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(54) **OLED DISPLAY AND METHOD FOR MANUFACTURING THEREOF**

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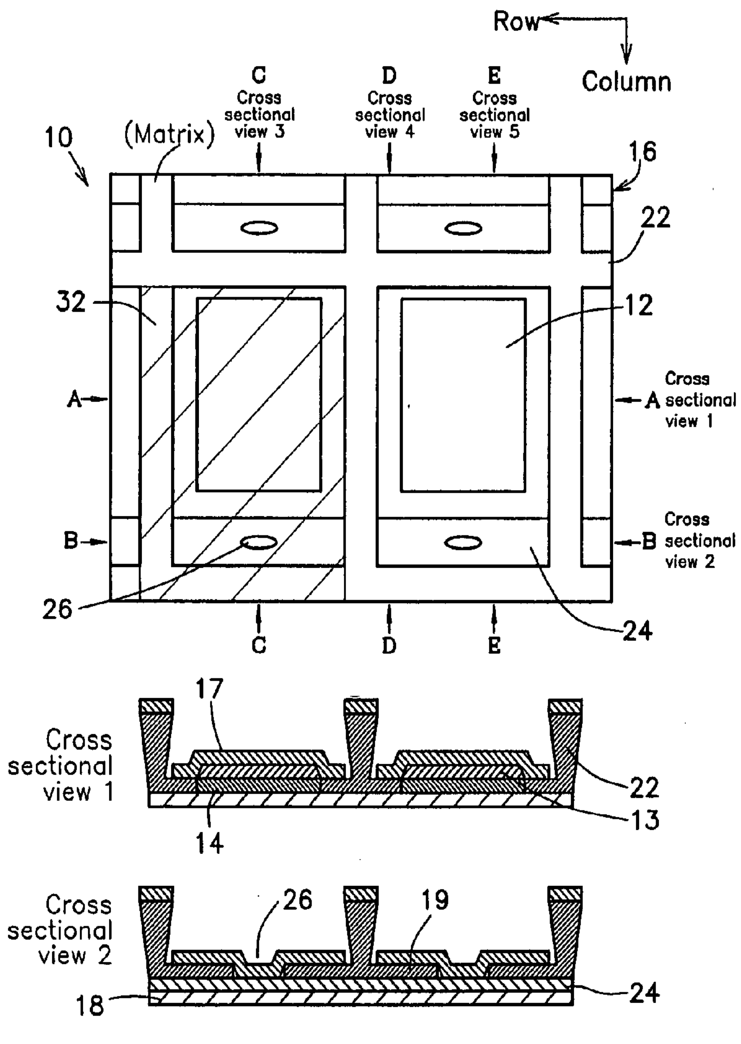
(52) **U.S. Cl.** **313/504**; 313/506; 445/24

(57) **ABSTRACT**

An organic light emitting diode display comprises: an insulating substrate; common electrodes; a first electrode layer formed in a region adjacent to the common electrodes formed on the insulating substrate by electrically isolating from the common electrodes; an insulating layer which coats on the insulating substrate by respectively opening a first opening window exposing a part of the common electrodes and a second opening window exposing at least a part of the first electrode layer; ribs which form a cell area by crossing the common electrodes on the insulating substrate and surrounding each of the opening windows; a material layer formed on the first electrode layer exposed from the second opening window; and a second electrode layer which coats within the cell area surrounded by the ribs and electrically connected to the common electrodes through the first opening window.



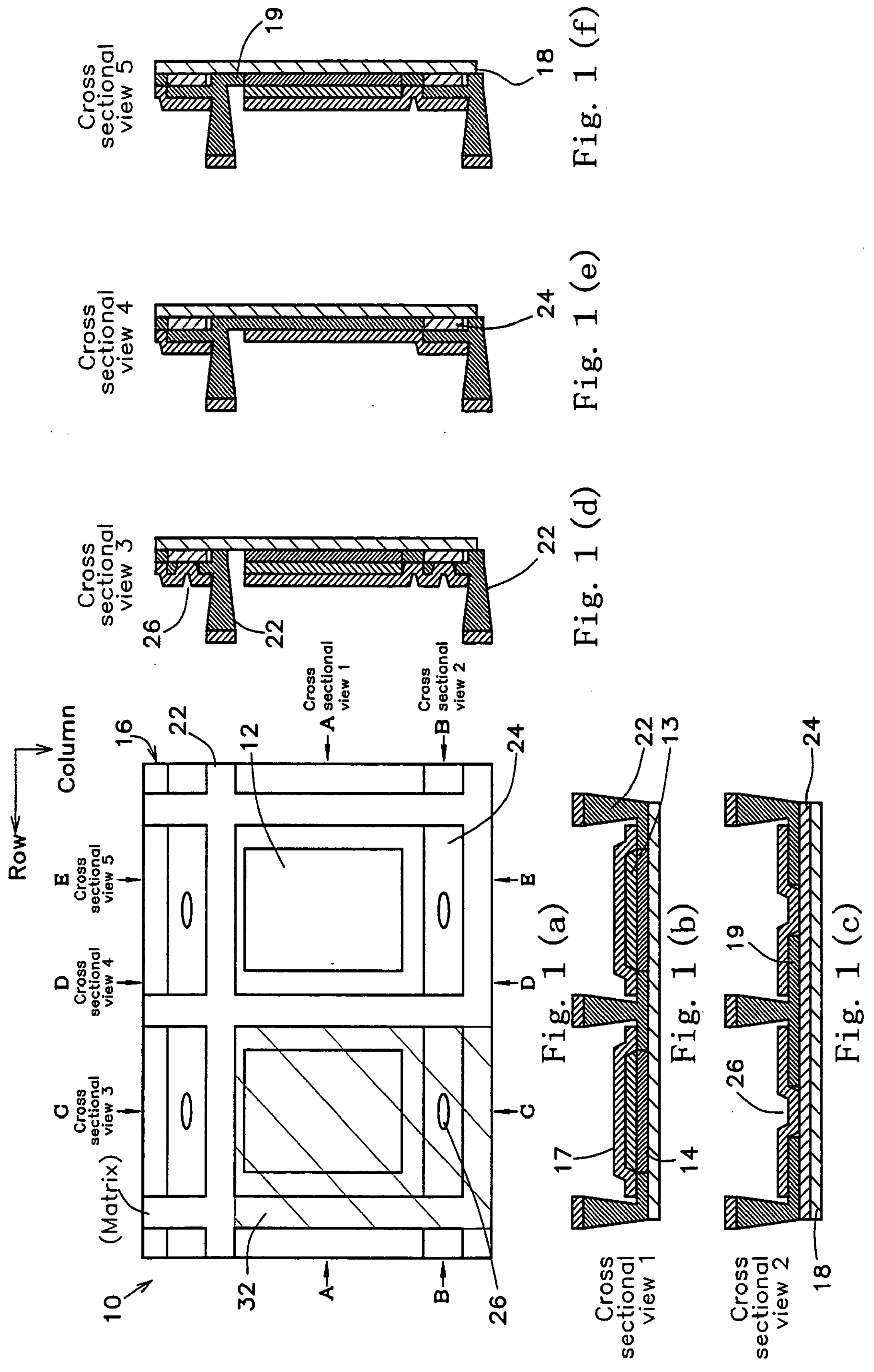

Cross sectional view 5
19
18
Fig. 1 (f)
Cross sectional view 4
24
Fig. 1 (e)
Cross sectional view 3
26
22
22
Fig. 1 (d)
Row
Column
10
(Matrix)
16
22
12
24
32
26
A
B
C
D
E
Cross sectional view 1
Cross sectional view 2
Cross sectional view 3
Cross sectional view 4
Cross sectional view 5
Fig. 1 (a)
Cross sectional view 1
22
13
17
14
Fig. 1 (b)
Cross sectional view 2
24
19
26
18
Fig. 1 (c)

Fig. 2 (a)

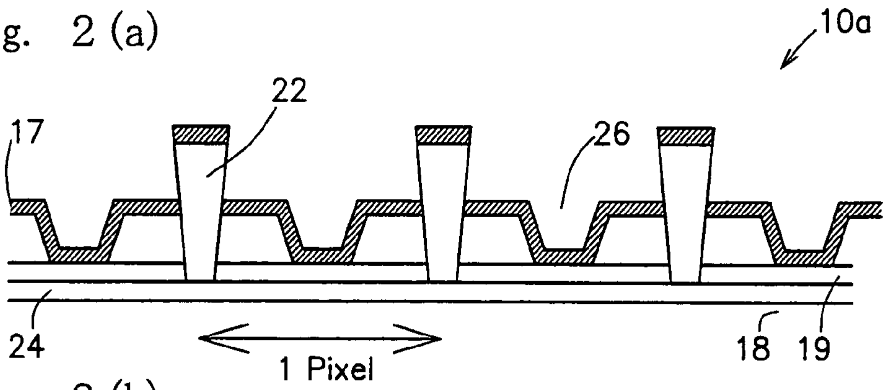


Fig. 2 (b)

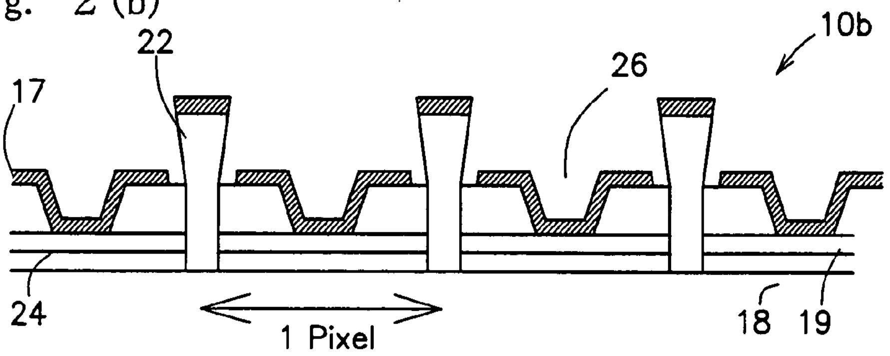


Fig. 3

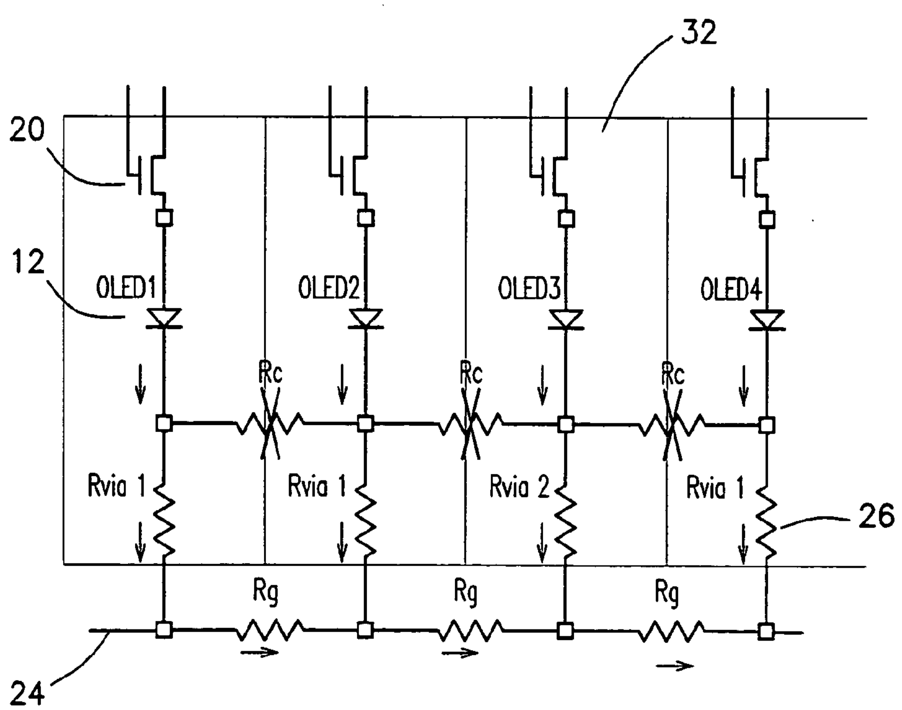


Fig. 4 (a)

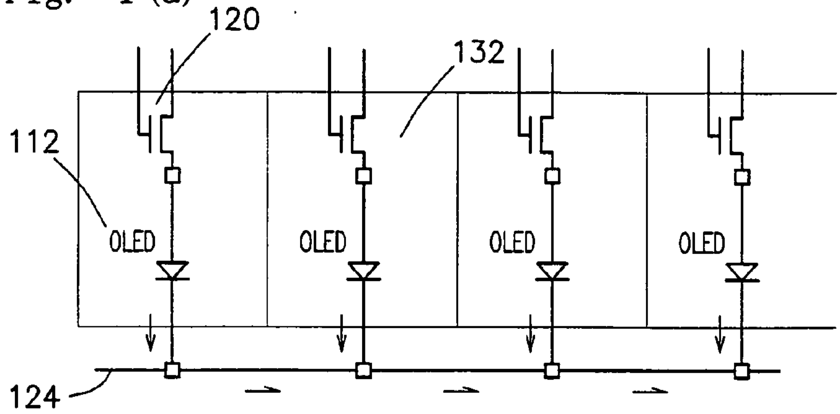


Fig. 4 (b)

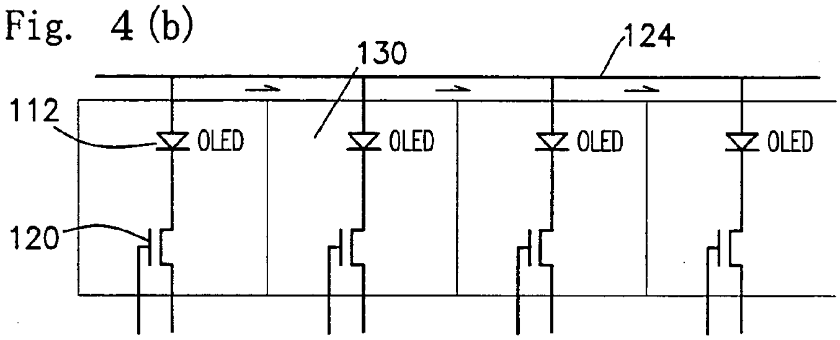
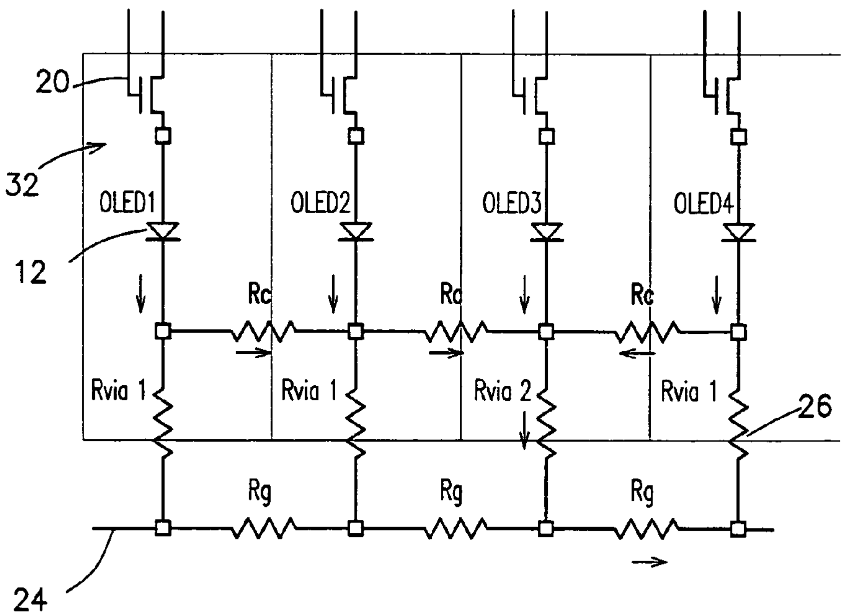


Fig. 4 (c)



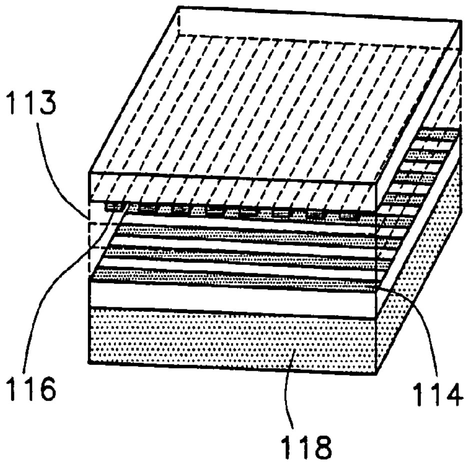


Fig. 5(a)

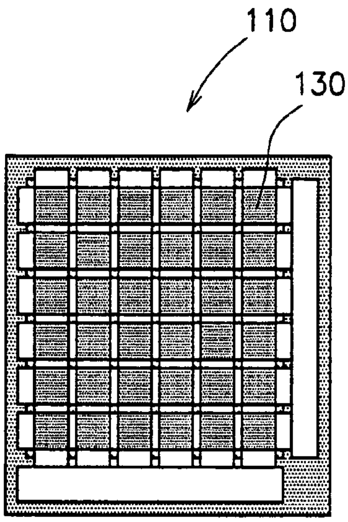


Fig. 5(b)

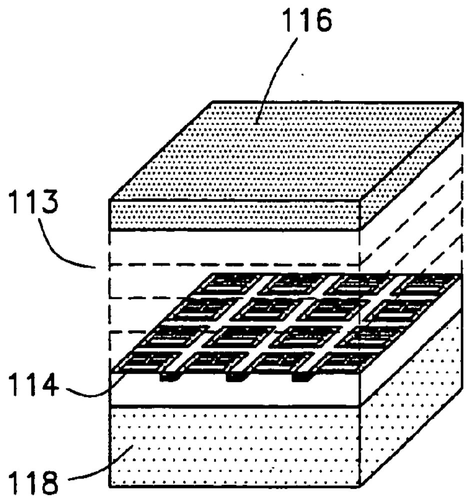


Fig. 6(a)

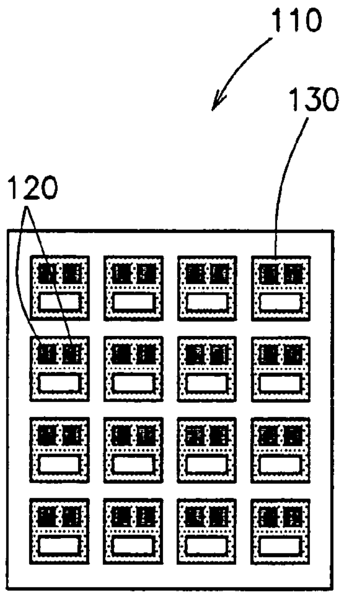


Fig. 6(b)

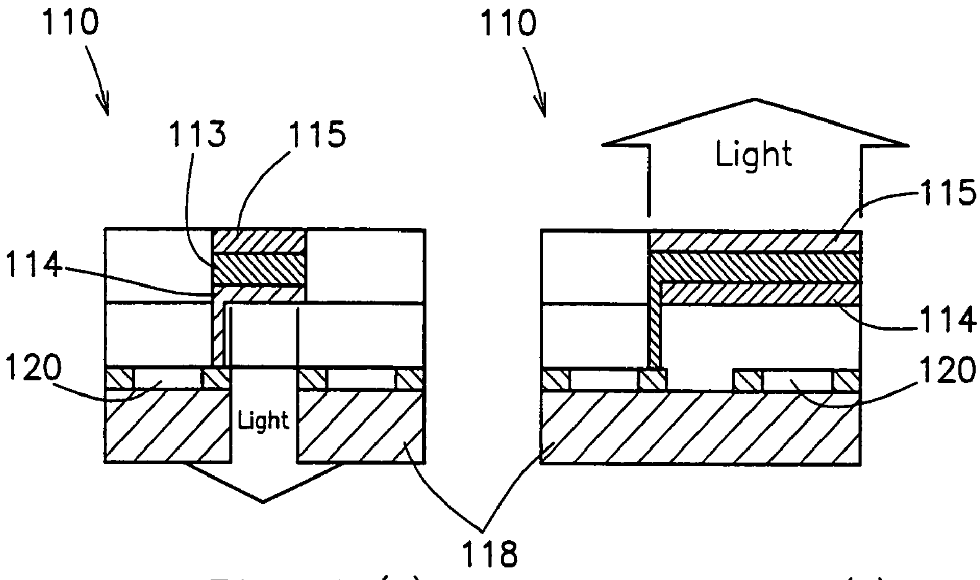


Fig. 7 (a) Fig. 7 (b)

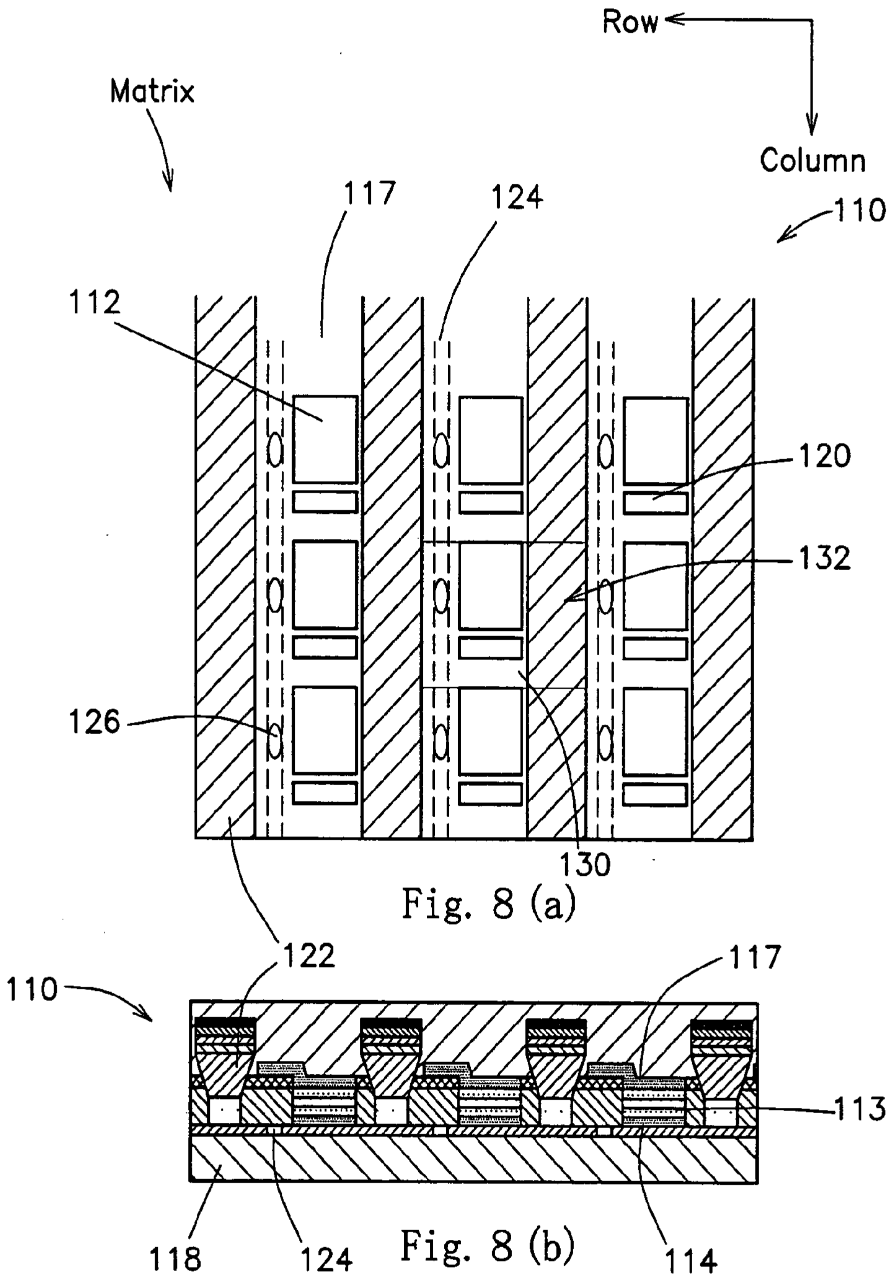
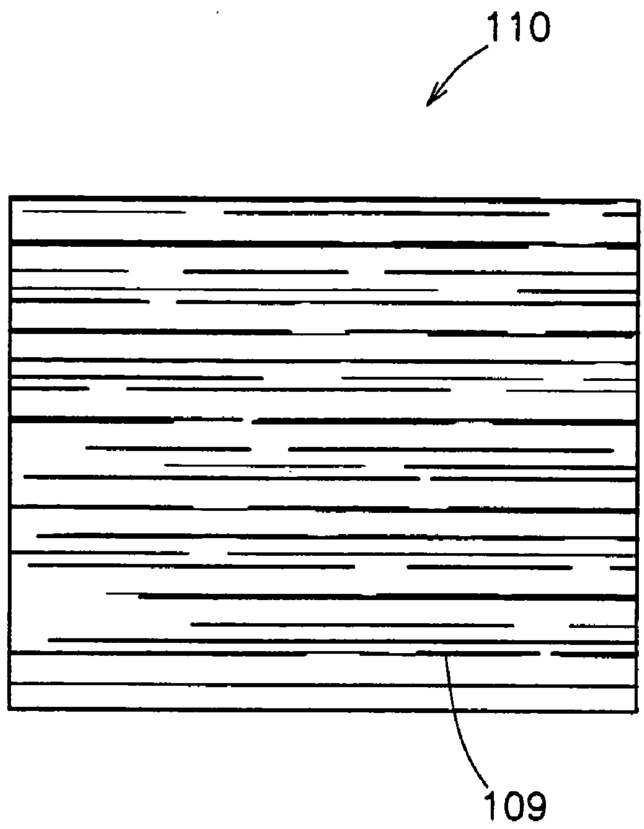

Row
Column
Matrix
117
124
110
112
120
132
126
130
122
117
110
113
118
124
114

Fig. 8 (a)

Fig. 8 (b)

Fig. 9



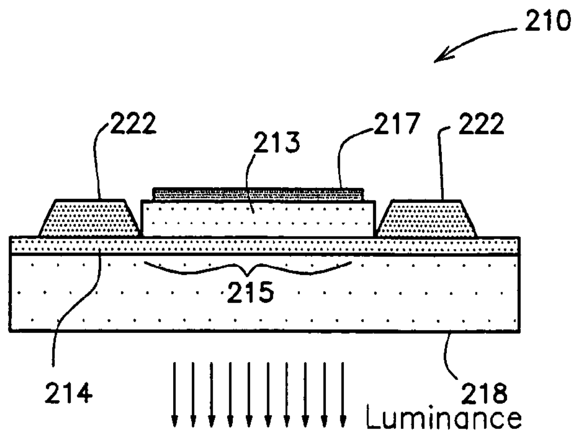


Fig. 1 0 (a)

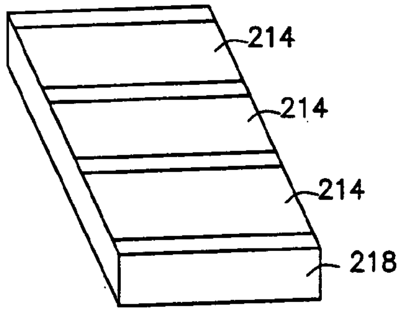


Fig. 1 0 (b)

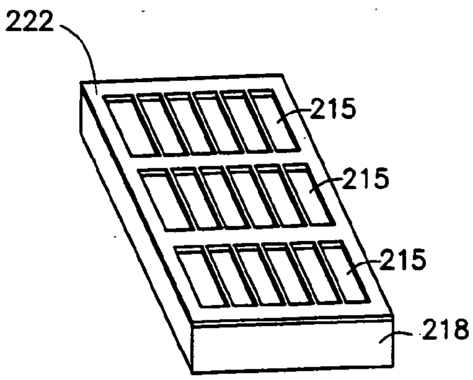


Fig. 1 0 (c)

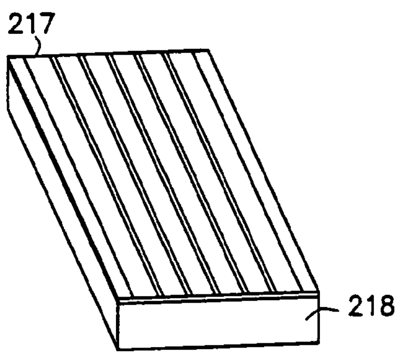
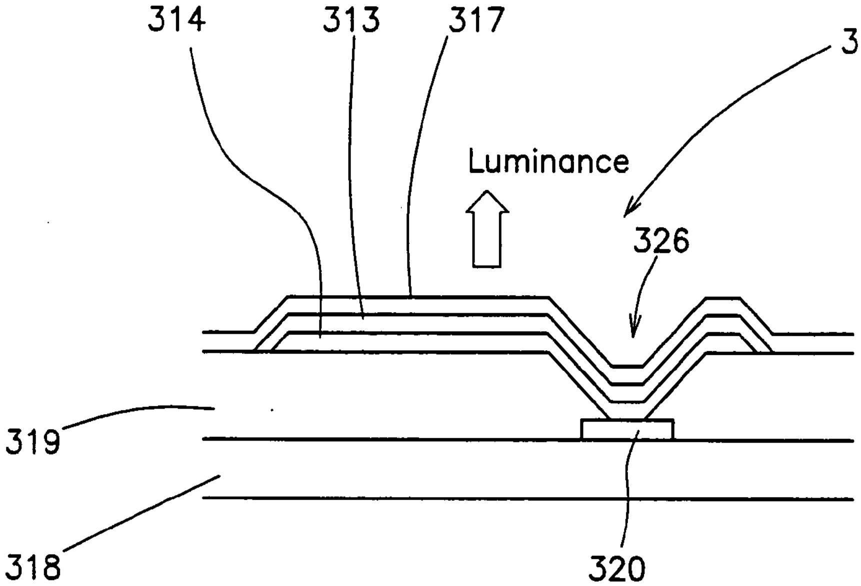


Fig. 1 0 (d)

Fig. 11



OLED DISPLAY AND METHOD FOR MANUFACTURING THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method for removing luminance nonuniformity and crosstalk occurs on a display using organic electroluminescence and an organic electroluminescence display manufactured by this method.

[0003] 2. Description of Related Art

[0004] Organic electroluminescent elements are configured by sandwiching a material layer between an anode and a cathode. The material layer may comprise a plurality of layers, such as an electron-injecting layer or a hole-injecting layer and an electron-transporting layer or a hole-transporting layer. Its emitting principle is similar to that of the emitting mechanism of light emitting diodes (LED). More specifically, a hole and an electron are fed into a light-emitting layer by the application of a direct current voltage between the anode and the cathode. The electronic state of organic molecules included in the light-emitting layer is changed to the excited state by energy generated by a recombination of the hole and electron in the light-emitting layer. Energy is emitted as light when this quite unstable electronic state falls to a ground state to emit organic light emitting diodes. Accordingly, organic electroluminescence is referred to also as organic light emitting device (OLED).

[0005] In an OLED display, OLED elements are arranged on a substrate, such as a glass substrate as a matrix to be emitted to show information. OLED displays are expected as epoch-making displays because of superiority in electric power consumption, reaction speed, visual field, and luminance compared with other types of displays, such as liquid crystal displays.

[0006] A method for driving OLED elements is roughly divided into two kinds of systems: passive matrix system and active matrix system. As shown in FIGS. **5**(*a*) and **5**(*b*), the passive matrix system is a driving method to intersect an anode **114** and a cathode **116** in a matrix state to selectively emit OLED elements sandwiched at an intersection. On the other hand, as shown in FIGS. **6**(*a*) and **6**(*b*), the active matrix system is a driving method to emit OLED elements by having switching and memory functions for each pixel **130** using a thin film transistor (TFT) **120**.

[0007] Using the passive matrix system enables low production costs of displays because of its simple structure. However, large electric power consumption is required to keep the screen at high luminance because this system indicates information by sequentially emitting lines and using an after-image branded on the eyes. For this reason, the active matrix system for emitting the pixels **130** by aggressively using a TFT **120** has been adopting more despite its high production costs. Compared with the passive matrix system, the active matrix system enables high luminance at a low electric power consumption.

[0008] On the other hand, a conventional method of taking out luminance of an OLED display **110** has two systems: bottom-emitting system and top-emitting system. As shown in **FIG. 7**(*a*), the bottom-emitting system takes out light from an insulating substrate side **118**. As shown in **FIG. 7**(*b*), the top-emitting system takes out light from a top surface layer side **115**.

[0009] Japanese Patent Publication No. 8-227276 (Cited document 2) discloses embodiments of a method of manufacturing bottom-emitting and top-emitting OLED displays. According to these embodiments, an OLED display shown in **FIG. 10**(*a*) is manufactured by the processes shown in FIGS. **10**(*b*) to **10**(*d*). More particularly, as shown in **FIG. 10**(*b*), a plurality of parallel first display electrode lines **214** made of indium tin oxide (ITO) or the like are deposited as stripes on a glass substrate **218**. And ribs **222** of polyimides or the like are formed on the first display electrode lines **214**, so that the island shaped first display electrode portions **215** are defined and surrounded as shown in **FIG. 10**(*c*). An OLED light-emitting layer **213** is formed on each recess of the glass substrate **218** wherein the ribs **222** are formed. Next, a plurality of parallel stripe second display electrode lines **217** of low resistance metal are vacuum-deposited or sputtered with a shadow mask with parallel slits on the ribs **222** and the light-emitting layers **213** so that the second display electrode lines **217** extend perpendicular to the first display electrode lines **214**.

[0010] In the area surrounded by the ribs **222**, a TFT connected to the first display electrode portions **215** is formed on the glass substrate **218**, where data signal lines and scan signal lines or the like are arranged. As shown in **FIG. 10**(*a*), in this embodiment, the OLED display takes out light from the glass substrate side **218**.

[0011] In the active matrix system, however, the aperture ratio is reduced due to TFT, capacitors, and wiring or the like after taking out luminescence from the glass substrate side **218** like the bottom-emitting system. Consequently, when the active matrix system is adopted, the top-emitting system is advantageous. Light is not shielded by the TFT, which results in an increase of the aperture ratio and high luminance when adopting the top-emitting system.

[0012] **FIG. 11** shows a cross sectional view of the structure of a top-emitting active matrix OLED display. In **FIG. 11**, an OLED display **310** comprises: an insulating substrate **318**; a thin film transistor (TFT) **320** formed on the insulating substrate **318**; an insulating layer **319**; a first electrode **314**; a material layer **313**; a second electrode **317**; and a via hole **326** for connecting the first electrode **314** and the TFT **320** through the insulating layer **319** (For examples, see cited document 1).

[0013] Unlike the bottom-emitting system, the second electrode **317** is required to be made from a transparent material because the OLED display **310** takes out luminescence from the second electrode side **317**. Further, to increase optical transmittance, the second electrode **317** needs to be as thin as possible. Moreover, the second electrode **317** may be laminated covering the entire surface of the OLED display.

[0014] A light-emitting layer included in the material layer **313** of the OLED display **310** emits light to take out the luminescence from the second electrode side **317**.

[0015] Since the structure of such top-emitting active matrix OLED displays is various, the second electrode **317** covering the entire surface of the above-mentioned OLED display may be divided in stripe like the passive matrix system. Further, the via hole **326** in **FIG. 11** connects the first electrode **314** to the TFT **320**, but may be used to connect, for examples, the second electrode and the common electrodes.

[**0016**] One example of a top-emitting active matrix OLED display having ribs will be now described by using FIGS. **8**(*a*) and **8**(*b*).

[**0017**] AS shown in **FIG. 8**(*b*), in an OLED display **110**, ribs **122** are arranged on an insulating substrate **118** in parallel. As shown in **FIG. 8**(*a*), OLED elements **112** are sandwiched between ribs **122**. The area of one unit of matrix divided by the ribs **122** and OLED elements **112** are referred to as a cell area **132**. The cells completed by equipping the cell area **132** with the TFT **120** and the OLED elements **112** are referred to as pixels **130**.

[**0018**] The pixels **130** in each cell area **132** are so configured that an anode **114** and the ribs **122** are formed on the insulating substrate **118** by sandwiching the anode **114** in the column direction of the matrix in parallel as shown in **FIG. 8**(*a*). Further, in parallel with the ribs **122**, common electrodes **124** isolated from the anode **114** and the ribs **122** are formed on the insulating substrate **118**. Furthermore, the OLED elements **112** are formed by the lamination of at least a light-emitting layer and a thin film cathode **117** on the upper part of the anode **114**. Moreover, the thin film cathode **117** is laminated on the pixels **130**. And the via holes **126** for conducting the thin film cathode **117** and the common electrodes **124** may be formed in each cell area **132**.

[**0019**] The thin film cathode **117** is laminated on the entire surface of the OLED display **110**. The thin film cathode **117** is partitioned by the ribs **122** formed among the adjacent cell areas **132** in a column direction when laminating the thin film cathode. The anode **114** is not needed to be optical transparent due to the-top emitting system but may be made from a metal, such as Al.

[**0020**] Additionally, the cell areas **132** are in a rectangle shape. Each cell area **132** includes OLED elements **112**. The common electrodes **124** are formed on the insulating substrate **118** in parallel with the ribs **122** to be isolated from the anode **114**. The common electrodes **124** may conduct with the thin film cathode **117** through the via holes **126** formed within each cell area. Accordingly, the thin film cathode **117** laminated on the surface of the OLED display **110** is equipotential through the common electrodes **124**.

[**0021**] When an OLED display **110** having such configuration is driven employing the active matrix and top-emitting systems, a circuit formed by circuit elements, such as the OLED elements **112** and common electrodes **124** are shown in a schematic diagram **4**(*a*) or **4**(*b*) as an ideal example. More specifically, the OLED elements **112** emit light by the application of a forward voltage between the OLED elements **112** through the TFT because of this mechanism. For example, in **FIG. 4**(*a*), a current passing via the OLED elements passes into the common electrodes **124** from the surface of the thin film cathode **117**. Following explanation is given using the schematic diagram **4**(*a*) for convenience sake.

[**0022**] Considering a circuit as shown in **FIG. 4**(*a*), a predetermined amount of current always passes through the OLED elements **112** selectively applied by a certain voltage. And a current does not always pass through the OLED elements **112** which are not selected. On the other hand, it is known that the luminance of the OLED elements **112** are virtually in proportional to the current passing through the OLED elements **112**. It follows that the light emission of the selected OLED elements **112** is performed at predetermined luminance and the light emission of the unselected OLED elements **112** is never performed, which results in no unexpected luminance nonuniformity.

[**0023**] Upon driving the OLED display **110** having the above-mentioned configuration, however, as shown in **FIG. 9**, it has turned out that an apparent linear luminance nonuniformity appears on the surface of the display. Especially, such linear luminance nonuniformity distinctly appears on top-emitting active matrix OLED displays wherein ribs **122** are arranged in parallel like the above-mentioned systems. Further, luminance nonuniformity in a spot state easily occurs on the kind of OLED displays without ribs **122**, wherein the entire surface is covered with a thin film electrode.

[**0024**] (Cited Document 1)

[**0025**] Japanese Patent Publication No. 2003-22035 (Page 2, **FIG. 1**)

[**0026**] (Cited Document 2)

[**0027**] Japanese Patent Publication No. 08-227276 (Pages 4 and 5, **FIGS. 13 and 14**)

SUMMARY OF THE INVENTION

[**0028**] An OLED display according to the present invention comprises: an insulating substrate; common electrodes formed on the insulating substrate; a first electrode layer formed in a region adjacent to the common electrodes formed on the insulating substrate by electrically isolating from the common electrodes; an insulating layer which coats on the insulating substrate by respectively opening a first opening window exposing a part of the common electrodes and a second opening window exposing at least a part of the first electrode layer; ribs which form a cell area by crossing the common electrodes on the insulating substrate and surrounding each of the opening windows; a material layer formed on the first electrode layer exposed from the second opening window; and a second electrode layer which coats within the cell area surrounded by the rib and electrically connected to the common electrodes through the first opening window. The crossing walls of these ribs include a reserve tapered shape.

[**0029**] A method for manufacturing an OLED display according to the present invention comprises: preparing an insulating substrate; forming common electrodes on the insulating substrate; forming a first electrode layer in a region adjacent to the common electrodes formed on the insulating substrate by electrically isolating from the common electrodes; coating on the insulating substrate with an insulating layer by respectively opening a first opening window exposing a part of the common electrodes and a second opening window exposing at least a part of the first electrode layer; forming a cell area on the insulating substrate by surrounding each of the opening windows with ribs across the common electrodes; forming a material layer on the first electrode layer exposed from the second opening window; and forming a second electrode layer electrically connected to the common electrodes through the first opening window by coating within the cell area.

[0030] The method for manufacturing an OLED display according to the present invention comprises: preparing an insulating substrate; forming band-like common electrodes on the insulating substrate; forming a first electrode layer in an region adjacent to the common electrodes formed on the insulating substrate; coating the insulating substrate with an insulating layer; forming ribs wherein the walls are in a reverse tapered shape and a thin insulating layer in a cell area surrounded with the ribs by etching the insulating layer across the common electrodes; forming a first opening window exposing a part of the common electrodes and a second opening window exposing a part of the first electrode layer on the insulating layer within the cell area; forming a material layer on the first electrode layer exposed from the second opening window; and electrically connecting the second electrode layer which coats the material layer to the common electrodes through the first opening window by coating the ribs with the second electrode layer as a mask within the cell area.

BRIEF DESCRIPTION OF THE DRAWING

[0031] **FIG. 1**(*a*) is a plan view of an OLED display, **FIG. 1**(*b*) is a cross sectional view taken on line A-A of **FIG. 1**(*a*), **FIG. 1**(*c*) is a cross sectional view taken on line B-B of **FIG. 1**(*a*), **FIG. 1**(*d*) is a cross sectional view taken on line of C-C of **FIG. 1**(*a*), **FIG. 1**(*e*) is a cross sectional view taken on line D-D of **FIG. 1**(*a*), and **FIG. 1**(*f*) is a cross sectional view taken on line E-E of **FIG. 1**(*a*) according to the present invention.

[0032] **FIG. 2**(*a*) is a cross sectional view of another embodiment of the OLED display of the present invention, and **FIG. 2**(*b*) is a cross sectional view of further another embodiment of the OLED display of the present invention.

[0033] **FIG. 3** is an equivalent circuit diagram of an OLED display of the present invention.

[0034] **FIG. 4**(*a*) is an ideal equivalent circuit diagram of a conventional top-emitting OLED display, and **FIG. 4**(*b*) is another ideal equivalent circuit diagram of a conventional top-emitting OLED display.

[0035] **FIG. 5**(*a*) is a perspective view of a passive matrix OLED display, and **FIG. 5**(*b*) is a plan view of a passive matrix OLED display.

[0036] **FIG. 6**(*a*) is a perspective view of an active matrix OLED display, and **FIG. 6**(*b*) is a plan view of an active matrix OLED display.

[0037] **FIG. 7**(*a*) is a cross sectional view of a bottom-emitting OLED display, and **FIG. 7**(*b*) is a cross sectional view of a top-emitting OLED display.

[0038] **FIG. 8**(*a*) is a plan view of a conventional OLED display, and **FIG. 8**(*b*) is a cross sectional view of **FIG. 8**(*a*).

[0039] **FIG. 9** shows a top-emitting OLED display having linear luminance nonuniformity.

[0040] **FIG. 10**(*a*) is a cross sectional view of a bottom-emitting active matrix OLED display, **FIG. 10**(*b*) is a perspective view of an OLED display wherein first display electrode lines, **FIG. 10**(*c*) is a perspective view of an OLED display wherein ribs are arranged, and **FIG. 10**(*d*) is a perspective view of an OLED display wherein second display electrode lines are formed.

[0041] **FIG. 11** is a cross sectional view of a top-emitting active matrix OLED display.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0042] The present invention will now be described in detail. For the sake of convenience, a first electrode refers to an anode and a second electrode refers to a cathode. Further, a first opening window opened in an insulating layer for coating on an insulating substrate refers to a via hole reaching from the surface of the cathode of OLED to common electrodes. An anode is exposed to the inside of a second opening window.

[0043] FIGS. 1(*a*) to 1(*f*) are a plan view and cross sectional views per each cut section of an OLED display in an embodiment of the present invention. In this embodiment, as shown in a shaded area of **FIG. 1**(*a*), an OLED display **10** is divided into cell areas **32** in matrix state by ribs **22** arranged on an insulating substrate **18** or an insulating layer **19** covering the insulating substrate **18**. Inside the cell area **32**, an anode **14** is formed on the insulating substrate **18**, where common electrodes **24** are formed by being isolated from the anode **14** in parallel with the ribs **22**. In addition, OLED elements **12** formed on the anode **14** by laminating a material layer **13** and a thin film cathode **17**, and via holes **26** conducting the thin film cathodes **17** and the common electrodes **24** are formed within the cell areas **32**.

[0044] The insulating substrate **18** herein may be, for example, a glass substrate. The ribs **22** are ribs made from an insulator, such as polymer and ribs in a reverse tapered shape. The anode **14** may be an electrode made from a metal, such as Al or an electrode made from other materials. Although the common electrodes **24** are preferably made from a metal having superior conductivity and the shape is not limited, as shown in **FIG. 1**(*a*), they may be common electrodes **24**. Further, the thin film cathode **17** is prepared by utilizing a transparent electrode material itself or by laminating ordinary metals to be formed with the surface of the cell areas **32** covered. Furthermore, the material layer **13** sandwiched between the anode **14** and thin film cathode **17** may include a plurality of layers, such as an electron or a hole-injecting layer, an electron or a hole-transporting layer other than a light-emitting layer.

[0045] To solve the above-mentioned problems, **FIG. 4**(*a*) assumed as equivalent circuit is amended to assume the circuit of **FIG. 4**(*c*) as equivalent circuit of a realistic OLED display. The presence of a leakage current passing through the surface of the thin film cathode **17** uniformly laminated on the OLED display needs to be considered in **FIG. 4**(*c*).

[0046] Referring to the circuit represented in **FIG. 4**(*c*), OLED 1 to OLED 4 are assumed as OLED elements **12**. The OLED elements **12** are respectively connected to TFT **20** within the cell areas **32** and similarly connected to the common electrodes **24** through via holes **26** in the cell areas **32**. Rg shows resistance of the common electrodes **24**. Rc shows resistance among the cell areas **32**. Rvia1 shows average resistance of the via holes **26**. Rvia2 shows resistance of the via holes **26** having resistance different from Rvia1.

[0047] As described in the above-mentioned conventional examples, the thin film cathode of the surface of the OLED display is unidirectionally isolated by the ribs **22** arranged in stripe. However, no isolation is provided among OLED elements formed along the ribs **22**, so that a leakage current may unidimensionally pass among the cell areas through the surface of the thin film cathode. Accordingly, in an equivalent circuit shown in **FIG. 4**(*c*), the presence of resistance Rc among the cell areas **32** needs to be considered.

[0048] Further, the via holes **26** are holes to reach from the surface of the thin film cathode **22** to the common electrodes **24** and seems to have large resistance Rvia1 comparing with the thin film cathode **22** in a planar state. Furthermore, the via holes **26** often have nonuniform resistance because it is difficult to keep uniform resistance. Consequently, resistance Rvia2 of via holes **26** different from that of the average via holes **26** has to be taken into consideration in the equivalent circuit diagram of **FIG. 3**. The equation of Rvia1>Rvia2>>Rc>>Rg is assumed to be established in the equivalent circuit diagram of **FIG. 4**(*c*).

[0049] In the equivalent circuit diagram of **FIG. 4**(*c*), such as the above-mentioned figure, current is passed into Rvia2 by passing a leakage current through Rc because Rvia2 is smaller than Rvia1. The effects of the presence of voltage depending on a path reaching Rvia2 enable the current value passing through each of the cell areas **32** to make difference from the estimated current value. As mentioned above, emitting luminance of the OLED elements **12** depends on the current value. As a result, luminance nonuniformity is observed around Rvia2 in the cell areas **32** due to different luminance from other places of the display. Further, the leakage current gives impact on the current passing through the OLED elements in the cell areas **32** near Rvia2, so that luminance nonuniformity easily appears as linear luminance nonuniformity in the direction of the ribs because the thin film cathode **17** which is used as a flowing path is unidirectionally isolated.

[0050] To avoid such luminance nonuniformity, a method for closing off a path where a leakage current passes through by separating an anode and a cathode for each adjacent cell area is adopted. More particularly, a wide range of luminance nonuniformity is replaced with luminance nonuniformity in the cell areas **32** by arranging ribs among the cell areas **32** to interrupt the leakage current passing through the cell areas **32** in **FIG. 3**.

[0051] In this embodiment, an OLED display **10** is formed as mentioned below. As shown in FIGS. **1**(*a*) to **1**(*f*), common electrodes **24** are formed on an insulating substrate **18** and then ribs **22** for dividing the insulating substrate into a plurality of cell areas **32** to electrically isolate among each cell area are formed on the insulating substrate **18** and the common electrodes **24**. Next, the anode **14** is formed within the plurality of cell areas **32** and OLED elements **12** are formed by laminating in the order of a material layer **13** and a thin film cathode **17**. Additionally, via holes **26** for electrically conducting the thin film cathode **17** and the common electrodes **24** are formed.

[0052] The ribs **22** are made from an insulator and separate the anode **14** and thin film cathode **17** for each cell area **32**. The thin film cathode **17** and common electrodes **24** in each cell area **32** are ordinarily equal potential because of being connected to each other through the via holes **26**. Even when a potential difference occurs among the cell areas **32** for a particular reason, there is no possibility of the current passing among the cell areas **32** via the surface of the thin film cathode **17** because of isolating each of the cell areas **32** from the other cell areas by the formation of the ribs **22**.

[0053] The ribs **22** are formed by applying a negative typed photo resist onto the insulating substrate **18** employing the spin coat method and being developed after exposure using a photo mask. These ribs are in a reverse tapered shape in 10 μm order previously arranged on the insulating substrate **18**. These ribs in a reverse tapered shape are formed, for example, with a negative-type photo polymer by utilizing the difference of developing speed caused by the difference in amount exposed in the thickness direction.

[0054] Such configuration of an OLED display **10** makes it possible to avoid the above-mentioned leakage current from occurring by electrically isolating each of the cell areas **32** from the thin film cathode **17** on the surface of the thin film cathode **17**. That is, the ribs **22** isolate among OLED elements **12** in cell state, which leads to prevent the current from passing among the cell areas **32** via the surface of the thin film cathode **17**.

[0055] Further, the impact of the ribs **22** made on luminance nonuniformity will be now described using **FIG. 3**. Since an anode and a cathode are separated for each cell area **32** by the ribs **22** to close off the path for the leakage current, the current passing through the OLED elements **12**, such as OLED **1**, OLED **2**, and OLED **4** reaches the common electrodes **25** through resistance Rvia1. Accordingly, the current passing through three OLED elements **12** is uniform and the luminance is also uniform.

[0056] However, the current passing through the OLED elements **12** indicated as OLED **3** reaches the common electrodes **24** via resistance Rvia2. From the above-mentioned conditions, Rvia1 is larger than Rvia2, so that the current passing through the OLED elements **12** indicated as OLED **3** becomes larger than the current passing through other OLED elements **12** indicated as OLED **1**, OLED **2**, and OLED **4**. As a result, the luminance of OLED **3** is unexpectedly larger than other 3 OLEDs, which leads to luminance nonuniformity.

[0057] Unlike conventional OLED displays, the OLED display of the present invention is capable of removing the whole linear luminance nonuniformity. More particularly, in **FIG. 3**, a wide range of luminance nonuniformity is replaceable with luminance nonuniformity in each of the cell areas **32**.

[0058] The structure of the OLED display according to the present invention is not limited to the above-mentioned embodiments. For example, common electrodes may be formed on the entire surface of the insulating substrate **18** to laminate an insulating layer **19** on the entire surface of the common electrodes **24**, and on the insulating layer **19**, the cell areas **32** may be formed by the ribs **22**.

[0059] An anode **14** is formed within each cell area **32**, and a material layer **13** and a thin film cathode **17** are laminated on the anode **14** in order to form the OLED elements **12**. The ribs **22** are high enough to divide the thin film cathode **17** into each cell area **32**. The via holes **26** for electrically conducting the thin film cathode **17** and the common electrodes **24** are formed by penetrating the anode **14** and insulating layer **19** in this embodiment.

[**0060**] The OLED display of this embodiment is capable of interrupting the leakage current passing via the surface of the thin film cathode **17** in the cell areas **32** by the arrangement of the ribs among the cell areas **32**. Accordingly, the OLED display of this embodiment is capable of removing a wide range of luminance nonuniformity easily discovered as well as the above-mentioned embodiments.

[**0061**] Alternatively, as shown in **FIG. 2**(*a*), common electrodes **24** may be formed on the entire surface of an insulating substrate **18**, and ribs **22** are arranged on the common electrodes **24** so that cell areas **32** may be formed, and then an insulating layer **19** may be laminated. After that, OLED elements **12** and via holes **26** are formed within each cell area in the same manner as the above-mentioned embodiments. The common electrodes **24** and an anode not shown in figures are isolated by the insulating layer **19** and the thin film cathodes **17** located adjacent to each other are isolated by the ribs **22** in this embodiment as well as the above-mentioned embodiments.

[**0062**] On the other hand, the ribs **22** may be directly arranged on the insulating substrate **18** in another embodiment shown in **FIG. 4**(*b*). Common electrodes **24**, an insulating layer **19**, an anode (not shown in figures), OLED elements (not shown in figures), and a thin film cathode **17** are laminated in order. In this case, a wide range of luminance nonuniformity is removable in the same manner as the OLED display of the above-mentioned embodiments.

[**0063**] Although a thin film cathode is used in the embodiments of the OLED display according to the present invention described above, a cathode with thicker thickness may be laminated on a material layer **13**. In this case, problems with luminance nonuniformity caused by a leakage current do not become evident so often because resistance of the thick cathode is smaller than that of the thin film cathode **17** and is sufficiently close to resistance of the common electrodes **24**. In addition, it is not so common that such problems of a wide range of luminance nonuniformity become evident when employing the bottom-emitting system for the similar reason.

[**0064**] Even when resistance of the thick cathode is small, luminance nonuniformity is presumed to appear not in a wide range but locally due to the mechanism of the above-mentioned description. Consequently, a method for removing luminance nonuniformity using the ribs **22** of the present invention is effective regardless of whether using the top-emitting system or the bottom-emitting system. The method for removing luminance nonuniformity using the ribs **22** of the present invention is effective to all OLED displays wherein OLED elements **12** are not electrically insulated from each other on the surface electrode.

[**0065**] Furthermore, the anode **14** and the thin film cathode **17** may be interchangeable in the above-mentioned embodiments of the present invention. More specifically, similar effects of removing luminance nonuniformity can be obtained in OLED displays wherein OLED elements **12** are formed by forming a cathode on the insulating substrate **18** and laminating the material layer **13** and an anode. In this case, partitioning among the OLED elements by the ribs **22** enables to remove luminance nonuniformity which occurs on OLED displays each having a structure in which the common electrodes are connected to the anode as shown in **FIG. 4**(*b*) In each embodiment of the present invention described so far, an insulating substrate **18** is made of glass and the like, but it is not limited to a transparent material as far as the top-emitting system is used for the OLED display. More particularly, the insulating substrate **18** is not particularly limited as far as it is an insulator and may be made of plastic and the like.

[**0066**] Similarly, the anode is not limited to a transparent material but may be made from a metal, such as Al and a thin plate made of stainless or the like. Further, the above-mentioned first opening window is not limited to be called as via holes and through holes or the like and includes all opening windows for electrically conducting the cathode surface of the OLED elements and common electrodes.

[**0067**] The ribs **22** preferably include a reverse tapered shape crossing upwardly on a second electrode layer and may be so-called cathode ribs. In this case, the ribs **22** also act as a role of a shadow mask at the time of laminating the cathode. Alternatively, the ribs **22** may be exclusively used for shutting down the continuity among the cell areas **32**. In this case, the ribs **22** are not limited to particular shape and material or the like as long as isolation among the cell areas **32** can be obtained.

[**0068**] Additionally, the cell areas **32** surrounded by the ribs **22** are in a rectangle shape partitioned in a row direction and a column direction, but the shape of the cell areas **32** are not particularly limited. The shape may be in other polygonal shape, such as triangle shape and the like. Alternatively, the shape of the cell area **32** may be a round shape or an oval shape. The shape and size of each of the cell areas **32** may be arbitrary.

[**0069**] The cell areas **32** in such shape are disposed on the row and column in matrix state. Alternatively, these cell areas **32** are aligned in such a manner to form a polygonal grating, such as a triangle grating and a hexagonal grating. These cell areas **32** may be arbitrarily disposed.

[**0070**] There have thus been shown and described a novel OLED display and a method for manufacturing thereof which fulfill all the objects and advantages sought therefor. Many changes, modifications, variations, combinations, and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification and accompanying drawings which disclose the preferred embodiments thereof. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, Which is to be limited only by the claims which follow. This application claims priority from Japanese Patent Application No. 2003-209273, which is incorporated herein by reference.

What is claimed is:

1. An organic light emitting diode display comprising:

an insulating substrate;

common electrodes formed on the insulating substrate;

a first electrode layer formed in a region adjacent to the common electrodes formed on the insulating substrate by electrically isolating from the common electrodes;

an insulating layer which coats on the insulating substrate by respectively opening a first opening window exposing a part of the common electrodes and a second opening window exposing at least a part of the first electrode layer;

ribs which form a cell area by crossing the common electrodes on the insulating substrate and surrounding each of the opening windows;

a material layer formed on the first electrode layer exposed from the second opening window; and

a second electrode layer which coats within the cell area surrounded by the ribs and electrically connected to the common electrodes through the first opening window.

2. The display according to claim 1, wherein said ribs include a reverse tapered shape.

3. The display according to claim 1 wherein said cell area is in a polygonal shape or a round shape or an oval shape partitioned by said ribs.

4. The display according to claim 1, wherein an opening window is a via hole to reach from the surface of said second electrode layer to said common electrodes.

5. A method for manufacturing an organic light emitting diode display comprising:

preparing an insulating substrate;

forming common electrodes on the insulating substrate;

forming a first electrode layer in a region adjacent to the common electrodes formed on the insulating substrate by electrically isolating from the common electrodes;

coating on the insulating substrate with an insulating layer by respectively opening a first opening window exposing a part of the common electrodes and a second opening window exposing at least a part of the first electrode layer;

forming a cell area on the insulating substrate by surrounding each of the opening windows with ribs across the common electrodes;

forming a material layer on the first electrode layer exposed from the second opening window; and

forming a second electrode layer electrically connected to the common electrodes through the first opening window by coating within the cell area.

6. A method for manufacturing an organic light emitting diode display comprising:

preparing an insulating substrate;

forming band-like common electrodes on the insulating substrate;

forming a first electrode layer in a region adjacent to the common electrodes formed on the insulating substrate;

coating the insulating substrate with an insulating layer;

forming ribs wherein the walls are in a reverse tapered shape and a thin insulating layer within a cell area surrounded with the ribs by etching the insulating layer across the common electrodes;

forming a first opening window exposing a part of the common electrodes and a second opening window exposing a part of the first electrode layer in the insulating layer within the cell area;

forming a material layer on the first electrode layer exposed from the second opening window; and

electrically connecting the second electrode layer which coats the material layer to the common electrodes through the first opening window by coating the ribs with the second electrode layer as a mask within the cell area.

7. The method according to claim 5, wherein said cell area is formed by partitioning with ribs in a polygonal shape or a round shape or an oval shape.

* * * * *

patsnap

专利名称(译)	OLED显示器及其制造方法		
公开(公告)号	US20050046341A1	公开(公告)日	2005-03-03
申请号	US10/926379	申请日	2004-08-25
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IPC分类号	H01L51/50 G09F9/30 H01L27/32 H01L51/52 H05B33/10 H05B33/12 H05B33/14 H05B33/22 H05B33/26		
CPC分类号	H01L27/3246 H01L51/5203 H01L27/3283		
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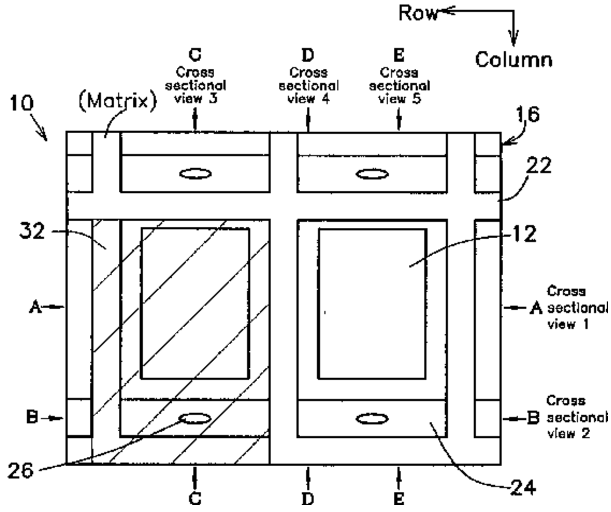
其他公开文献	US7122956		
外部链接	Espacenet USPTO		

摘要(译)

一种有机发光二极管显示器，包括：绝缘基板;公共电极;第一电极层形成在与形成在绝缘基板上的公共电极相邻的区域中，通过与公共电极电隔离;绝缘层，其通过分别打开暴露部分公共电极的第一开口窗口和暴露第一电极层的至少一部分的第二开口窗口而涂覆在绝缘基板上;通过在绝缘基板上交叉公共电极并围绕每个开口窗口形成单元区域的肋;形成在从第二开口窗暴露的第一电极层上的材料层;第二电极层涂覆在由肋条围绕的单元区域内，并通过第一开口窗口电连接到公共电极。



Row
Column
C
Cross sectional view 3
D
Cross sectional view 4
E
Cross sectional view 5
10
(Matrix)
16
22
32
12
A
A
Cross sectional view 1
B
B
Cross sectional view 2
26
24
C
D
E