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Lee et al.

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(45) **Date of Patent: Jun. 16, 2009**

(54) **PATTERN MASK, LIGHT-EMITTING UNIT MANUFACTURED USING THE SAME, DISPLAY APPARATUS MANUFACTURED USING THE SAME AND METHOD OF MANUFACTURING DISPLAY APPARATUS USING THE SAME**

(75) Inventors: **Dong-Won Lee**, Seongnam-si (KR); **Joon-Hoo Choi**, Seoul (KR); **Jin-Koo Chung**, Suwon-si (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.** (KR)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01L 27/15 (2006.01)

(52) **U.S. Cl.** **257/79**; 257/93

(58) **Field of Classification Search** 257/79, 257/88, 93
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Mark Prenty
(74) *Attorney, Agent, or Firm*—Cantor Colburn LLP

(57) **ABSTRACT**

A display apparatus includes a light-emitting unit. The light-emitting unit includes a first electrode, a bank, an organic light-emitting layer and a second electrode. The first electrode is formed on a substrate. The first electrode receives a first driving signal from a circuit unit. The bank surrounds sides of the first electrode and has a receiving portion formed on an upper face of the bank. The organic light-emitting layer is formed on the first electrode. The second electrode is formed on the organic light-emitting layer. The second electrode receives a second driving signal from the circuit unit. Therefore, even though the organic light-emitting material is abnormally dropped onto an unintended position, the receiving portion prevents the organic light-emitting material from flowing into a neighboring cavity, so that yield increases and productivity is enhanced.

3 Claims, 15 Drawing Sheets

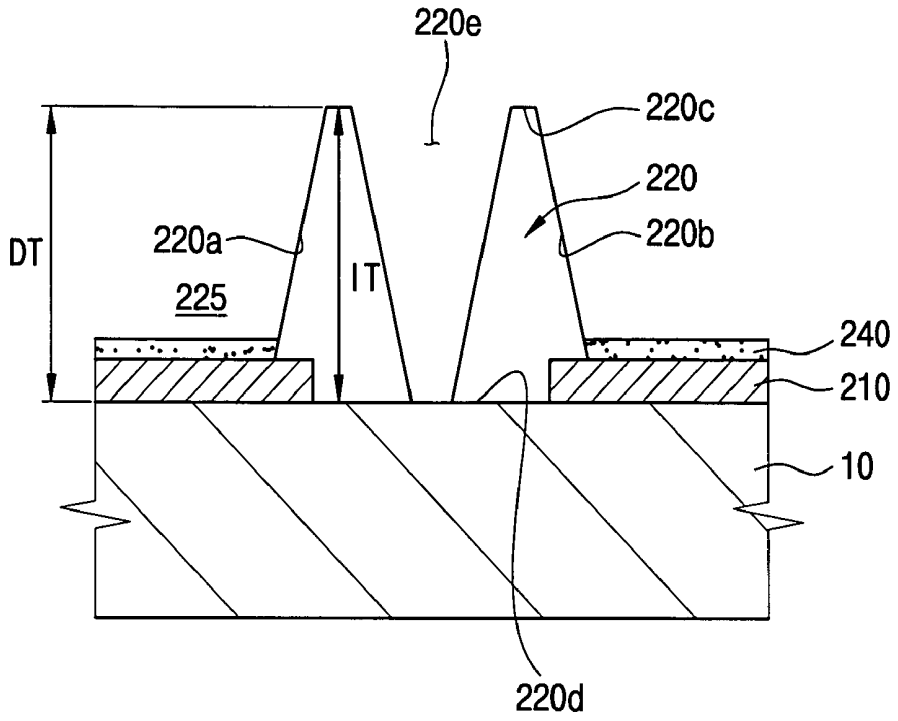


FIG. 1

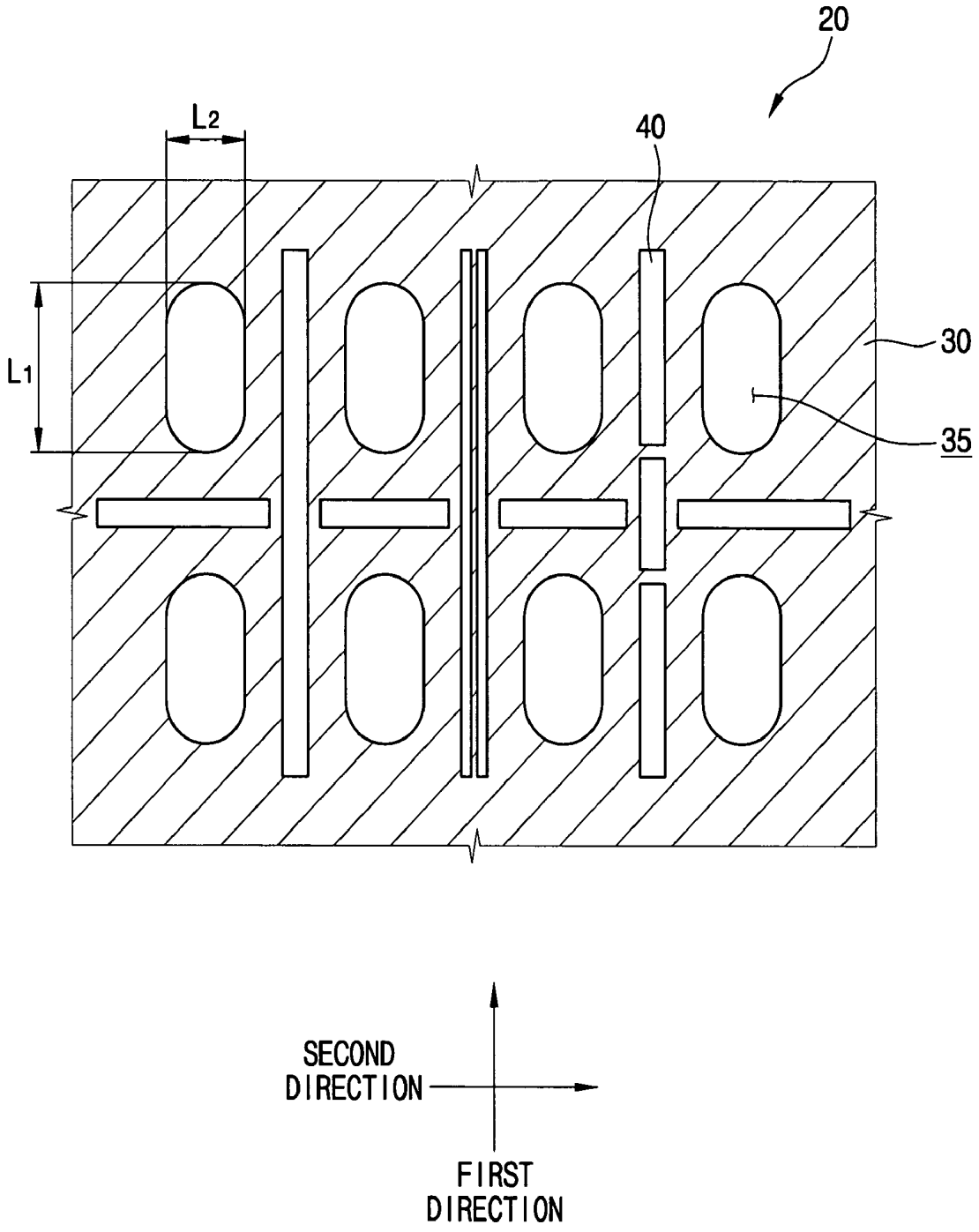


FIG. 2

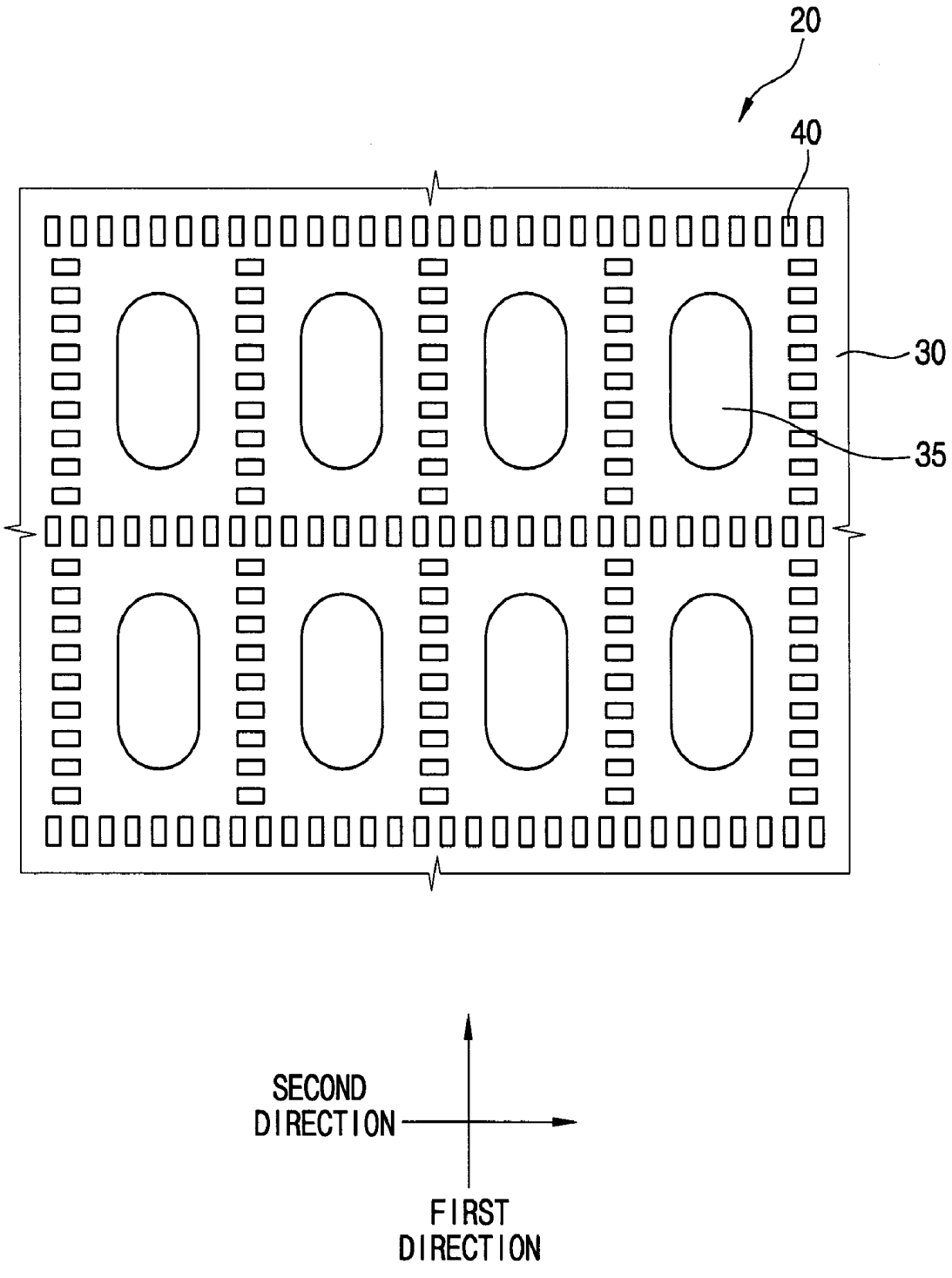


FIG. 3

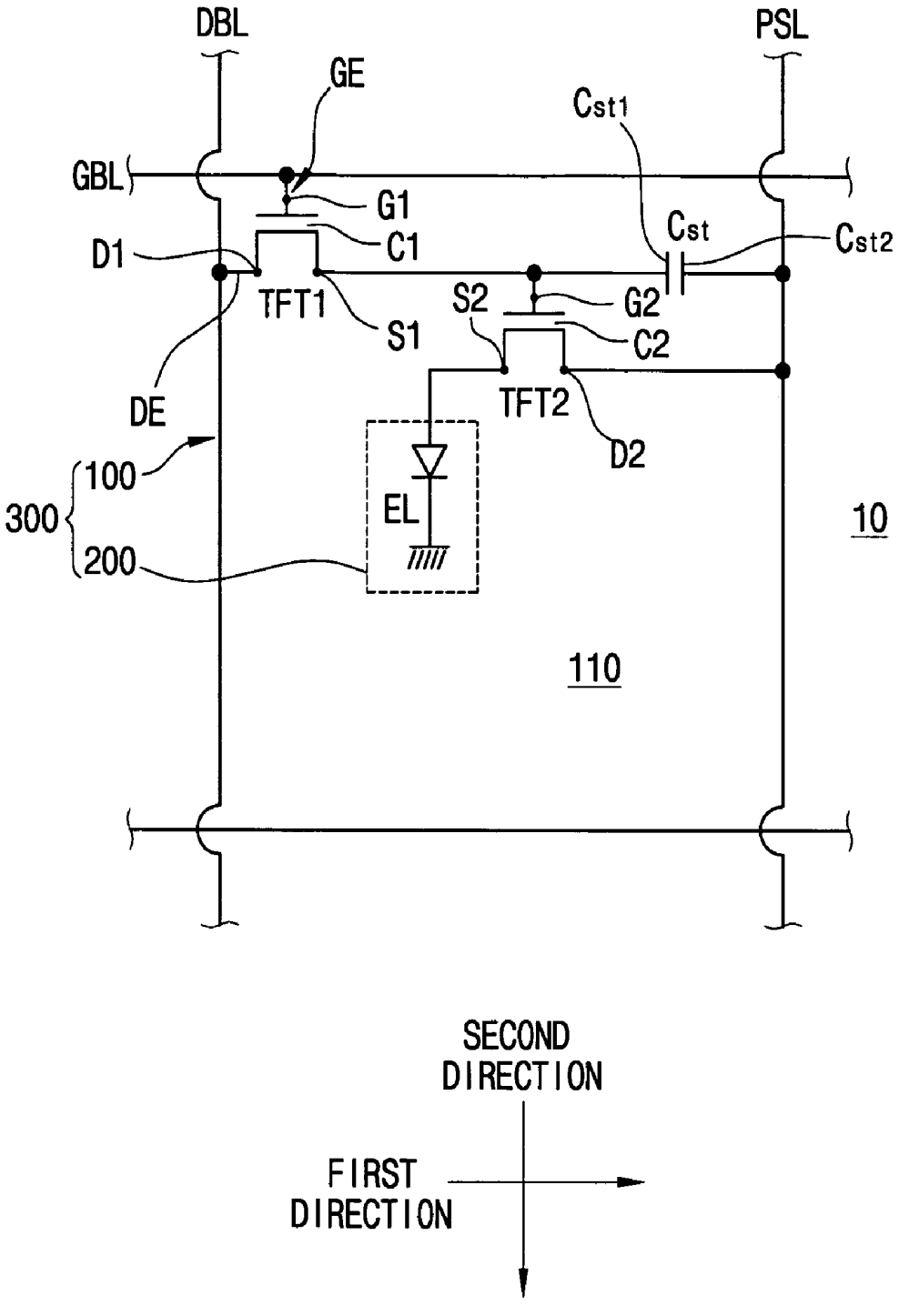

DBL
PSL
GE
Cst1
GBL
G1
Cst
Cst2
D1
C1
TFT1
S1
S2
G2
C2
TFT2
D2
DE
100
300
200
EL
10
110
SECOND DIRECTION
FIRST DIRECTION

FIG. 4

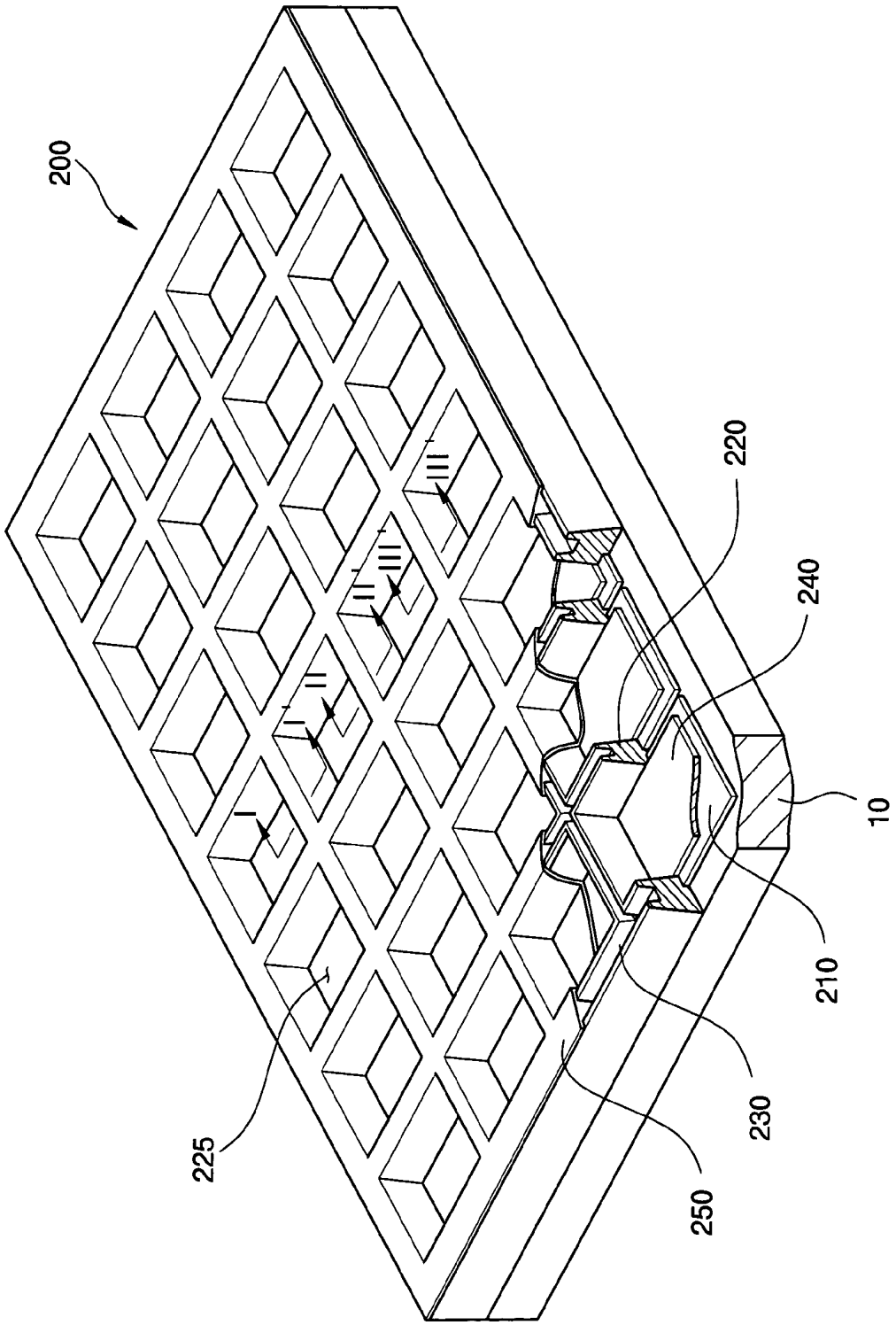


FIG. 5

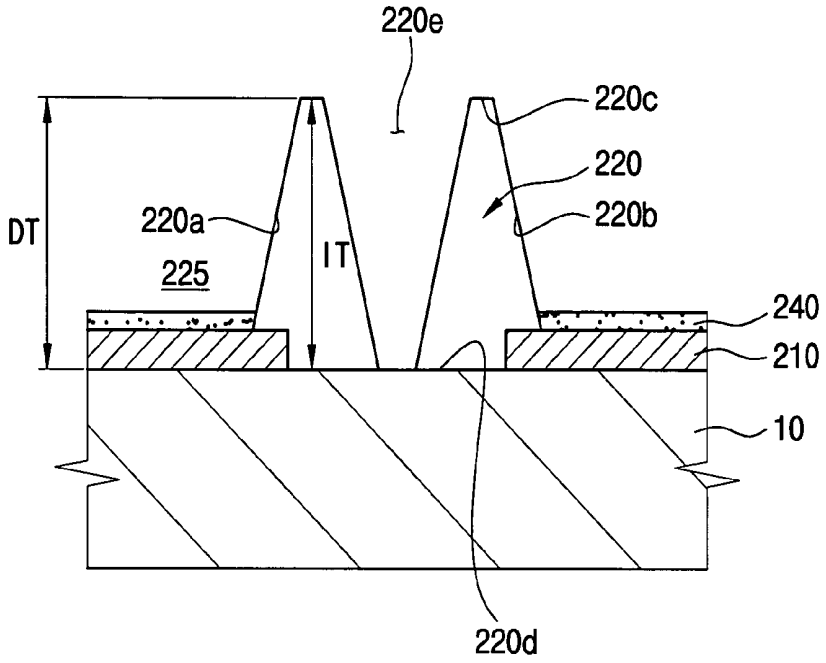

220e
220c
220
220b
DT
220a
225
IT
240
210
10
220d

FIG. 6

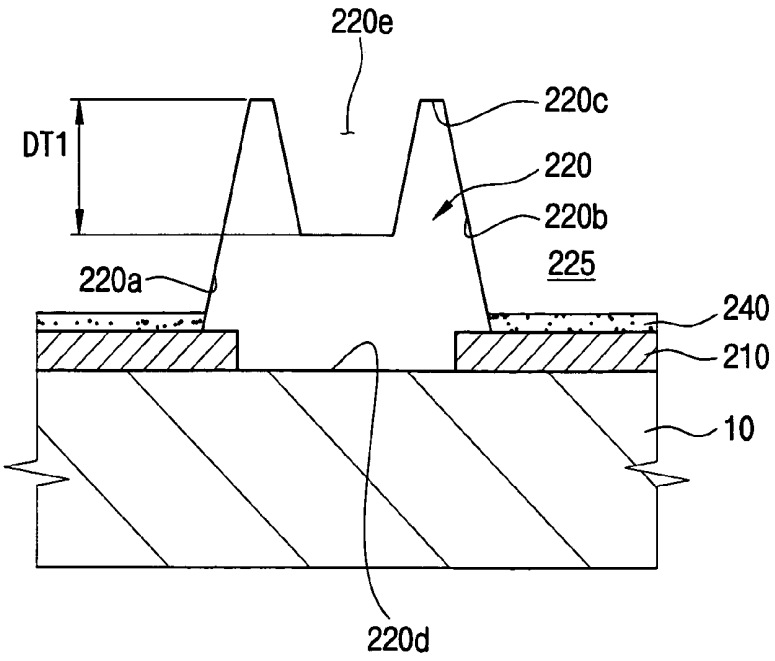

220e
220c
DT1
220
220b
225
220a
240
210
10
220d

FIG. 7

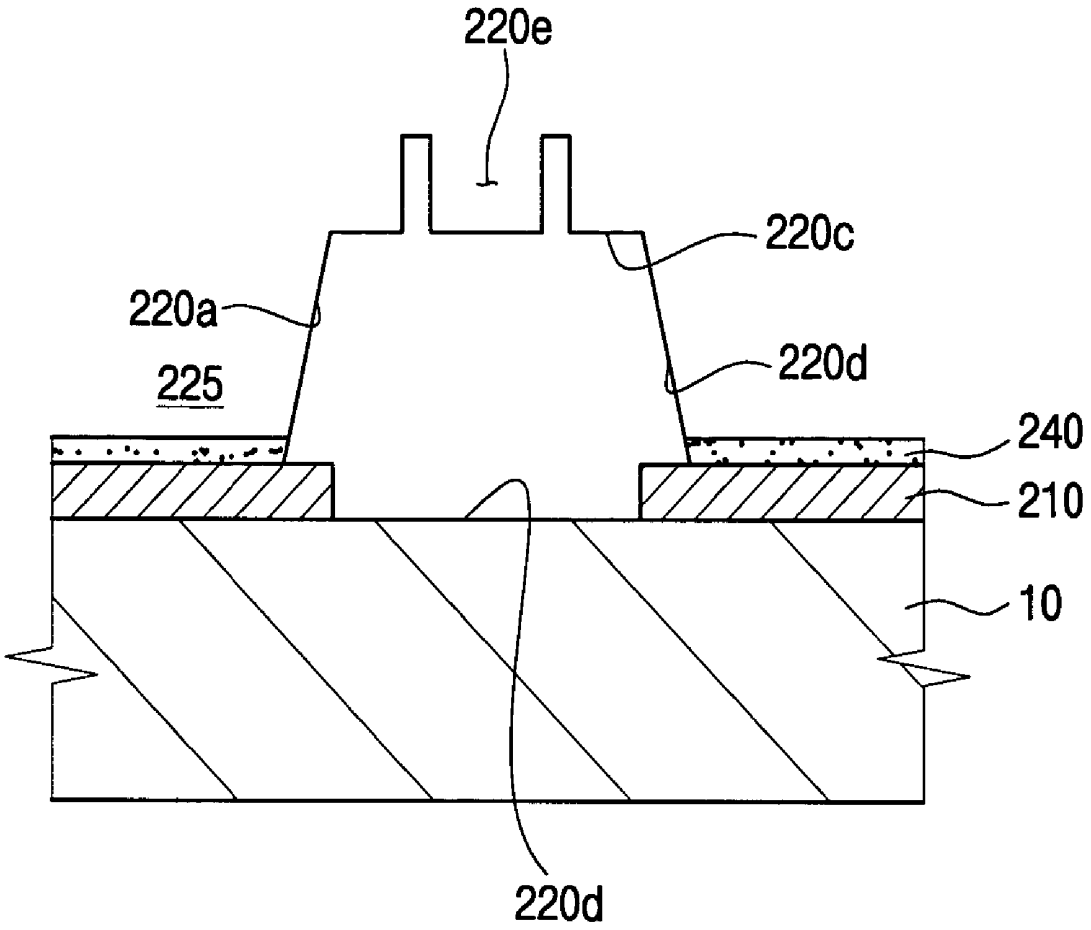


FIG. 8

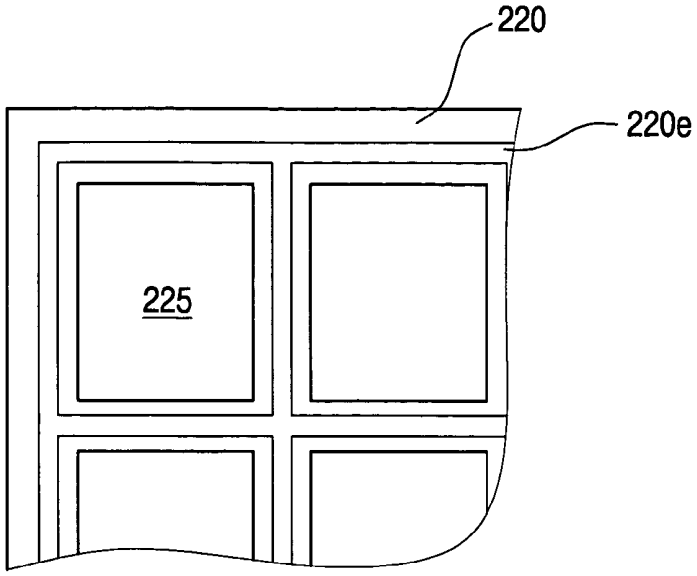


FIG. 9

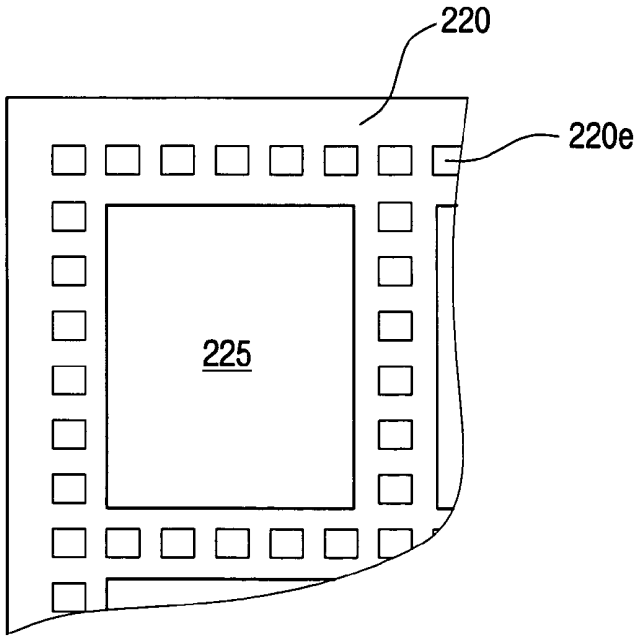
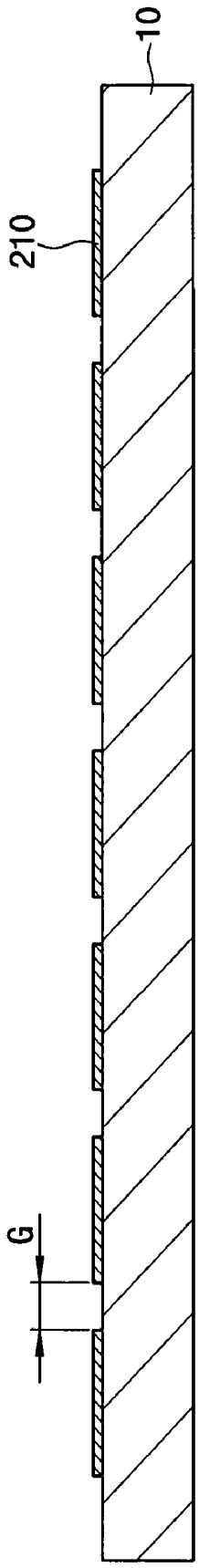


FIG. 10A



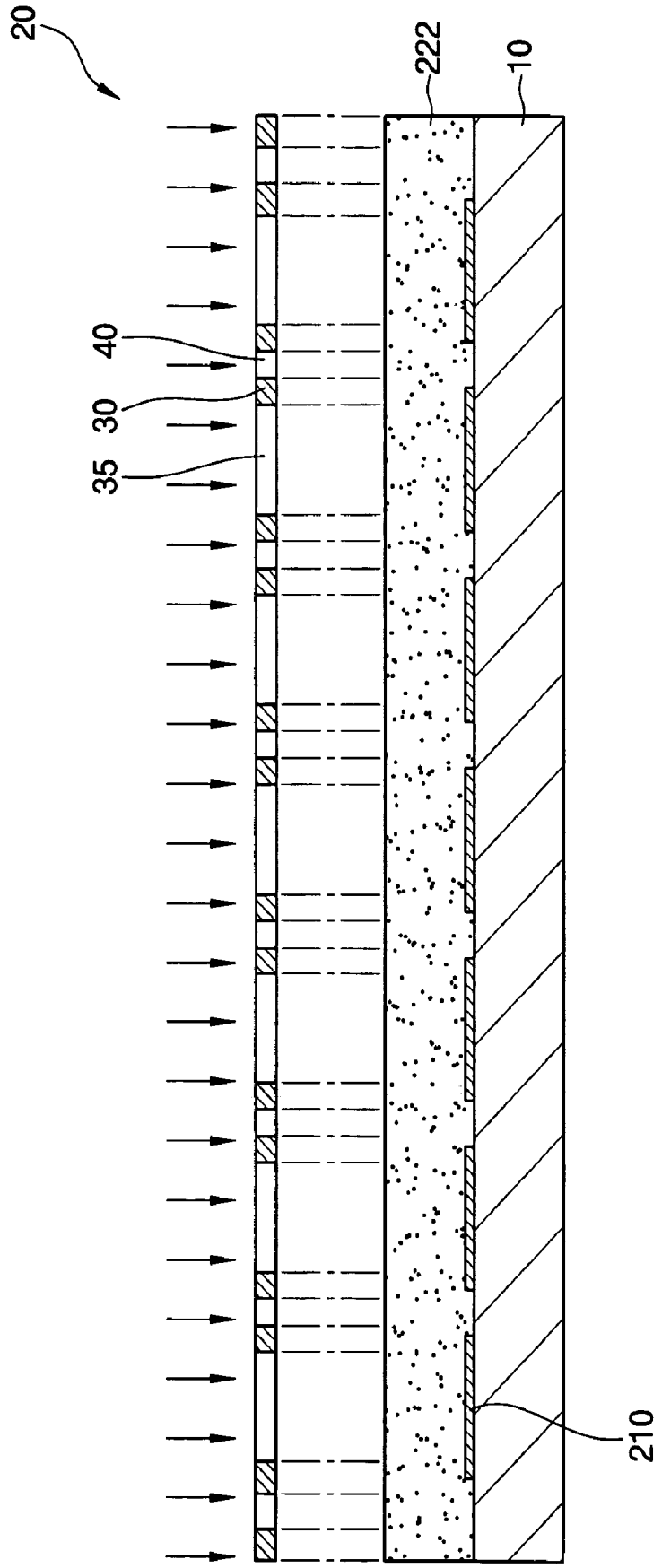


FIG. 10B

FIG. 10C

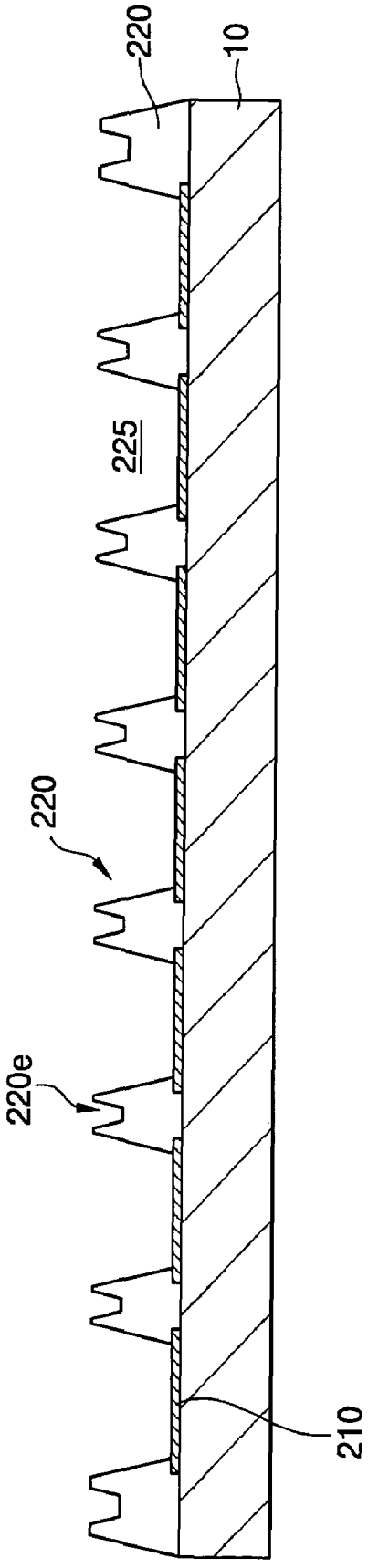


FIG. 10D

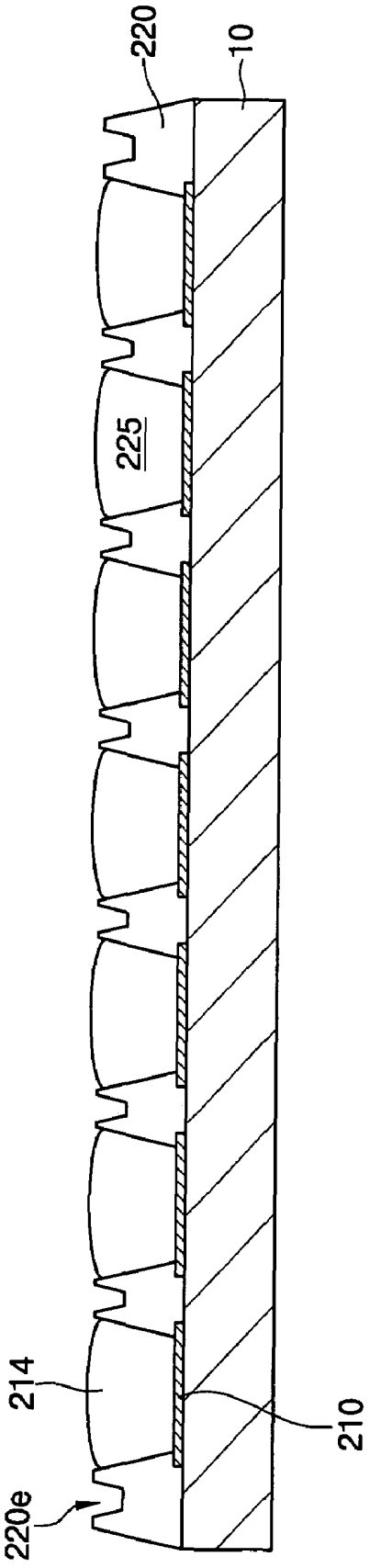


FIG. 10E

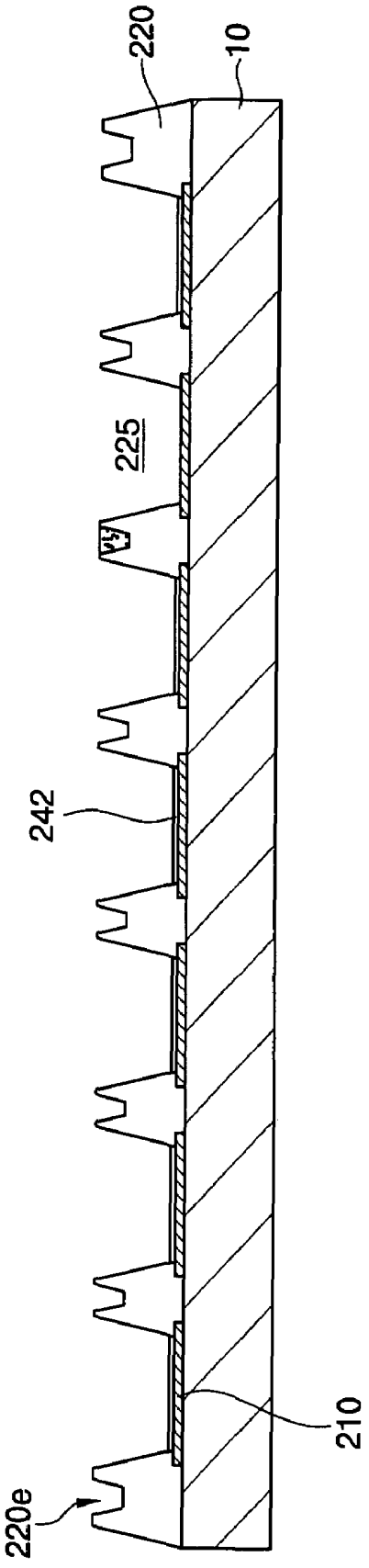


FIG. 10F

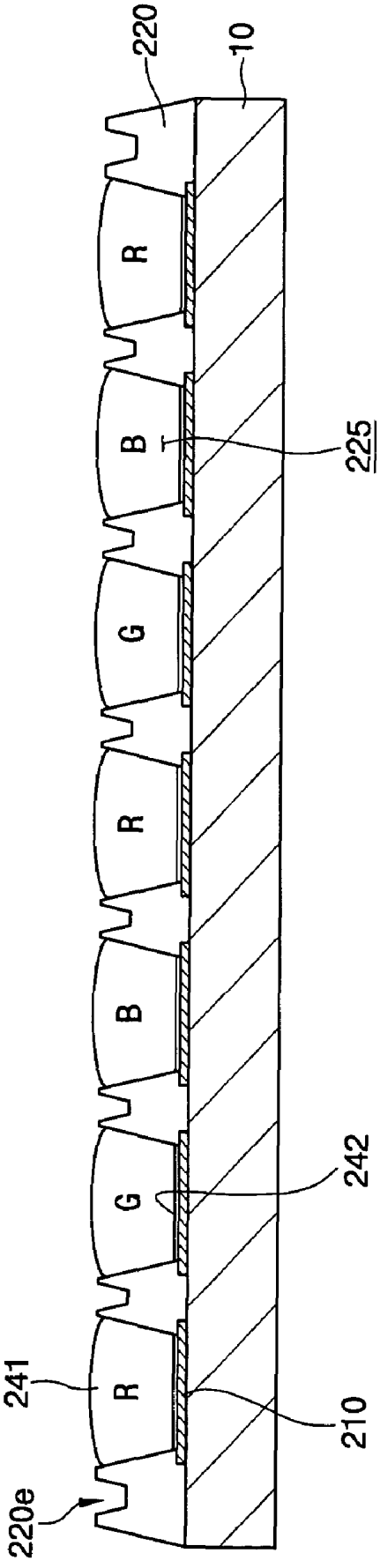


FIG. 10G

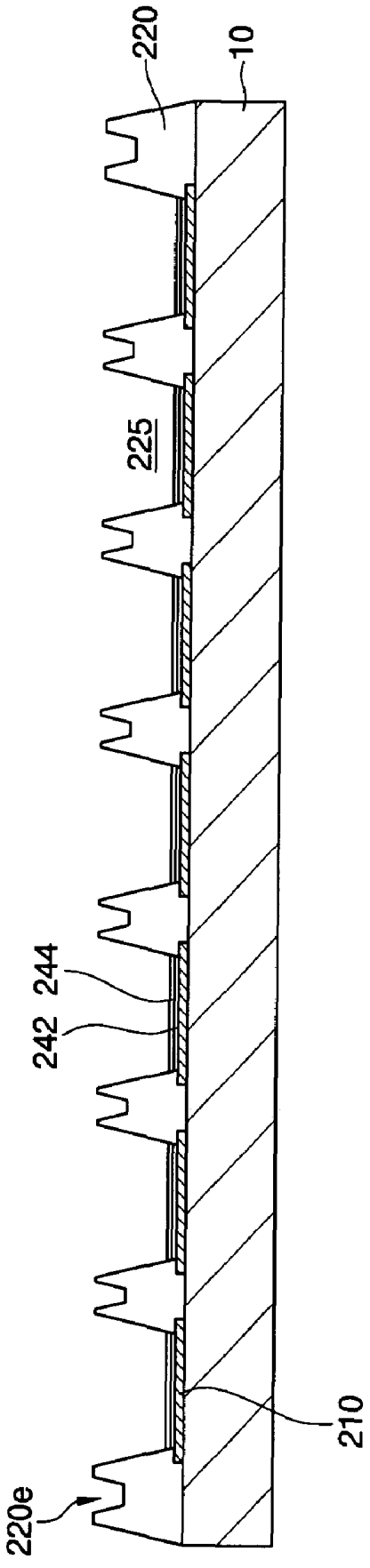
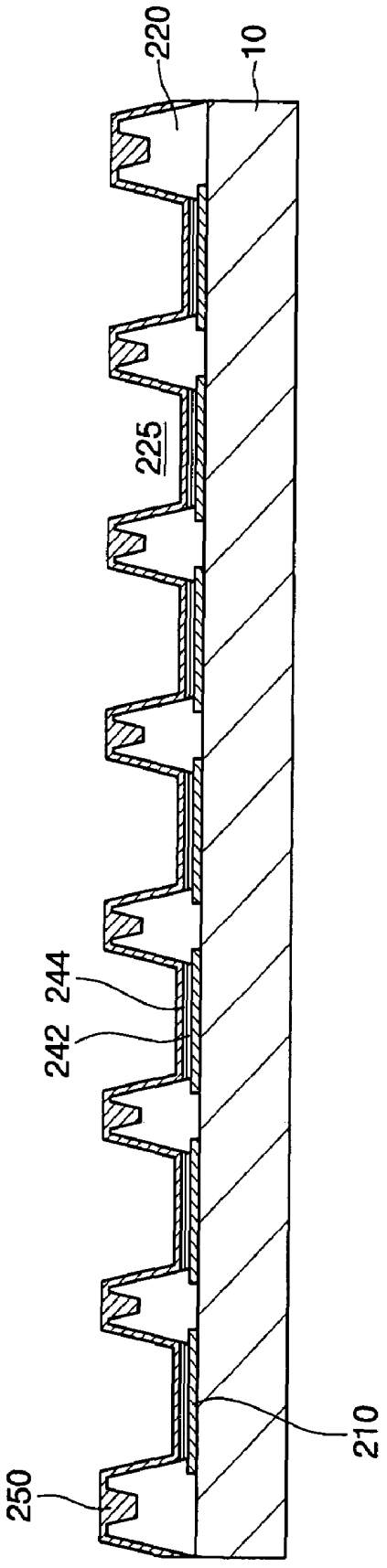


FIG. 10H



PATTERN MASK, LIGHT-EMITTING UNIT MANUFACTURED USING THE SAME, DISPLAY APPARATUS MANUFACTURED USING THE SAME AND METHOD OF MANUFACTURING DISPLAY APPARATUS USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application relies for priority upon Korean Patent Application No.2003-85763 filed on Nov. 28, 2003, the contents of which are herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a pattern mask, a light-emitting unit manufactured by using the pattern mask, a display apparatus manufactured by using the pattern mask, and a method of manufacturing the display apparatus by using the pattern mask. More particularly, the present invention relates to a pattern mask capable of enhancing productivity, a light-emitting unit manufactured by using the pattern mask, a display apparatus manufactured by using the pattern mask, and a method of manufacturing the display apparatus by using the pattern mask.

2. Description of the Related Art

Recently, an information processing apparatus is used in various fields. Data processed by the information processing apparatus generates electric signals. Therefore, the information processing apparatus includes a display apparatus that converts the electric signals into light so that a user may recognize an output processed by the information processing apparatus.

The display apparatus may be classified into an emissive type display apparatus and a non-emissive type display apparatus.

The emissive type display apparatus displays an image using light generated by an emissive element. The emissive type display apparatus include a cathode ray tube (CRT) display apparatus, a plasma display panel (PDP), a light-emitting display (LED) apparatus, etc.

The non-emissive type display apparatus displays an image using light generated by a backlight assembly, an external light etc. The non-emissive type display apparatus include a liquid crystal display (LCD) apparatus, an electrochemical display (ECD) apparatus, an electrophoretic image display (EPID), etc.

The LED may be classified into an organic light-emitting display (OLED) apparatus and an inorganic light-emitting display apparatus depending on materials for emitting light.

Electrons emitted by high voltage collide with light-emitting center of the inorganic light-emitting display apparatus to generate the light.

The OLED includes an anode, a cathode and an organic light-emitting layer interposed between the anode and the cathode. When electrons from the anode are combined with holes from the cathode in the organic light-emitting layer, excitons of high energy are generated. When the excitons are transferred from an excited state to a ground state, light is generated.

In order to form the organic light-emitting layer, a screen-printing method or a printing method may be employed.

According to the screen-printing method, organic light-emitting materials may be formed on proper positions through openings of a mask.

According to the printing method, the organic light-emitting materials may be dropped on predetermined positions. In detail, banks are formed on the anode, and droplets of the organic light-emitting materials are dropped onto cavities defined by the banks. Then, the organic light-emitting materials that fill the cavities are dried to form the organic light-emitting layer.

Recently, as a resolution of the display apparatus is enhanced, the number of anodes per unit area increases, and a distance between the anodes decreases. When droplets of the organic light-emitting material are not dropped onto the positions, yield of the OLED apparatus decreases. In addition, when the droplets of the organic light-emitting material are not dropped onto the cavities, additional droplets are dropped onto the empty cavities so that productivity of the OLED apparatus is lowered.

SUMMARY OF THE INVENTION

The present invention provides a pattern mask for forming a bank of a display apparatus.

The present invention also provides a light-emitting unit manufactured by using the pattern mask.

The present invention also provides a display apparatus manufactured by using the pattern mask.

The present invention also provides a method of manufacturing a display apparatus by using the pattern mask.

In an exemplary pattern mask according to the present invention, the pattern mask includes a light blocking region, a plurality of first light-transmitting regions and a plurality of second light-transmitting regions. The light-blocking region blocks light. The first light-transmitting regions transmit light. The first light-transmitting regions are formed adjacent to the light-blocking region such that the first light-transmitting regions are arranged in a matrix shape. The second light-transmitting regions transmit light. The second light-transmitting regions are between the first light-transmitting regions.

In another exemplary pattern mask according to the present invention, the pattern mask includes a transparent substrate, a plurality of first light blocking patterns and a plurality of second light blocking patterns. The first light blocking patterns are on the transparent substrate in a matrix shape. The second light blocking patterns are between the first light blocking patterns.

In another exemplary light-emitting unit according to the present invention, the light-emitting unit includes a first electrode, a bank, an organic light-emitting layer and a second electrode. The first electrode is formed on a substrate. The first electrode receives a first driving signal from a circuit unit. The bank surrounds sides of the first electrode. The bank has a receiving portion on an upper face of the bank. The organic light-emitting layer is formed on the first electrode. The second electrode is formed on the organic light-emitting layer. The second electrode receives a second driving signal from the circuit unit.

In an exemplary display apparatus according to the present invention, the display apparatus includes a light-emitting unit. The light-emitting unit includes a first electrode, a bank, an organic light-emitting layer and a second electrode. The first electrode is formed on a substrate. The first electrode receives a first driving signal from a circuit unit. The bank surrounds sides of the first electrode, and has a receiving portion formed on an upper face of the bank. The organic

light-emitting layer is formed on the first electrode. The second electrode is formed on the organic light-emitting layer. The second electrode receives a second driving signal from the circuit unit.

In an exemplary display apparatus according to the present invention, the display apparatus includes a switching device, a driver device and a light-emitting unit. The switching device is formed on a substrate to output an image signal. The driver device is formed on the substrate. The driver device outputs a first driving signal based on the image signal. The light-emitting unit includes a first electrode, a bank, an organic light-emitting layer and a second electrode. The first electrode is formed on the substrate. The first electrode receives the first driving signal. The bank surrounds sides of the first electrode. The bank has a receiving portion on an upper face of the bank. The organic light-emitting layer is formed on the first electrode. The second electrode is formed on the organic light-emitting layer. The second electrode receives a second driving signal from the circuit unit.

In an exemplary method of manufacturing a display apparatus according to the present invention, a first electrode that receives a first driving signal from a circuit unit is formed on a substrate having the circuit unit formed thereon. A bank is formed on the substrate. The bank surrounds sides of the first electrode, and has a receiving portion formed on an upper face of the bank is formed on the first substrate. An organic light-emitting layer is formed on the first electrode. Then, a second electrode that receives a second driving signal from the circuit unit is formed on the organic light-emitting layer.

According to the present invention, the bank includes the receiving portion. Therefore, even though the organic light-emitting material is dropped onto an unintended position, the receiving portion prevents the organic light-emitting material from flowing into a neighboring cavity, so that a yield of the display apparatus increases to enhance productivity of the display apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present invention will become more apparent by describing in detailed exemplary embodiments thereof with reference to the accompanying drawings, in which:

FIG. **1** is a plan view illustrating a pattern mask according to an exemplary embodiment of the present invention;

FIG. **2** is a plan view illustrating a pattern mask according to another exemplary embodiment of the present invention;

FIG. **3** is an equivalent circuit diagram illustrating a unit pixel of a display apparatus according to an exemplary embodiment of the present invention;

FIG. **4** is a partially cut out perspective view illustrating a light-emitting unit in FIG. **3**;

FIG. **5** is a cross-sectional view taken along a line I-I' in FIG. **4**;

FIG. **6** is a cross-sectional view taken along a line II-II' in FIG. **4**;

FIG. **7** is a cross-sectional view taken along a line III-III' in FIG. **4**;

FIG. **8** is a plan view illustrating an exemplary receiving portion having a groove shape and formed at a bank;

FIG. **9** is a plan view illustrating another exemplary receiving portion having a groove shape and formed at a bank; and

FIGS. **10**A to **10**H are cross-sectional views illustrating a process of manufacturing a display apparatus according to an exemplary embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

Hereinafter, the embodiments of the present invention will be described in detail with reference to the accompanied drawings.

Pattern Mask

FIG. **1** is a plan view illustrating a pattern mask according to an exemplary embodiment of the present invention, and FIG. **2** is a plan view illustrating a pattern mask according to another exemplary embodiment of the present invention.

Referring to FIGS. **1** and **2**, a pattern mask **20** according to the present invention includes a light-blocking region **30**, a plurality of first light-transmitting regions **35** and a plurality of second light-transmitting regions **40**.

The light-blocking region **30** surrounds the first light-transmitting regions **35** and the second light-transmitting regions **40**.

The first light-transmitting regions **35** are adjacent to the light-blocking region **30** in a matrix shape. The first light blocking regions **35** correspond to cavities **225** in FIG. **10**C that are to be explained, respectively.

The second light-transmitting regions **40** are between the first light-transmitting regions **35**. The second light blocking regions **35** correspond to receiving portions **220***e* in FIG. **10**C that are to be explained, respectively.

Each of the second light-transmitting regions **40** may have various shapes, and be arranged in various ways.

When light that passes through the first and second light-transmitting regions **35** and **40** is irradiated onto a photosensitive layer, and the photosensitive layer is developed, the photosensitive layer corresponding to the first and second light-transmitting regions **35** and **40** are recessed from an upper face of the photosensitive layer to form the cavities **225** and the receiving portions **220***e* in FIG. **10**C, respectively.

When an organic light-emitting material for forming an organic light-emitting layer is dropped onto each of the cavities **225** in FIG. **10**C, the receiving portions **220***e* prevent the organic light-emitting material from flowing into a neighboring cavity.

Additionally, when the photosensitive layer is negative type, a pattern mask may have opposite images to the pattern mask **20** in FIGS. **1** and **2**. When the negative type photosensitive layer is developed, a portion of the negative type photosensitive layer, onto which a light is not irradiated, is removed. Therefore, in order to form the cavity **225** and the receiving portion **220***e*, the pattern mask has opposite image of the light blocking region and the light-transmitting region to that the image of the pattern mask **40** in FIGS. **1** and **2**. Therefore, when the photosensitive layer is negative type, the light-blocking region **30** corresponds to a transparent substrate that transmits light, and the first and second light-transmitting regions **35** and **40** correspond to first and second light blocking regions, respectively.

The pattern mask for the negative type photosensitive layer may be formed by printing a light blocking material such as chromium (Cr) on a transparent substrate such as a glass substrate.

Display Apparatus

FIG. **3** is an equivalent circuit diagram illustrating a unit pixel of a display apparatus according to an exemplary embodiment of the present invention.

Referring to FIG. **3**, a display apparatus **300** includes a circuit unit **100** and a light-emitting unit (or light-emitting device) **200**. The circuit unit **100** and the light-emitting unit **200** are formed on a substrate **10**.

The circuit unit **100** includes a switching device TFT**1**, a driver device TFT**2**, a storage capacitor C_{st}, a gate bus line GBL, a data bus line DBL and a power supplying line PSL.

The gate bus line GBL is extended along a first direction. The gate bus line includes a metal having low electric resistance such as aluminum (Al), aluminum alloy, chromium (Cr), chromium alloy, molybdenum (Mo), molybdenum alloy, titanium (Ti), titanium alloy, tantalum (Ta), tantalum alloy, silver (Ag), silver alloy, copper (Cu), copper alloy, etc.

The number of the gate bus line GBL is determined by a resolution of the display apparatus. For example, when a resolution is 1024×768, the display apparatus **300** has 768 gate bus lines GBL.

Each of the gate bus lines GBL is extended in a first direction. The gate bus lines GBL are arranged in a second direction that is substantially in perpendicular to the first direction such that the gate bus lines GBL are substantially in parallel with each other.

Each of the gate bus lines GBLs includes a gate electrode portion GE. The gate electrode portion GE is protruded from the gate bus line GBL in the second direction. For example, when the resolution is 1024×768, 1024×3 units of gate electrode portions GE are protruded from each of the gate bus lines GBL with a substantially same distance.

The data bus line DBL is extended in the second direction. The data bus line DBL includes a metal having a low resistance such as aluminum (Al), aluminum alloy, chromium (Cr), chromium alloy, molybdenum (Mo), molybdenum alloy, titanium (Ti), titanium alloy, tantalum (Ta), tantalum alloy, silver (Ag), silver alloy, copper (Cu), copper alloy, etc.

The number of the data bus line DBL is determined by a resolution. For example, when the resolution is 1024×768, the display apparatus **300** has 1024×3 gate bus lines GBL.

Each of the data bus lines DBL is extended in the second direction. The data bus lines DBLs are arranged in the first direction such that the data bus lines DBLs are substantially in parallel with each other.

Each of the data bus lines DBLs includes a drain electrode portion DE. The drain electrode portion DE is protruded from each of the data bus lines DBL in the first direction. For example, when the resolution is 1024×768, 768 units of gate electrode portions GE are protruded from each of the gate bus lines GBLs with a substantially same distance.

The power supplying line PSL is extended in the second direction such that the power supplying line PSL is spaced apart from the data bus line DBL. A voltage Vdd is applied to the power supplying line PSL.

The switching device TFT**1** and the driver device TFT**2** are in each of unit pixel regions **110** defined by gate bus lines GBLs adjacent to each other and data bus lines DBLs adjacent to each other.

The switching device TFT**1** includes a first gate electrode G**1**, a first semiconductor pattern C**1**, a first source electrode S**1** and a first drain electrode D**1**.

The first gate electrode G**1** is electrically connected to the gate electrode portion GE protruded from each of the gate bus lines GBLs.

The first semiconductor pattern C**1** is disposed over the first gate electrode such that the first semiconductor pattern C**1** is electrically insulated from the first gate electrode G**1**. That is, a first gate insulation layer (not shown) including a dielectric material is interposed between the semiconductor pattern C**1** and the first gate electrode G.

The first drain electrode D**1** is formed on the first semiconductor pattern C**1**. The first drain electrode D**1** is electrically connected to the drain electrode portion DE protruded from the data bus line DBL.

The first source electrode S**1** is spaced apart from the first drain electrode D**1**. The first source electrode S**1** is electrically connected to the first semiconductor pattern C**1**.

The driver device TFT**2** is also disposed in the pixel region **110**. The driver device TFT**2** includes a second gate electrode G**2**, a second semiconductor pattern C**2**, a second drain electrode D**2** and a second source electrode S**2**.

The second gate electrode G**2** is electrically connected to the first source electrode S**1** of the switching device TFT**1**.

The second semiconductor pattern C**2** is disposed over the second gate electrode G**2** such that the second semiconductor pattern C**2** is electrically insulated from the second gate electrode G**2**. That is, a second gate insulation layer (not shown) is interposed between the second gate electrode G**2** and the second semiconductor pattern C**2**.

The second drain electrode D**2** is formed on the second semiconductor pattern C**2**. The second drain electrode D**2** is electrically connected to the power supplying line PSL.

The second source electrode S**2** is formed on the second semiconductor pattern is C**2**. The second drain electrode is spaced apart from the second drain electrode D**2**. The second drain electrode is electrically connected to the light-emitting unit **200**.

The storage capacitor C_{st} includes a first capacitor electrode C_{st1}, a second capacitor electrode C_{st2} and a dielectric layer. The first capacitor electrode C_{st1} is electrically connected to the second gate electrode G**2**. The second capacitor electrode C_{st2} is electrically connected to the power supplying line PSL. The dielectric layer is interposed between the first and second capacitor electrodes C_{st1} and C_{st2}. The driver device TFT**2** may be kept in a turned-on state during one frame period due to the storage capacitor C_{st}.

When an image signal and a turn-on voltage are applied to the data bus line DBL and the gate bus line GBL, respectively, the image signal is applied to the first source electrode S**1** of the switching device TFT**1** through the first drain electrode D**1** and the first semiconductor pattern C**1** of the switching device TFT**1**.

Then, the image signal outputted from the first source electrode S**1** of the switching device TFT**1** is applied to the second gate electrode G**2** of the driver device TFT**2** to turn on the driver device TFT**2**. A voltage level of the image signal determines resistance of the second semiconductor pattern C**2**. When the driver device TFT**2** is turned on, the voltage Vdd of the power supplying line PSL is applied to the second source electrode S**2** of the driver device TFT**2** through the second drain electrode D**2** and the second semiconductor pattern C**2**. The voltage Vdd is dropped in accordance with the resistance of the second semiconductor pattern C**2** to output a first driving signal corresponding to the voltage level of the image signal.

FIG. **4** is a partially cut out perspective view illustrating a light-emitting unit in FIG. **3**.

Referring to FIG. **4**, the light-emitting unit **200** includes a first electrode **210**, a bank **220**, a light-emitting layer **240** and a second electrode **250**.

The first electrode **210** receives the first driving signal from second source electrode S**2** of the driver device TFT**2**. The first electrode **210** may include an optically transparent and electrically conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), aluminum (Al), aluminum alloy, silver (Ag), silver alloy, etc. The first electrode **210** and the second source electrode S**2** may be electrically connected to each other through a via-hole (not shown).

A plurality of the first electrodes **210** is arranged in a matrix shape on the substrate **10**. For example, when a resolution is 1024×768, 1024×768×3 units of the first electrodes **210** are arranged.

The bank **220** is formed on the substrate **10**. The bank **220** is disposed between the first electrodes **210**. That is, the bank **220** separates the first electrodes **210** from one another. The bank **220** surrounds sides of each of the first electrodes **210** to define a cavity over each of the first electrodes **210**.

During forming the light-emitting layer **240** by a light-emitting material, the bank **220** prevents the light-emitting material from flowing into neighboring cavities.

The bank **220** may have various shapes such as a circular shape, a polygonal shape, etc.

FIG. **5** is a cross-sectional view taken along a line I-I' in FIG. **4**.

Referring to FIG. **5**, the bank **220** is formed between the first electrodes **210**. A vertical cross-sectional shape of the bank **220** may be a trapezoidal-shape. In detail, the bank **220** includes two side faces **220***a* and **220***b*, an upper face **220***c*, a lower face **220***d* that is substantially in parallel with the upper face **220***c*, and a receiving portion **220***e*. The bank **220** may include a photosensitive material or a photoresist material.

The receiving portion **220***e* is formed on the upper face **220***c*. In detail, the receiving portion **220***e* is recessed from the upper face **220***c* toward the lower face **220***d*. A volume of the receiving portion **220***e* is substantially same or smaller than that of the cavity.

The receiving portion **220***e* may have a depth DT that is substantially same as a height IT of the bank **220**. That is, the receiving portion **220***e* exposes the substrate **10**. The receiving portion **220***e* receives the organic light-emitting material that is abnormally dropped. FIG. **6** is a cross-sectional view taken along a line II-II' in FIG. **4**.

Referring to FIG. **6**, the receiving portion **220***e* is recessed from the upper face **220***c* toward the lower face **220***d*. The receiving portion **220***e* may have a depth DT**1** that is smaller than a height IT of the bank **220**. A volume of the receiving portion **220***e* is substantially same or smaller than that of the cavity.

The receiving portion **220***e* receives the organic light-emitting material that is abnormally dropped.

FIG. **7** is a cross-sectional view taken along a line III-III' in FIG. **4**.

Referring to FIG. **7**, portions of the bank **220** protrude upward and are substantially in parallel with each other to define the receiving portion **220***e*. A volume of the receiving portion **220***e* is substantially same or smaller than that of the cavity.

The receiving portion **220***e* receives the organic light-emitting material that is abnormally dropped.

Although three different lines I-I', II-II' and III-III' are illustrated in the light emitting unit **200** in FIG. **4**, the light-emitting unit **200** in FIG. **4** preferably has the bank **220** having only one kind of the receiving portions **220***e* in FIGS. **5**, **6** and **7**. The bank **220** may also have various combinations thereof.

FIG. **8** is a plan view illustrating an exemplary receiving portion having a groove shape and formed at a bank.

Referring to FIG. **8**, the receiving portion **220***e* formed on the bank **220** is recessed from the upper face of the bank **220**. The bank **220** has a lattice shape. That is, the bank **220** has horizontal portions and longitudinal portions. Each of the horizontal portions and each of the longitudinal portions may be connected to each other. Alternatively, each of the horizontal portions and each of the longitudinal portions may be spaced apart from each other. The recessed portion **220** in FIG. **8** may have thickness smaller than a height of the bank **220**.

FIG. **9** is a plan view illustrating another exemplary receiving portion having a groove shape and formed at a bank.

Referring to FIG. **9**, the receiving portions **220***e* are recessed from the upper face toward to the lower face of the bank **220**. The receiving portions **220***e* are arranged along the horizontal and longitudinal portions of the bank **220**. The recessed portion in FIG. **9** may have substantially same thickness as a height of the bank **220**.

Referring again to FIG. **4**, the light-emitting layer **240** is formed on the first electrode **210**.

In this exemplary embodiment, a positive charge carrier injecting layer (not shown) is formed between the first electrode **210**, and the light-emitting layer **240** is formed on the positive charge carrier injecting layer.

The second electrode **250** is disposed on the substrate **10** having the first electrode **210**, the bank **220** and the light-emitting layer **240** formed thereon such that the second electrode **250** covers the light-emitting layer **240**. A negative charge carrier injecting layer (not shown) may further be formed between the light emitting layer **240** and the second electrode **250**. A second driving signal is applied to the second electrode **250**. The second electrode **250** may include an alkaline metal such as lithium (Li) or an alkaline earth metal such as magnesium (Mg), calcium (Ca) or barium (Ba). The second electrode **250** may also have a double layered structure of the metal layer and a capping layer. The second electrode **250** may be formed through a chemical vapor deposition (CVD) method.

Method of Manufacturing a Display Apparatus by Using a Pattern Mask

FIGS. **10**A to **10**H are cross-sectional views illustrating a process of manufacturing a display apparatus according to an exemplary embodiment of the present invention.

FIG. **10**A is a cross-sectional view illustrating a first electrode formed on a substrate. The substrate **10** includes the circuit unit **100** in FIG. **3** formed thereon. The circuit unit **100** includes a switching device, a driver device, a capacitance, a gate bus line, a data bus line and a power supply line as explained above.

Referring to FIG. **10**A, a first electrode **210** is formed on the substrate **10** having the circuit unit formed thereon. The circuit unit **100** of FIG. **3** is omitted in FIG. **10**A. The first electrode **210** may include an optical transparent and electrically conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), etc. In detail, a layer including ITO or IZO is coated on the substrate **10** and patterned to form the first electrode **210**.

For example, when a resolution of a display apparatus is 1024×764, 1024×764 units of the first electrodes **210** are formed and arranged in a matrix shape. The first electrodes **210** are spaced apart from one another by a distance G.

FIG. **10**B is a cross-sectional view illustrating an exposure process.

Referring to FIG. **10**B, a photosensitive layer **222** is formed on the substrate **10** having the first electrode **210** formed thereon. The photosensitive layer **222** may be formed through a spin coating method. The photosensitive layer **222** may have a thickness of about 3 μm.

The pattern mask **20** having the light blocking region **30**, and the first and second light-transmitting regions **35** and **40** is arranged over the photosensitive layer **222**. Then, the photosensitive layer **222** is exposed through the pattern mask **20**.

FIG. **10**C is a cross-sectional view illustrating the bank formed on the first substrate.

Referring to FIG. **10**C, the exposed photosensitive layer **222** in FIG. **10**B is developed to form the bank **220**. Alternatively, the bank **220** may not have the photosensitive material. When the bank does not have the photosensitive material, the bank is formed through a photolithography process that has a photo process and an etching process. The bank **220** defines the cavity **225** over the first electrode **210**. The bank **220** includes the receiving portion **220***e* recessed from the upper face of the bank **220**. A depth of the receiving portion **220***e* may be adjusted by changing patterns of the second light-transmitting region **40** in FIGS. **1** and **2**.

FIG. **10**D is a cross-sectional view illustrating a positive charge carrier injecting material having fluidity, which is dropped onto the cavity, and FIG. **10**E is a cross-sectional view illustrating a positive charge carrier injecting layer formed on the first electrode.

Referring to FIGS. **10**D and **10**E, a positive charge carrier injecting material **214** having fluidity is dropped onto the cavity **225** over the first electrode **210**. The positive charge carrier injecting material **214** may further include a volatile material, addictives, etc.

Then, the positive charge carrier injecting material **214** is dried. Therefore, a volume of the positive charge carrier injecting material **214** is reduced to form a positive charge carrier injecting layer **242** having a thin film shape.

FIG. **10**F is a cross-sectional view illustrating a light-emitting material having fluidity, which is dropped onto the cavity.

Referring to FIG. **10**F, a light-emitting material **241** having fluidity is dropped onto the cavity **225** over the positive charge carrier injecting layer **242** that is formed on the first electrode **210**. The light-emitting material **241** may further include a volatile material, addictives, etc.

Then, the light-emitting material **241** is dried. Therefore, a volume of the light-emitting material **241** is reduced to form the light-emitting layer **244** having a thin film shape.

The positive charge carrier injecting layer **242** and the light-emitting layer **244** form an organic light-emitting layer **240**.

FIG. **10**H is a cross-sectional view illustrating a second electrode formed on the substrate having the first electrode, the bank and the organic light-emitting layer.

Referring to FIG. **10**H, the second electrode **250** is formed on the substrate **10** having the first electrode **210**, the bank **220**, the positive charge carrier injecting layer **242** and the light-emitting layer **244**. The second electrode **250** may include an alkaline metal such as lithium (Li) or an alkaline earth metal such as magnesium (Mg), calcium (Ca) or barium (Ba). The second electrode **250** may also have a double layered structure of the metal layer and a capping layer.

The second electrode **250** covers the bank **220** and the light-emitting layer **244** so that the second electrode **250** is electrically connected to the light-emitting layer **244**. A second driving voltage is applied to the second electrode **250** to display images.

According to the present invention, the bank includes the receiving portion. Therefore, even though the organic light-emitting material is abnormally dropped onto an unintended position, the receiving portion prevents the organic light-emitting material from flowing into a neighboring cavity so that yield of a display apparatus may increases, and a productivity of the display apparatus is enhanced.

Having described the exemplary embodiments of the present invention and its advantages, it is noted that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by appended claims.

What is claimed is:

1. A display apparatus comprising:

a light-emitting unit including:

a first electrode formed on a substrate, the first electrode configured to receive a first driving signal from a circuit unit;

a bank that surrounds sides of the first electrode, the bank having a receiving portion on an upper face of the bank;

a light-emitting layer formed on the first electrode; and

a second electrode formed on the light-emitting layer, the second electrode configured to receive a second driving signal from the circuit unit, wherein the receiving portion corresponds to a portion recessed from the upper face of the bank such that a depth of the recessed portion is substantially same as a height of the bank.

2. A display apparatus comprising:

a light-emitting unit including:

a first electrode formed on a substrate, the first electrode configured to receive a first driving signal from a circuit unit;

a bank that surrounds sides of the first electrode, the bank having a receiving portion on an upper face of the bank;

a light-emitting layer formed on the first electrode; and

a second electrode formed on the light-emitting layer, the second electrode configured to receive a second driving signal from the circuit unit,

wherein the receiving portion corresponds to a plurality of recessed portions arranged along the first electrode.

3. A display apparatus comprising:

a light-emitting unit including:

a first electrode formed on a substrate, the first electrode configured to receive a first driving signal from a circuit unit;

a bank that surrounds sides of the first electrode, the bank having a receiving portion on an upper face of the bank;

a light-emitting layer formed on the first electrode; and a second electrode formed on the light-emitting layer, the second electrode configured to receive a second driving signal from the circuit unit,

wherein the receiving portion corresponds to portions protruded substantially in parallel with one another.

* * * * *

专利名称(译)	图案掩模，使用其制造的发光单元，使用其制造的显示装置和使用其制造显示装置的方法		
公开(公告)号	US7547920	公开(公告)日	2009-06-16
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[标]申请(专利权)人(译)	李东WON CHOI JOON HOO 钟金KOO		
申请(专利权)人(译)	李东WON 崔俊HOO 钟金辜		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	LEE DONG WON CHOI JOON HOO CHUNG JIN KOO		
发明人	LEE, DONG-WON CHOI, JOON-HOO CHUNG, JIN-KOO		
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摘要(译)

显示装置包括发光单元。发光单元包括第一电极，堤，有机发光层和第二电极。第一电极形成在基板上。第一电极从电路单元接收第一驱动信号。堤岸围绕第一电极的侧面并且具有形成在堤岸的上表面上的接收部分。有机发光层形成在第一电极上。第二电极形成在有机发光层上。第二电极从电路单元接收第二驱动信号。因此，即使有机发光材料异常地落到非预期位置，接收部分也防止有机发光材料流入相邻的空腔，从而提高产量并提高生产率。