **16**RI and the B organic material ink **16**BI collectively undergo forced drying processing after being applied to the entire organic EL display panel **1** regardless of the application order. By performing forced drying processing on the two types of organic material inks having a high viscosity at once, it is possible to further reduce the manufacturing time period compared with that in Embodiment 1.

[Modifications]

1. Process of Forming Light-Emitting Layers

**[0133]** In the above embodiments, application of the R and B organic material inks is started after application of G organic material ink is completed. In order to further reduce an influence on the G organic material ink exercised by the difference in solvent atmosphere on the both sides, application of each of the R and B organic material inks should be desirably started after application of G organic material ink is completed.

**[0134]** However, the configuration is not limited to this.

**[0135]** Even by starting application of at least one of the R and B organic material inks before application of the G organic material ink is completed, it is possible to suppress variation in cross-sectional shape of the G light-emitting layers formed using the G organic material ink. The following describes, as Modification, one example of application order that is expected to exhibit effects, with reference to a time chart of the process of forming light-emitting layers shown in FIG. **15**A and FIG. **15**B.

**[0136]** At a time immediately after the G organic material ink is applied, since the solvent remains in the G subpixel regions, the G organic material ink is influenced by the difference in solvent atmosphere between the R and B subpixel regions which are adjacent to each of the G subpixel regions on the both sides thereof. Therefore, by securing a time period during which no organic material ink has not been yet applied to the R and B subpixel regions which are adjacent to each of the G subpixel regions after application of the G organic material ink is completed, it is possible to suppress variation in shape of the light-emitting layers between the subpixel regions.

**[0137]** As shown in FIG. **15**A, while application of the G organic material ink is performed, application of the R organic material ink and application of the B organic material ink are started in respective orders. Then, the R, G, and B organic material inks undergo forced drying processing. The present modification is common with the above embodiments in terms of that when application of the G organic material ink is started, the R and B organic material inks have not been yet applied respectively to the R and B subpixel regions which are adjacent to each of the G subpixel regions on both sides thereof. With this feature, it is possible to suppress an influence on the G organic material ink exercised by difference in solvent atmosphere between the R and B organic material inks. While application of the G organic material ink is still performed, spontaneous drying of part of the G organic material ink which has been applied is progressing, thereby suppressing variation in cross-sectional shape of the G light-emitting layers between the G subpixel regions. In addition, the R, G, and B organic material inks simultaneously undergo forced drying processing. Accordingly, it is possible to further reduce the manufacturing time period compared with that in Embodiment 1.

**[0138]** Also, as shown in FIG. **15**B, after application of the G organic material ink is completed, application of the R organic material ink may be performed. Then, the G and R organic material inks may undergo forced drying processing at once. Then, application and forced drying processing of the B organic material ink application may be performed. The B organic material ink has a higher viscosity than the G organic material ink. B light-emitting layers resulting from applying the B organic material ink are less subject to variation in film thickness than G light-emitting layers resulting from applying the G organic material ink. It is of course possible to suppress variation in film thickness of the B light-emitting layers between the B subpixel regions, by starting application of the B organic material ink after drying of the G and R organic material inks is completed.

**[0139]** Note that, in the above embodiments and the present modification, the application order of the R and B organic material inks may be replaced. Also, in the same way as in Embodiment 1, by starting application with one of the R and B organic material inks which has a longer operating life than the other, it is possible to keep a long operating life of the organic EL display panel **1**. Alternatively, after application of the G organic material ink is started, application of the R and B organic material inks may be started in an order of R and B or in an order of B and R. For example, application of the G organic material ink is started after application of the R organic material ink is completed, and then application of the B organic material ink is started after application of the G organic material ink is started.

2. Properties of Organic Material Ink

(Viscosity)

**[0140]** The above embodiments have given the description that the G organic material ink includes an organic light-emitting material that has the lowest viscosity among R, G, and B organic light-emitting materials. Alternatively, the B or R organic light-emitting material may have the lowest viscosity.

**[0141]** For example, it is preferable that in the case where the B organic material ink has a lower viscosity than the R and G organic material inks, application of the B organic material ink should be started before application of the R and G organic material inks is started.

**[0142]** Also, an organic material ink for use in the device structure by the inkjet method should have a viscosity of 5 mPas to 50 mPas. Here, a high viscosity of organic material inks in the present invention falls in a range of approximately 9 mPas to 15 m Pas. Also, a low viscosity of organic material inks in the present invention falls in a range of approximately 4 mPas to 7 mPas.

**[0143]** Furthermore, even if more than three types of organic material inks are used, it is possible to exhibit the same effects as those in the above embodiments, by starting application with an organic material ink having the lowest viscosity among the more than three types of organic material inks in the same manner as in the above embodiments.

(Surface Tension)

**[0144]** The organic material ink should preferably have a surface tension of 20 mN/m to 70 mN/m, and should particularly preferably have a surface tension of 25 mN/m to 45 mN/m. By setting the surface tension of the organic material ink in this range, it is possible to prevent a so-called flight curve of droplets of the organic material ink during discharge. Specifically, in the case where the organic material ink has a surface tension of less than 20 mN/m, the organic material ink has an increased wettability on a surface of the nozzle. As a result, when the organic material ink is discharged, the organic material ink might attach asymmetrically around a nozzle hole. In this case, since an attractive force occurs between part of the organic material ink which attaches the nozzle hole and part of the organic material ink which is to be discharged, the organic material ink is discharged by non-uniform force. As a result, a flight curve often occurs and the organic material ink cannot reach a target position. On the contrary, in the case where the organic material ink has a surface tension of more than 70 mN/m, the shape of droplets at the front end of the nozzle is unstable. This results in difficulty controlling the discharge diameter and discharge timing of the organic material ink.

(Solids Concentration)

**[0145]** The organic material ink should preferably have a solid content concentration of 0.01 wt % to 10.0 wt % and more preferably 0.1 wt % to 5.0 wt % relative to all compositions. If the organic material ink has a too low solid content concentration, many times of discharges are required for obtaining a necessary film thickness. This deteriorates manufacturing efficiency. On the contrary, if the organic material ink has a too high solid content concentration, the organic material ink has an increased viscosity. This exercises an influence on discharge properties.

(Solvent)

**[0146]** Generally, an organic material for layers having a light-emitting function such as light-emitting layers and hole injection layers is dissolved in an organic solvent so as to be converted to an organic material ink for application. A solvent for the organic material is selected in consideration of solubility and stability of the organic material, viscosity and surface tension of an organic material ink which are necessary for forming light-emitting layers, a boiling temperature which is necessary for securing uniformity of the light-emitting layers, and so on.

**[0147]** The solvent for the organic material ink may range from a solvent having a comparatively low boiling temperature such as toluene and xylene to a solvent having a boiling temperature of more than 300 degrees C. such as dodecylbenzene.

**[0148]** For example, a hydrocarbon solvent or an aromatic solvent may be used, such as n-dodecylbenzene, n-decylebenzene, isopropylbiphenyl, 3-ethylbiphenylnonylbenzene, 3-methylbiphenyl, 2-isopropylnaphthalene, 1,2-dimethylnaphthalene, 1,4-dimethylnaphthalene, 1,6-dimethylnaphthalene, 1,3-diphenylpropane, diphenylmetan, octylbenzene, 1,3-dimethylnaphthalene, 1-ethylnaphthalene, 2-ethylnaphthalene, 2,2-dimethylbiphenyl, 3,3-dimethylbiphenyl, 2-methylbiphenyl, 1-methylnaphthalene, 2-methylnaphthalene, cyclohexylbenzene, 1,3,5-triisopropylbenzene, hexylbenzene, 1,4-diisopropylbenzene, tetralin, 1,3-diisopropylbenzene, 5-tert-butyl-m-xylene, amylbenzene, 1,2,3,5-tetramethylbenzene, 5-isopropyl-m-xylene, 3,5-dimethylanisole, 4-ethyl-m-xylene, n-butylbenzene, methoxytoluene, seG-butylbenzene, isobutylbenzene, 1,2,4-trimethylbenzene, tert-butylbenzene, 1,3,5-trimethylbenzene, anisole, dibutyl phthalate, dihexyl phthalate, dicyclohexylketone, cyclopentylphenylketone, diethyl phthalate, dimethyl phthalate, hexylbenzoate, isoamylbenzoate, n-buthylbenzoate, 2-cyclohexylcyclohexanone, 2-n-heptylcyclopentanone, phenoxytoluene, diphenylether, 1-ethoxynaphthalene, 2-methoxybiphenyl, isobutylbenzoate, propylbenzoate, isovaleric acid cyclohexyl ester, ethylbenzoate, cyclopropylphenylketone, 2-hexylcyclopentanone, 2-pyrrolidone, 2-cyclopentylcyclopentanone, 1-methyl-2-pyrrolidone, 6-methoxy-1,2,3,4-tetrahydronaphthalene, 2,5-dimethoxytoluene, 1-methoxy-2,3,5-trimethylbenzene, butylphenylether, 3,4-dimethylanisole, methylbenzoate, and 4-ethylcyclohexanone. Alternatively, monohydric alcohol such as methanol, ethanol, isopropyl alcohol, and n-butanol, or a cellosolve solvent such as methylcellosolve and ethylcellosolve may be used. Further alternatively, in consideration of solubility and so on of materials, other solvent may be used.

**[0149]** Furthermore, though only one type of these solvents may be used, these solvents should preferably be used in mixture. Here, by using a solvent having a comparative low boiling temperature in mixture with a solvent having a high boiling temperature, it is possible to increase planarity of light-emitting layers after the solvent has been dried. For example, in the case where a solvent having a boiling temperature of 100 degrees C. to 200 degrees C. is used in mixture with a solvent having a boiling temperature of 250 degrees C.

to 350 degrees C., light-emitting layers having an excellent planarity are obtained by the inkjet method and the nozzle-coat method.

3. Ink Jet Head

**[0150]** Since a piezo ink jet head discharges an ink by deforming piezo elements. For this reason, the use of an ink having a too high viscosity deteriorates discharge properties, thereby deteriorating landing accuracy. Accordingly, it is necessary to consider the performance of the piezo ink jet head in use of an ink having a high viscosity.

**[0151]** Also, in the above embodiments and so on, the multipath printing method is used according to which printing is performed by plural times of ink jet head scanning. Alternatively, a method such as a line bank method may be used according to which printing is performed by a single time of ink jet head scanning.

4. Drying Method

**[0152]** It is important that how an organic material ink is dried from a viewpoint of suppressing variation in cross-sectional shape of light-emitting layers. An organic material ink is dried by a drying method such as vacuum drying processing, heated-air drying processing, or drying processing inert gas. Also, there is a case where an organic material ink is dried under an atmosphere filled with a certain amount of a solvent for the organic material ink.

5. Layer Configuration

**[0153]** The organic EL display panel **1** may be of a so-called bottom emission type in which light emitted from light-emitting layers is extracted from the side of a glass substrate or a so-called top emission type in which light emitted from the light-emitting layers is extracted from the opposite side of the glass substrate. In the case where the organic EL display panel **1** is of the top emission type, light-reflective anodes and a cathode that is substantially translucent should preferably be used. The anodes and the cathode often each have a multi-layer structure. Furthermore, the organic EL display panel **1** may have a so-called reverse structure in which one of two types of electrodes that is provided close to the substrate is used as a cathode. The effects of the present invention are expected to be exhibited by both of the bottom emission type with the reverse structure and the top emission type with the reverse structure.

6. Light-Emitting Layers and IL Layers

**[0154]** Light emitting layers are formed on hole injection layers by applying an organic semiconductor material. Also, an electron injection layer is formed between each of the light-emitting layers and a cathode. From a viewpoint of light-emitting efficiency, it is preferable that an IL layer should be provided as a hole blocking layer between each of the light-emitting layers and each of the hole injection layers. The hole blocking layer is made of a polyfluorene high-polymer material such as TFB that has a higher LUMO (lowest unoccupied molecular orbital) or a lower electron mobility than the material of the light-emitting layers. However, the configuration of the hole blocking layer is not limited to this. Also, the light-emitting layers may be made of any type of polyfluorene materials, polyphenylenevinylene materials, and low molecular materials such as pendant, dendrimer, and coating-type materials, as long as the material is dissolved in a solvent and applied to form a thin film.

**[0155]** The light-emitting layers may be made of a plurality of types of materials having a light-emitting function, such that mobility and injection properties of holes and electrons and luminescent chromaticity are adjusted. Also, in the case where a light-emitting material is used as a dopant, an application liquid resulting from mixing a host material with a dopant may be used. The dopant may be known fluorescent light-emitting material or phosphorescent light-emitting material. These materials each may be low molecular, high molecular, oligomer, or the like. Furthermore, these materials may be variously combined with each other. For example, a low molecular dopant may be added to a high molecular host material.

7. Barrier Rib Layer and Bank

**[0156]** A barrier rib layer should desirably have a thickness of 100 nm or greater, though largely depending on a concentration of an organic material ink for printing. Also, the barrier rib layer may be arbitrarily made of any material having electrical insulating properties. Specifically, the barrier rib layer should preferably be made of resin having electrical insulating properties and resistance properties against heat and solvent, such as polyimide resin. Furthermore, it is desirable that the barrier rib layer should have a function of preventing overflow of an organic material ink at the time of printing in regions separated by a bank by an ink jet or the like, by including a component that is repellent to an organic material ink in an organic material of the barrier rib layer. The barrier rib layer is formed by patterning with use of a photolithography technology or the like. For example, after a material of the barrier rib layer is applied, the barrier rib layer with a desired shape is formed on a TFT substrate through base processing, mask exposure processing, development processing, and so on. Moreover, the barrier rib layer in the above embodiments has a forward tapered cross section. This forward tapered shape is preferable in terms of that overflow of an organic material ink is prevented and that a formation state of light-emitting layers is checked. However, the cross-sectional shape of the barrier rib layer is not limited to the forward tapered shape.

8. Hole Injection Layers

**[0157]** Hole injection layers are made of an organic material such as polythiophene PEDT:PSS by a spin-coat method, the inkjet method, or the nozzle-coat method. Alternatively, the hole injection layers may be made of polyaniline material. Further alternatively, it is known that the hole injection layers are made of an inorganic material, and may be made of molybdenum oxide, tungsten oxide, vanadium oxide, ruthenium oxide, or the like. Yet alternatively, the hole injection layers may be formed by evaporating a carbon compound such as fullerene, molybdenum oxide, and tungsten oxide, with use of the vacuum evaporation method, an electron beam evaporation method, a sputtering method, or the like.

**[0158]** The hole injection layer should preferably be made of in particular transition metal oxide material because of having high ionization potential, ease of injecting holes to a light-emitting material, and high stability. By forming the hole injection layers from these oxide materials such that the hole injection layers have a defect level at the time of or after formation, it is effective to increase the hole injection properties of the hole injection layers. Also, the hole injection layers should preferably have a film thickness of 5 nm to 200 nm.

9. Cathode

**[0159]** A cathode is made of metal or alloy having a low work function. In the above embodiments, in the case of an organic EL display panel of the top emission type, a transparent cathode should be formed by forming an extremely thin film having high light transmissivity from metal having low work function, and laminating a conductive film that is made of a translucent material such as ITO and IZO on the extremely thin film. The extremely thin film, which is made of metal having low work function, is not limited to having a two-layer structure of Ba and AI, and may have a two-layer structure of Ca and AI. Alternatively, the extremely thin film may be made of metal such as Li, Ce, Ca, Ba, In, Mg, and Ti, or metal oxide of any of these metals, halide typified by fluoride, Mg alloy such as Mg—Ag alloy and Mg—In alloy, and AI alloy such as AI—Li alloy, AI—Sr alloy, and AI—Ba alloy. Alternatively, a cathode should preferably made of an extremely thin film having a laminated structure of a combination of LiO2 and AI, a combination of LiF and AI, or the like and a translucent conductive film that is laminated on the extremely thin film. Furthermore, an electron injection layer may be made of transition metal oxide material having oxygen deficiency and conductivity such as TiOx, MoOx, WOx, TiOx, and ZnO.

10. Electrical Connection of Organic EL Display Panel

**[0160]** As shown in FIG. **16**, the organic EL display panel relating to the above embodiments is connected to drive circuits **31** that are controlled by a control circuit **32**.

11. Product Form

**[0161]** It is possible to distribute the organic EL display panel relating to the above embodiments as a single device to a market channel. In addition, without being limited to distribution as a single device, the organic EL display panel may be distributed by being incorporated into a display device such as a digital television as shown in FIG. **17**.

## INDUSTRIAL APPLICABILITY

**[0162]** In manufacturing of organic EL display panels including organic EL elements formed by an ink jet device, the present invention suppresses uneven luminance that occurs in the organic EL display panels due to the use of an ink having a low viscosity. The present invention provides an organic EL display panel having a high image quality with no uneven luminance caused by a viscosity of an ink material or the like, and therefore exhibits high versatility and availability in the field of displays for various types of electronic appliances.

## REFERENCE SIGNS LIST

**[0163]** **1** organic EL display panel
**[0164]** **11** TFT substrate
**[0165]** **12** barrier rib layer
**[0166]** **13** anode
**[0167]** **14** hole injection layer
**[0168]** **15** IL layer
**[0169]** **16** light-emitting layer
**[0170]** **16**R R light-emitting layer
**[0171]** **16**G G light-emitting layer
**[0172]** **16**B B light-emitting layer
**[0173]** **161** organic material ink
**[0174]** **16**RI R organic material ink
**[0175]** **16**GI G organic material ink
**[0176]** **16**BI B organic material ink
**[0177]** **17** electron injection layer
**[0178]** **18** cathode
**[0179]** **19** sealing layer
**[0180]** **20** ink jet head
**[0181]** **31** drive circuit
**[0182]** **32** control circuit

**1-10**. (canceled)

**11**. A manufacturing method of an organic EL display panel comprising:

preparing a first ink including a first organic light-emitting material and a solvent;

preparing a second ink including a second organic light-emitting material and a solvent, the second organic light-emitting material differing from the first organic light-emitting material in terms of light-emitting wavelength;

preparing a third ink including a third organic light-emitting material and a solvent, the third organic light-emitting material differing from the first organic light-emitting material and the second organic light-emitting material in terms of light-emitting wavelength;

applying the first ink to first subpixel regions on a substrate; and

applying the second ink to second subpixel regions that are each adjacent to a corresponding one of the first subpixel regions; and

applying the third ink to third subpixel regions that are each adjacent to a corresponding one of the first subpixel regions on an opposite side of the first subpixel region relative to a corresponding one of the second subpixel regions, wherein

the first ink has a lower viscosity than the second ink and the third ink, and

after application of the first ink is started, application of the second ink and the third ink is started.

**12**. The manufacturing method of claim **11**, wherein

after application of the first ink is completed, application of the second ink and the third ink is started.

**13**. The manufacturing method of claim **11**, further comprising:

drying the first ink, after the applying the first ink, wherein

after drying of the first ink is started, application of the second ink and the third ink is started.

**14**. The manufacturing method of claim **13**, wherein

drying of the first ink is performed through natural drying processing and forced drying processing subsequent to the natural drying processing.

**15**. The manufacturing method of claim **11**, wherein

after application of the first ink is started, application of one of the second ink and the third ink is started earlier than the other, where one of the second organic material and the third organic material, corresponding to the one of the second ink and the third ink, has a longer operating life than the other.

**16**. The manufacturing method of claim **11**, wherein

a natural drying time period of the first ink is longer than a natural drying time period of each of the second ink and the third ink, the natural drying time period being a time period from when application is completed to when forced drying processing is started.

**17**. The manufacturing method of claim **14** wherein

drying of the second ink and the third ink is performed through forced drying processing without performing natural drying processing.

**18**. The manufacturing method of claim **13** wherein

after drying of the first ink is completed, application of the second ink and the third ink is started.

**19**. The manufacturing method of claim **11**, further comprising

drying the second ink and drying the third ink, after the applying the second ink and the applying the third ink.

**20**. A manufacturing method of an organic EL display panel comprising:

preparing a first ink including a first organic light-emitting material and a solvent;

preparing a second ink including a second organic light-emitting material and a solvent, the second organic light-emitting material differing from the first organic light-emitting material in terms of light-emitting wavelength;

preparing a third ink including a third organic light-emitting material and a solvent, the third organic light-emitting material differing from the first organic light-emitting material and the second organic light-emitting material in terms of light-emitting wavelength;

applying the first ink to first subpixel regions on a substrate; and

applying the second ink to second subpixel regions that are each adjacent to a corresponding one of the first subpixel regions; and

applying the third ink to third subpixel regions that are each adjacent to a corresponding one of the first subpixel regions on an opposite side of the first subpixel region relative to a corresponding one of the second subpixel regions, wherein

the first ink has a lower viscosity than the second ink and the third ink, and

a natural drying time period of the first ink is longer than a natural drying time period of each of the second ink and the third ink, the natural drying time period being a time period from when application is completed to when forced drying processing is started.

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| | | | |
|---|---|---|---|
| 专利名称(译) | 制造有机EL显示板的方法 | | |
| 公开(公告)号 | US20140335639A1 | 公开(公告)日 | 2014-11-13 |
| 申请号 | US14/362683 | 申请日 | 2012-12-14 |
| 申请(专利权)人(译) | 松下电器产业株式会社 | | |
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| IPC分类号 | H01L51/00 H01L51/50 | | |
| CPC分类号 | H01L51/0004 H01L51/5036 H01L2227/323 H01L27/3211 H01L27/3246 H01L51/0005 H01L51/0007 | | |
| 优先权 | 2011274414 2011-12-15 JP | | |
| 外部链接 | Espacenet USPTO | | |


摘要(译)

一种有机EL显示面板的制造方法，包括：制备G，R和B墨水，每种墨水包括溶剂，并且分别包括在发光波长方面彼此不同的G，R和B有机发光材料;将G墨水涂敷到基板上的G子像素区域;将R墨水应用于R子像素区域;并且将B墨水应用于B子像素区域。 R和B子像素区域各自与其两侧的G个子像素区域中的相应一个相邻。 G墨水的粘度低于R和B墨水。在开始施加G墨水之后，开始施加R和B墨水。