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(54) **Organic electroluminescence display panel and method for fabricating the same**

Organische elektrolumineszente Anzeigevorrichtung und Herstellungsverfahren

Dispositif d'affichage électroluminescent organique et méthode de fabrication

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**US-A1- 2002 089 633**



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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** The present invention relates to an organic electroluminescence display panel and a method for fabricating the same. Although the present invention is suitable for a wide scope of applications, it is particularly suitable for decreasing line resistance and improving adhesion between a glass substrate and a seal-cover, thereby enhancing efficiency and durability of the organic electroluminescence display panel.

#### Discussion of the Related Art

**[0002]** Recently, a wide range of self-emissive luminescent display devices has been developed. However, the basic structure of such devices includes using a luminescence device that operates a single pixel as the main element, whereby the luminescence device is in planar alignment. Plasma display panels (PDP) using cells divided by discharge areas as a luminescence device, vacuum fluorescence displays (VFD), electroluminescence displays (ELD), light-emitting diodes (LED), and field emission displays (FED) can be given as examples of the above-described display devices.

**[0003]** Among such display devices, the organic electroluminescence (EL) display panel using an organic electroluminescence device as its main element, which provides a high-luminance surface emission at a low voltage and also an RGB light emission having a high color purity depending upon the selected material. Accordingly, the organic electroluminescence display panel is viewed as one of the most prominent display devices having the characteristics of slim design, lightweight, and full color representation.

**[0004]** The organic electroluminescence device is formed of an organic layer including an emission layer between a pair of electrodes formed of an anode having a positive voltage applied thereto and a cathode having a negative voltage applied thereto. By applying a voltage between the electrodes, an electron is injected into the organic layer from the cathode, and a hole is injected into the organic layer from the anode. Subsequently, the electron and the hole are paired to each other within the organic layer, thereby emitting light.

**[0005]** The organic electroluminescence display panel formed of the organic electroluminescence device having the above-described structure will now be described with reference to the accompanying drawings.

**[0006]** FIG. 1 illustrates a plane view of a general organic electroluminescence display panel.

**[0007]** Referring to FIG. 1, an indium-tin-oxide (ITO) strip 102 is linearly aligned in a strip form on a glass substrate 101. Subsequently, a counter electrode 103 having a width narrower than the ITO strip 102 is formed on the ITO strip 102. And, an organic electroluminous (EL) layer 104 formed of a hole transport layer, an emission layer, and an electron transport layer serially deposited thereon, is formed over the ITO strip 102. An insulating layer 106 is formed between the ITO strip 102 and a barrier rib 107. A cathode strip 105 formed in the shape of a strip overlaps the ITO strip 102 above the organic EL layer 104. Then, a barrier rib 107 formed in the shape of a strip is formed between each cathode strip 105, so as to separate the cathode strips 105 adjacent to one another. Finally, the organic EL display panel is completed when the substrate having the cathode strips 105 formed thereon is paired with a seal-cover 109 by using a sealant 108.

**[0008]** Herein, the organic EL display panel is formed of the organic EL layer 104 inserted between the ITO strip 102 having a high work function and the cathode strip 105 having a low work function on the glass substrate 101. The ITO strip 102 having a high work function is used as an anode for injecting a hole, and the cathode strip 105 having a low work function is used as a cathode for injecting an electron.

**[0009]** FIGs. 2A to 2F illustrate perspective views of the process steps for fabricating the general organic electroluminescence display panel.

**[0010]** Referring to FIG. 2A, the ITO strip 102 (*i.e.*, a transparent electrode) for applying an anode is formed on the glass substrate 101. Simultaneously, an ITO strip 102-A having a shorter length is formed between the barrier rib 107, so as to facilitate the removal of the cathode strip 105 in a later process.

**[0011]** Subsequently, as shown in FIG. 2B, the counter electrode 103 is formed of a highly conductive metal, such as molybdenum (Mo) and chrome (Cr). Herein, at a vertical crossing point between the sealant 108 used in the sealing process and the counter electrode 103, when the width of the counter electrode 103 is larger than the width of the ITO strip 102, the sealant 108 formed on the counter electrode 103 cannot be hardened during a hardening process of the sealant 108 by using UV light rays in a later process step. Therefore, at the crossing point between the sealant 108 and the counter electrode 103, the width of the counter electrode 103 is formed to be smaller than that of the ITO strip 102 formed thereunder.

**[0012]** Thereafter, referring to FIGs. 2C and 2D, in order to insulate the cathode strip 105 from the ITO strip 102, the insulating layer 106 and the barrier rib 107 are formed on the ITO strip 102. Herein, the insulating layer 106 is formed of an organic compound, an inorganic compound, a polymer, and a blended form of the same.

**[0013]** Furthermore, as shown in FIGs. 2E and 2F, the organic EL layer 104 is deposited over the insulating layer 106 and the barrier rib 107, so as to form the cathode strip 105, which is formed of a magnesium (Mg)-silver (Ag) alloy and aluminum (Al) or other conductive materials.

**[0014]** In the organic EL display panel having the

above-described structure, the role of the sealing process is very important to the durability and efficiency of the display panel, which will now be described in detailed with reference to FIGs. 3A and 3B.

**[0015]** FIG. 3A illustrates a cross-sectional view of the panel taken along a sealant direction of FIG. 1. And, FIG. 3B illustrates a cross-sectional view of the panel taken along a sealant direction of FIG. 1.

**[0016]** Referring FIGs. 3A and 3B, when hardening the sealant 108 with UV light rays in a later process, if the width of the counter electrode 103 is larger than that of the ITO strip 102 at the point where the sealant 108 and the counter electrode 103 vertically cross each other, then the UV light rays cannot be transmitted through the counter electrode 103, which is formed of a metal. Therefore, an unhardened sealant 108-A remains on the counter electrode 103, as shown in FIG. 3B.

**[0017]** As described above, if the sealant 108 at the crossing point between the sealant 108 and the counter electrode 103 is not hardened, then the glass substrate 101 and the seal-cover 109 cannot be adhered to each other, which results in a penetration of moisture and oxygen, thereby causing a critical influence on the durability of the organic EL display panel.

**[0018]** Meanwhile, in order to resolve such problems and to facilitate the hardening of the sealant 108, a portion of the counter electrode 103 formed on the area where the sealant 108 is sprayed can either be removed or be dividedly formed in thin layers, as shown in FIG. 4.

**[0019]** However, when the portion of the counter electrode 103 formed on the area where the sealant 108 is sprayed is either removed or dividedly formed in thin layers, a line resistance is increased, thereby causing the problem of an increase in the driving voltage. Since the organic EL display panel is driven by electric current, the driving voltage increases as the line resistance rises.

**[0020]** Furthermore, since a plurality of cathode strips 105 is connected to a single ITO strip 102, a large amount of electric current is flown therein, thereby causing the efficiency of the organic EL display panel to be highly sensitive to the resistance.

Further prior att is known from EP 0 971 564 A2 and DE 101 33 684 A1.

## SUMMARY OF THE INVENTION

**[0021]** Accordingly, the present invention is directed to an organic electroluminescence display panel and a method for fabricating the same that substantially obviate one or more problems due to limitations and disadvantages of the related art.

**[0022]** An object of the present invention is to provide an organic electroluminescence display panel and a method for fabricating the same that improves the adhesion between a glass substrate and a seal-cover.

**[0023]** Another object of the present invention is to provide an organic electroluminescence display panel and a method for fabricating the same that reduces a line resistance caused by a counter electrode.

**[0024]** Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

**[0025]** To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, an organic electroluminescence display panel according to claim 1 is provided.

**[0026]** In another aspect of the present invention, a method for fabricating an organic electroluminescence display panel according to claim 4 is provided.

**[0027]** It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0028]** The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention. In the drawings;

FIG. 1 illustrates a plane view of a general organic electroluminescence display panel;

FIGs. 2A to 2F illustrate perspective views of the process steps for fabricating an organic electroluminescence display panel;

FIG. 3A illustrates a cross-sectional view of the panel taken along a sealant direction of FIG. 1;

FIG. 3B illustrates a cross-sectional view of the panel taken along a sealant direction of FIG. 1;

FIG. 4 illustrates a cross-sectional view of a related art organic electroluminescence display panel taken along a Y direction; of Fig. 2F;

FIGs. 5A to 5F illustrate perspective views of the process steps for fabricating an organic electroluminescence display panel useful for the understanding of the present invention;

FIG. 6 illustrates a detailed view showing the structure of a counter electrode according to the present invention;

FIG. 7A illustrates the structure of a counter electrode of a general organic electroluminescence display panel;

FIG. 7B illustrates the structure of a counter electrode of a related art organic electroluminescence display panel; and

FIG. 7C illustrates a comparison between the structure of the counter electrode of FIGs. 7A and 7B and the structure of the counter electrode useful for the understanding of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

**[0029]** Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

**[0030]** FIGs. 5A to 5F illustrate perspective views of the process steps for fabricating an organic electroluminescence display panel useful for the understanding of the present invention.

**[0031]** Referring to FIG. 5A, the ITO strip 512 for applying an anode is formed on the glass substrate 511. Simultaneously, an ITO strip 512-A having a shorter length is formed between the barrier rib formed in a later process, so as to facilitate the removal of the cathode strip 515, also formed in a later process.

**[0032]** Subsequently, as shown in FIG. 5B, the counter electrode 513 is formed of a highly conductive metal, such as molybdenum (Mo) and chrome (Cr), so as to have a width smaller than that of the ITO strip 512. Herein, the counter electrode 513 at a vertical crossing point between the sealant, used in a later sealing process, and the counter electrode 513 is formed in a grid form. Therefore, when the sealant is hardened by using UV light rays, the unhardened portion of the sealant and the line-width of the counter electrode 513 are simultaneously reduced, thereby preventing the increase in the line resistance.

**[0033]** More specifically, as shown in FIG. 6, the counter electrode 513 is formed of a cross in the form of a grid. However, the grid patterns should be spaced apart at an optimum distance, so as to prevent the adjacent grid patterns from contacting one another. Preferably, the distance between each grid pattern should be greater than zero (0).

**[0034]** Subsequently, the insulating layer 516 is formed, as shown in FIG. 5C. Herein, the insulating layer 516 is extended to a predetermined region including the region whereby the counter electrode 513 overlaps the sealant, and also to a portion of the glass substrate 511, so as to be formed at a peripheral region of the organic EL layer, which is formed in a later process. Moreover, referring to FIG. 5D, a barrier rib 517 is formed to electrically insulate the cathode strips, which are also formed in a later process.

**[0035]** Thereafter, as shown in FIG. 5E, the organic EL layer 514 formed of a hole transport layer, an emission layer, and an electron transport layer is deposited, and then, a plurality of cathode strips 515, which is formed of a magnesium (Mg)-silver (Ag) alloy and aluminum or other a conductive materials, is formed thereon. Finally, the sealant 518 is used to adhere the seal-cover 519, as shown in FIG. 5F, thereby completing the organic EL display panel.

**[0036]** FIGs. 7A to 7C illustrate a comparison between the conventional counter electrode and the counter electrode useful for the understanding of the present invention.

**[0037]** FIG. 7A illustrates the counter electrode 103 formed by the fabrication process shown in FIGs. 2A to 2F. FIG. 7B illustrates the counter electrode formed by the fabrication process shown in FIG. 4. And, FIG. 7C illustrates the counter electrode 513 useful for the understanding of the present invention.

**[0038]** Herein, the counter electrode 513 according to the present invention is formed to have a width smaller than that of the ITO strip 512. In other words, the width of the ITO strip 102 and 512, shown in FIGs. 7A to 7C, is uniform, however, the width of the respective counter electrodes of FIGs. 7B and 7C is the smallest. Moreover, as shown in FIG. 7C, the counter electrode 512 is formed in a grid form, thereby reducing line resistance.

**[0039]** As described above, in the organic electroluminescence display panel according to the present invention, the surface of the crossing point between the sealant 518 and the counter electrode 513 is reduced, thereby enhancing the adhesion between the glass substrate 511 and the seal-cover 519.

**[0040]** Furthermore, by decreasing line resistance and enhancing adhesion between the glass substrate 511 and the seal-cover 519, the efficiency and durability of the organic electroluminescence display panel according to the present invention can also be improved.

### Claims

**1.** An organic electroluminescence display panel comprising:

- a glass substrate (511) including
  - a first ITO strip (512),
  - a second ITO strip (512-A),
  - a counter electrode (513) formed on the first ITO strip (512) and the second ITO strip (512-A) in regions other than an emitting region,
  - an organic electroluminous layer (514), and
  - a cathode strip (515) electrically connected with the second ITO strip (512-A); and

- a seal-cover (519) adhered to the glass substrate (511) by using a sealant (518);

**characterised in that**

- the counter electrode (513) is formed in a grid form having a plurality of cross-shaped holes at a crossing point between the counter electrode (513) and the sealant (518).

2. The display panel according to claim 1, wherein the counter electrode (513) is formed of molybdenum (Mo) or chrome (Cr).

3. The display panel according to claim 1 or 2, wherein the cathode strip (515) is formed of a magnesium (Mg)-silver (Ag) alloy or aluminum (Al).

4. A method for fabricating an organic electroluminescence display panel according to any one of the preceding claims, comprising the steps of:

- fonning a first ITO strip (512) and a second ITO strip (512-A) on a glass substrate (511);
- forming a counter electrode (513) on the first ITO strip and the second ITO strip in regions other than an emitting region;
- forming an electroluminous layer (514) on the first ITO strip (512);
- forming a cathode strip (515) on the electroluminous layer (514) to be electrically connected to the second ITO strip (512-A); and
- adhering a seal-cover (519) to the glass substrate (511) by using a sealant (518);
- **characterised in that** the counter electrode is formed in a grid form having a plurality of cross
- shaped holes at a crossing point between the counter electrode (513) and the sealant (518).

5. The method according to claim 4, wherein the first ITO strip (512) and the second ITO strip (512-A) are formed simultaneously.

**Patentansprüche**

1. Organische Elektrolumineszenz-Anzeigetafel, die umfasst:

- ein Glassubstrat (511), das enthält:
  - einen ersten ITO-Streifen (512),
  - einen zweiten ITO-Streifen (512-A),
  - eine Gegenelektrode (513), die auf dem ersten ITO-Streifen (512) und dem zweiten ITO-Streifen (512-A) in Bereichen, die von einem Emissionsbereich verschieden sind, gebildet ist,
  - eine organische Elektrolumineszenzschicht (514) und
  - einen Katodenstreifen (515), der mit dem zweiten ITO-Streifen (512-A) elektrisch verbunden ist; und

- eine Versiegelungsabdeckung (519), die an das Glassubstrat (511) unter Verwendung eines Versiegelungsmittels (518) geklebt ist;
**dadurch gekennzeichnet, dass**
- die Gegenelektrode (513) in einer Gitterform ausgebildet ist und an Kreuzungspunkten zwischen der Gegenelektrode (513) und dem Versiegelungsmittel (518) mehrere kreuzförmige Löcher besitzt.

2. Anzeigetafel nach Anspruch 1, wobei die Gegenelektrode aus Molybdän (Mo) oder Chrom (Cr) gebildet ist.

3. Anzeigetafel nach Anspruch 1 oder 2, wobei der Katodenstreifen (515) aus einer Magnesium-Silber-Legierung (Mg-Ag-Legierung) oder aus Aluminium (A1) gebildet ist.

4. Verfahren zum Herstellen einer organischen Elektrolumineszenz-Anzeigetafel nach einem der vorhergehenden Ansprüche, das die folgenden Schritte umfasst:

- Bilden eines ersten ITO-Streifens (512) und eines zweiten ITO-Streifens (512-A) auf einem Glassubstrat (511);
- Bilden einer Gegenelektrode (513) auf dem ersten ITO-Streifen und dem zweiten ITO-Streifen in Bereichen, die von einem Emissionsbereich verschieden sind;
- Bilden einer Elektrolumineszenzschicht (514) auf dem ersten ITO-Streifen;
- Bilden eines Katodenstreifens (515) auf der Elektrolumineszenzschicht (515), so dass er mit dem zweiten ITO-Streifen (512-A) elektrisch verbunden ist; und
- Kleben einer Versiegelungsabdeckung (519) auf das Glassubstrat (512) unter Verwendung eines Versiegelungsmittels (518);

**dadurch gekennzeichnet, dass** die Gegenelektrode in einer Gitterform ausgebildet ist, die an Kreuzungspunkten zwischen der Gegenelektrode (513) und dem Versiegelungsmittel (518) mehrere kreuzförmige Löcher besitzt.

5. Verfahren nach Anspruch 4, wobei der erste ITO-Streifen (512) und der zweite ITO-Streifen (512-A) gleichzeitig gebildet werden.

**Revendications**

1. Panneau d'affichage électroluminescent organique comprenant :

- un substrat de verre (511) comprenant
  - une première bande ITO (512),
  - une deuxième bande ITO (512-A),
  - une contre-électrode (513) constituée sur

la première bande ITO (512) et la deuxième bande ITO (512-A) dans des régions autres qu'une région d'émission,
- une couche électroluminescente organique (514), et
- une bande de cathode (515) reliée électriquement à la deuxième bande ITO (512-A) ; et

- un cache-joint (519) adhéré au substrat de verre (511) en utilisant un mastic (518) ;

**caractérisé en ce que**

- la contre-électrode (513) est constituée sous forme de grille comportant une pluralité de trous en forme de croix à un point d'intersection entre la contre-électrode (513) et le mastic (518).

**2.** Panneau d'affichage selon la revendication 1, dans lequel la contre-électrode (513) est constituée de molybdène (Mo) ou de chrome (Cr).

**3.** Panneau d'affichage selon la revendication 1 ou 2, dans lequel la bande de cathode (515) est constituée d'un alliage de magnésium (Mg) et d'argent (Ag) ou est constituée d'aluminium (A1).

**4.** Procédé de fabrication d'un panneau d'affichage électroluminescent organique selon l'une quelconque des revendications précédentes, comprenant les étapes de :

- la constitution d'une première bande ITO (512) et d'une deuxième bande ITO (512-A) sur un substrat de verre (511) ;
- la constitution d'une contre-électrode (513) sur la première bande ITO et la deuxième bande ITO dans des régions autres qu'une région d'émission,
- la constitution d'une couche électroluminescente (514) sur la première bande ITO (512) ;
- la constitution d'une bande de cathode (515) sur la couche électroluminescente (514) à relier électriquement à la deuxième bande ITO (512-A) ; et
- l'adhérence d'un cache-joint (519) au substrat de verre (511) en utilisant un mastic (518) ;

**caractérisé en ce que**

- la contre-électrode est constituée sous forme de grille comportant une pluralité de trous en forme de croix à un point d'intersection entre la contre-électrode (513) et le mastic (518).

**5.** Procédé selon la revendication 4, dans lequel la première bande ITO (512) et la deuxième bande ITO (512-A) sont constituées simultanément.

FIG. 1
Related Art

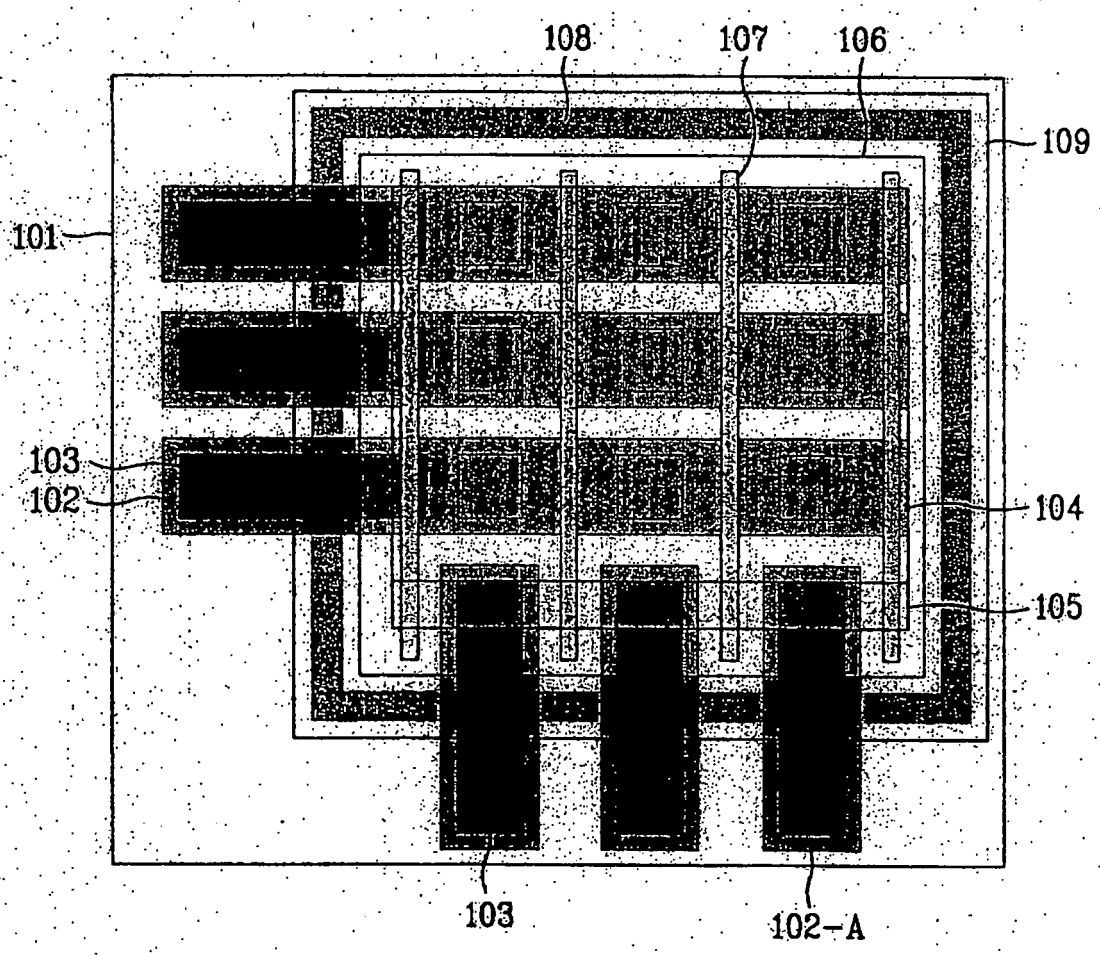


FIG. 2A
Related Art

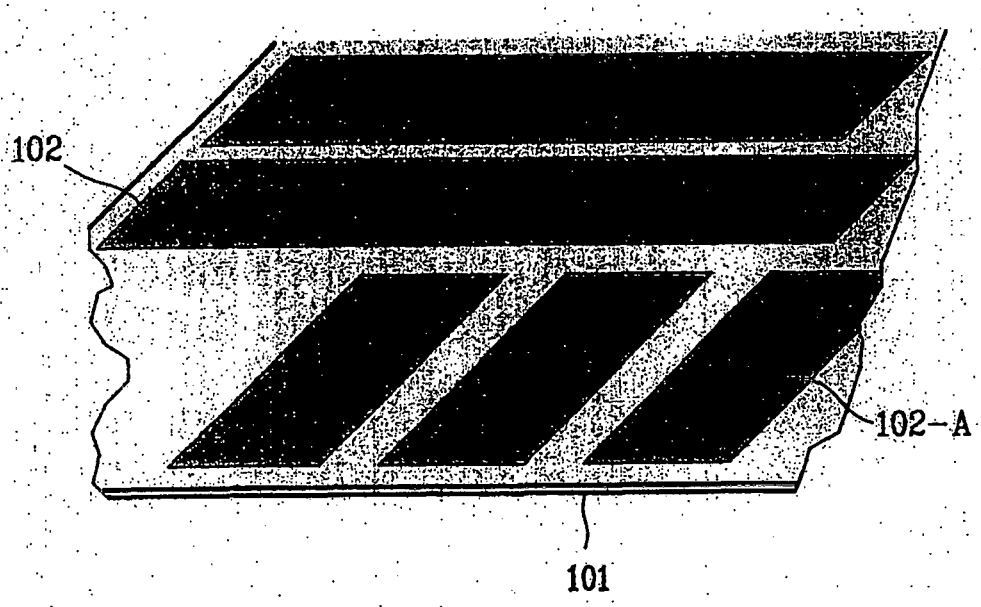



FIG. 2B
Related Art

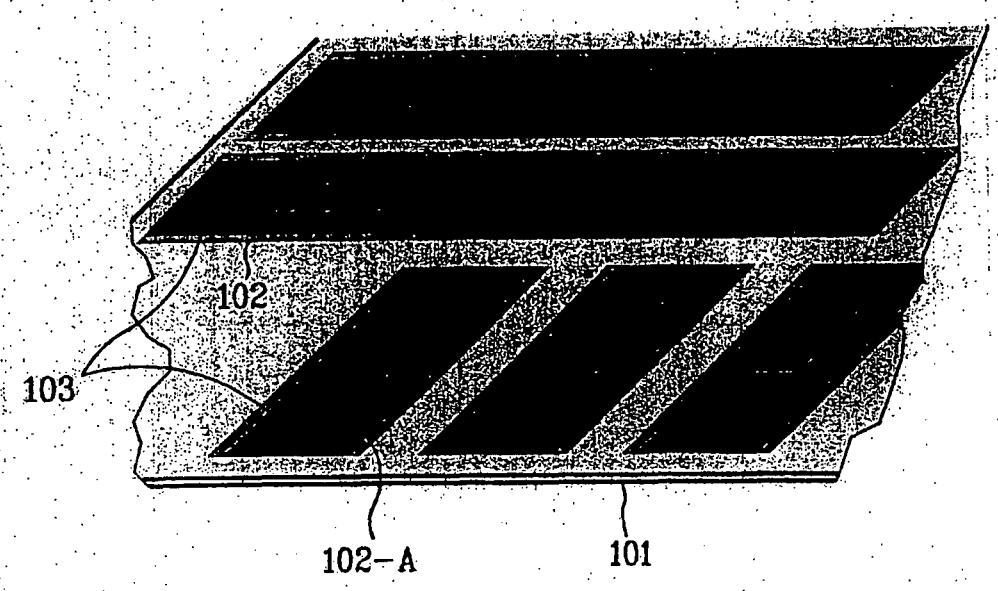


FIG. 2C
Related Art

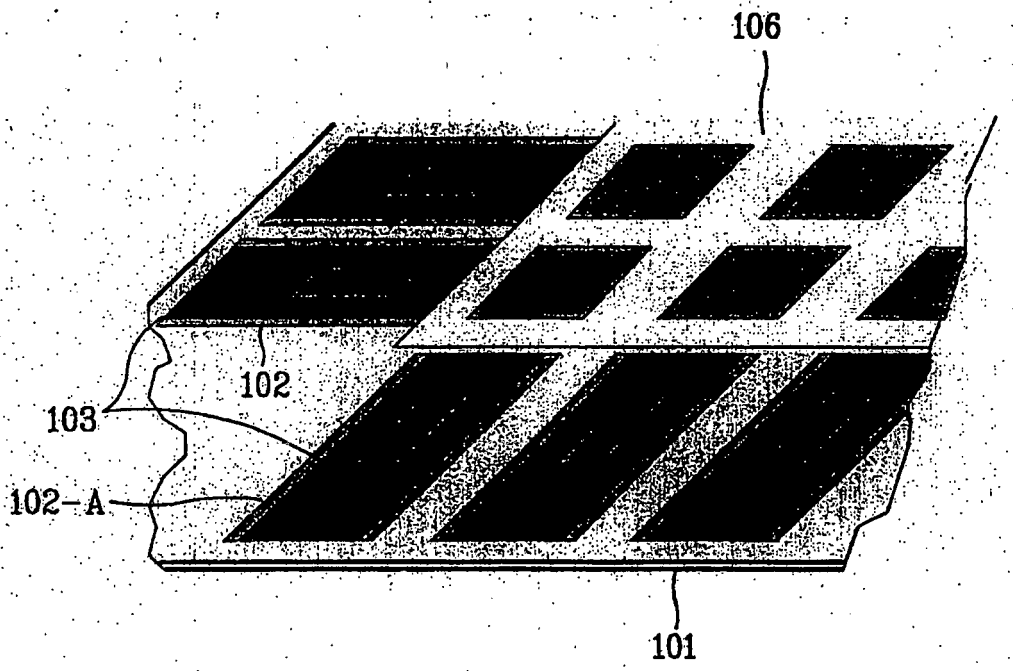



FIG. 2D
Related Art

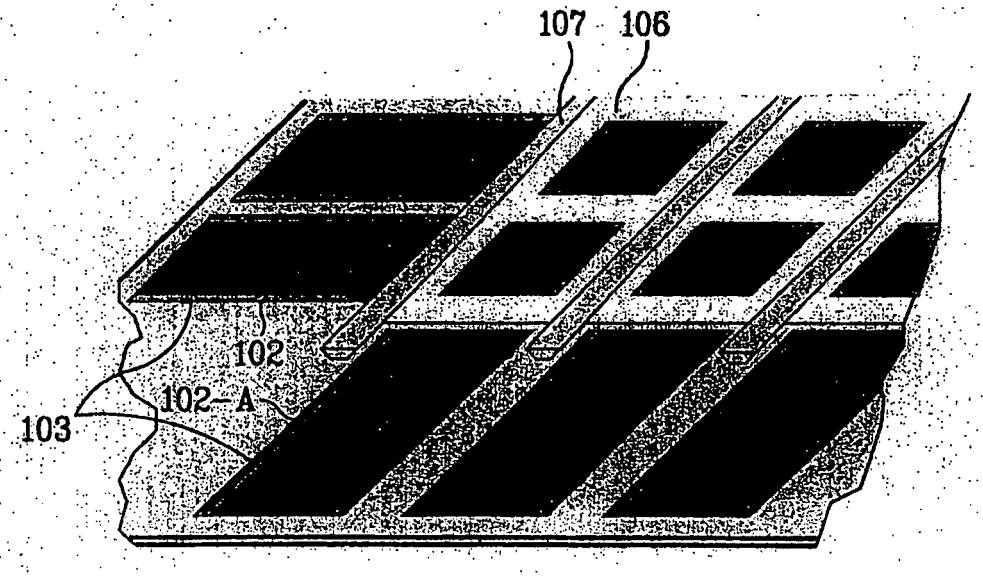


FIG. 2E
Related Art

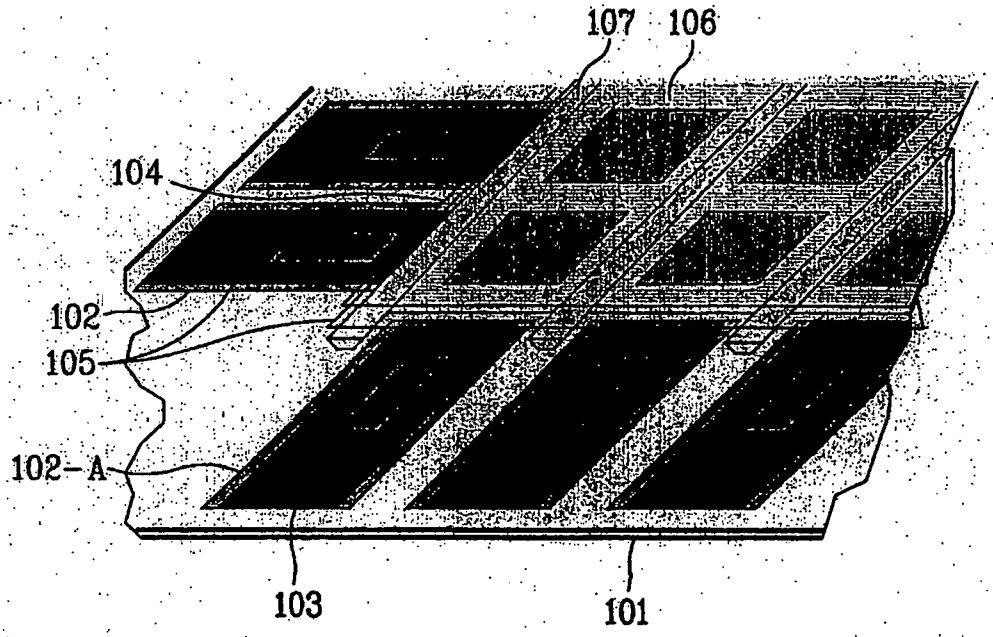



FIG. 2F
Related Art

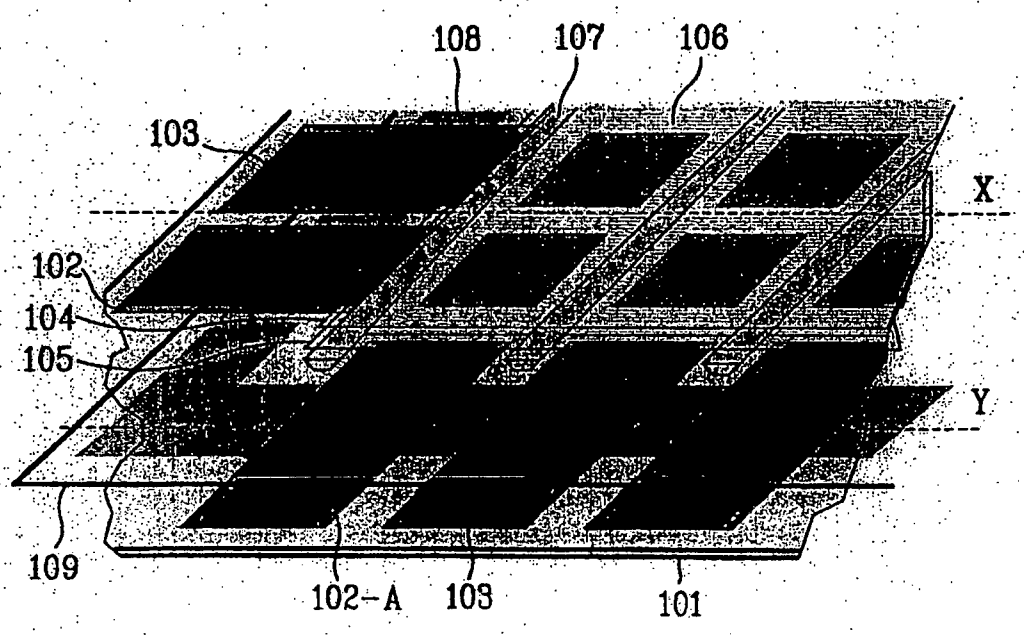


FIG. 3A
Related Art

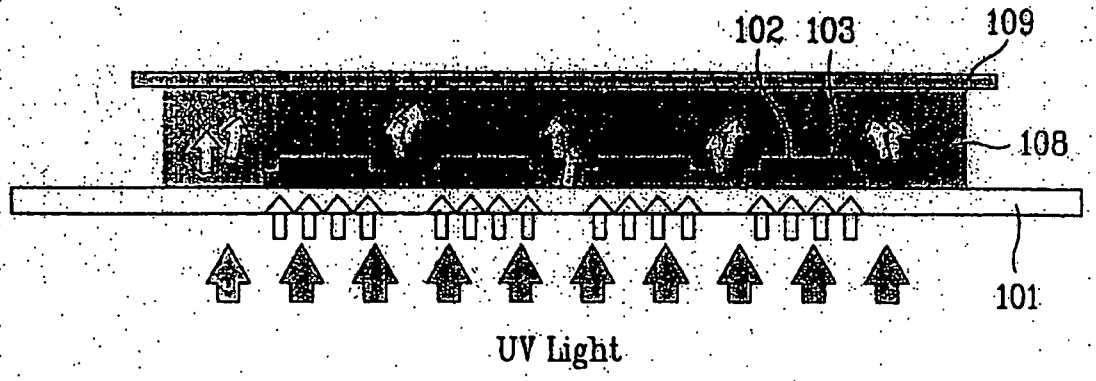



FIG. 3B
Related Art

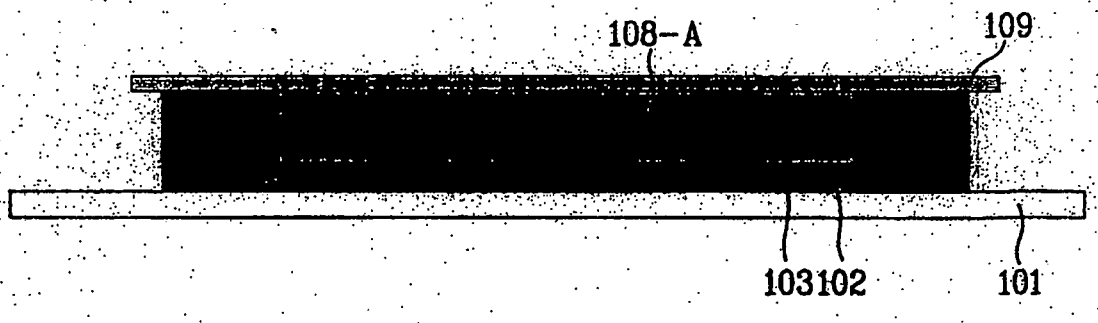


FIG. 4

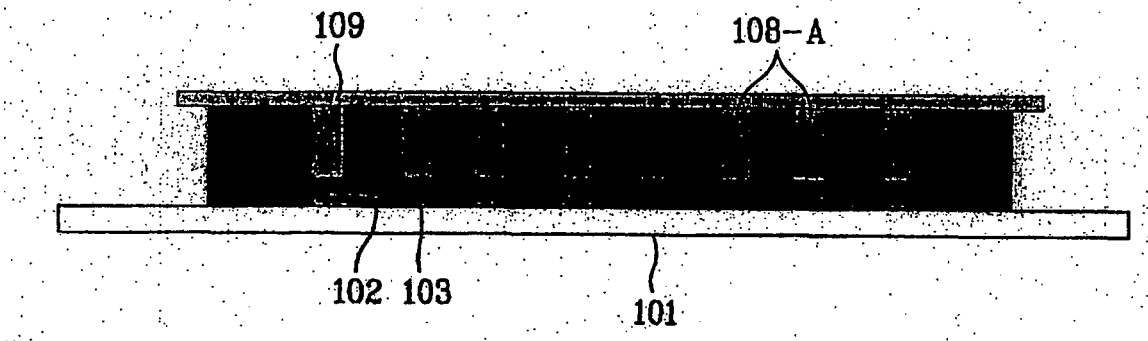


FIG. 5A

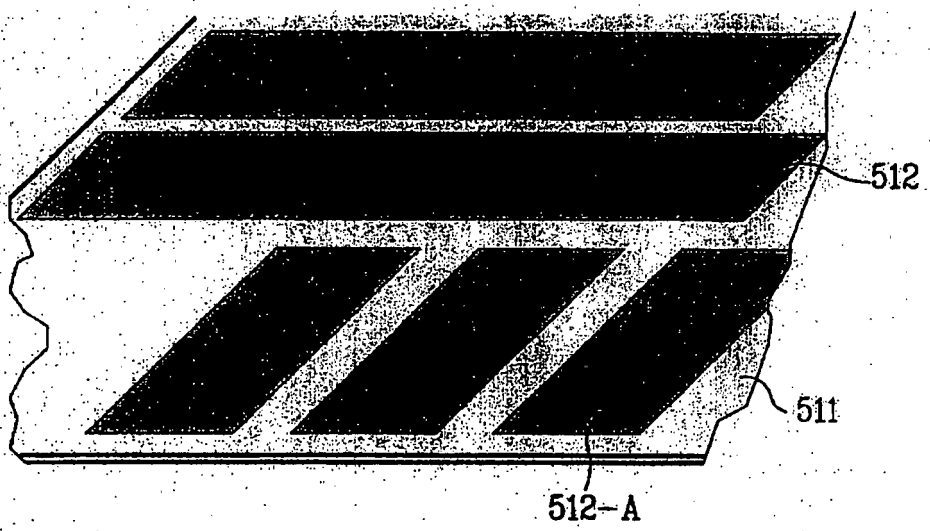



FIG. 5B

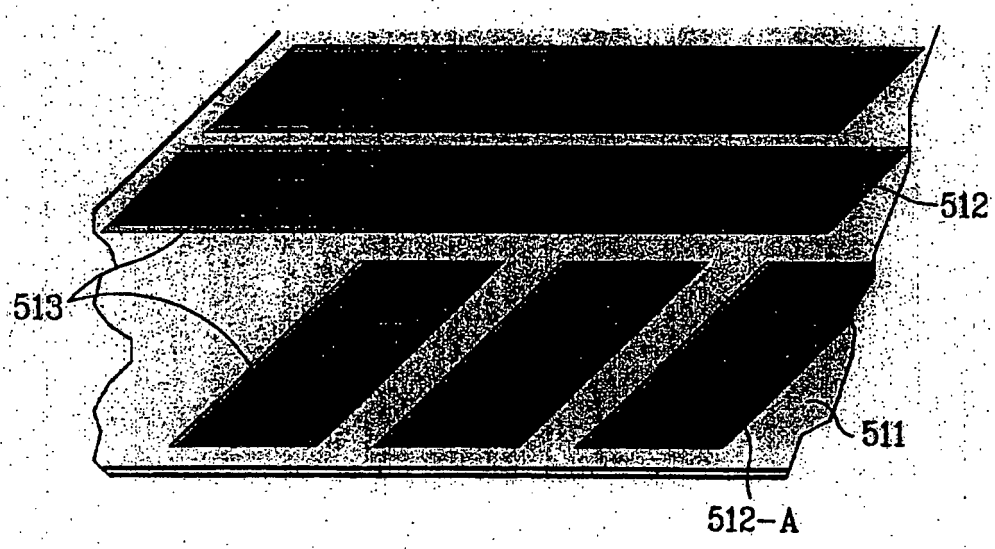


FIG. 5C

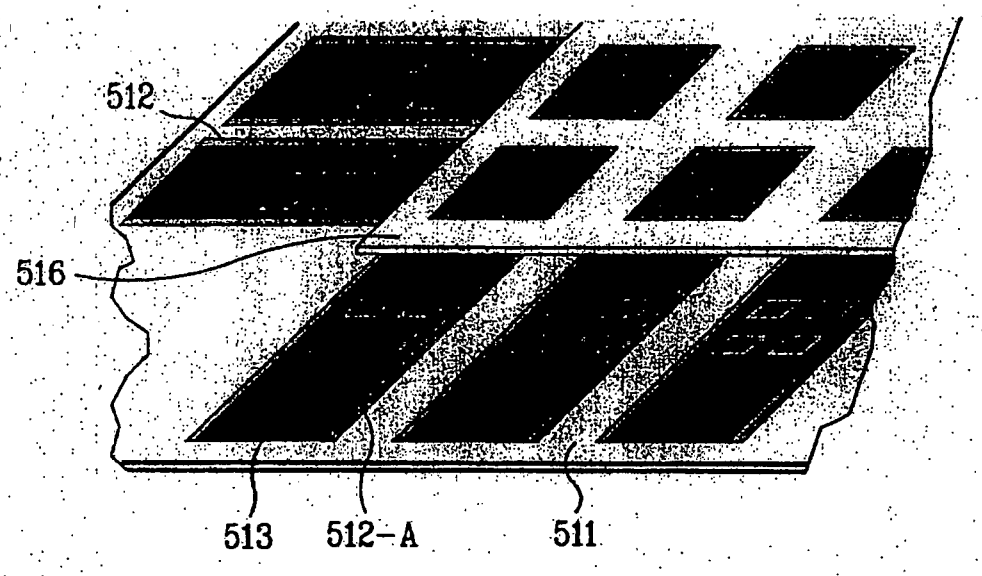



FIG. 5D

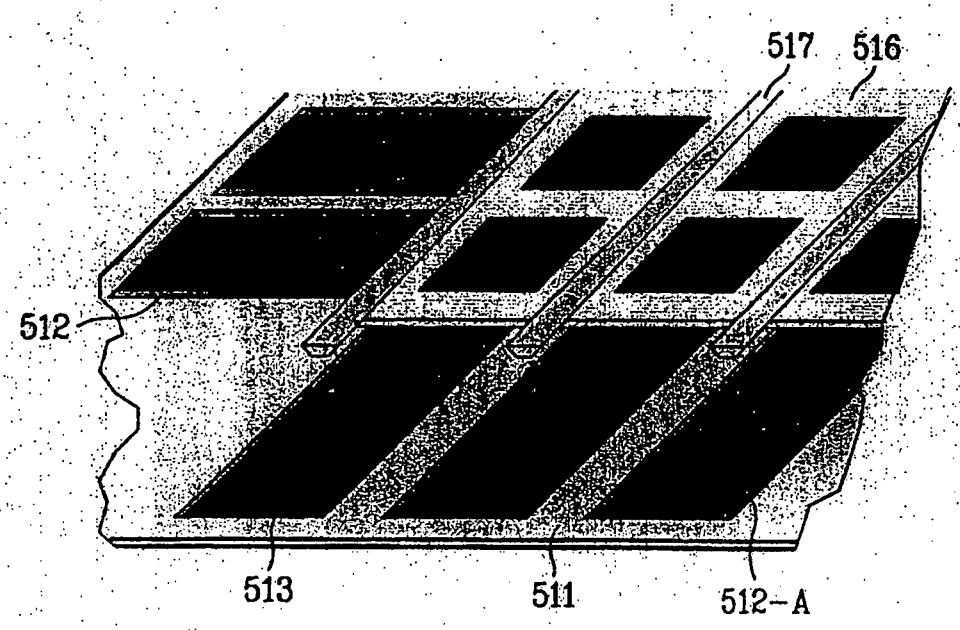


FIG. 5E

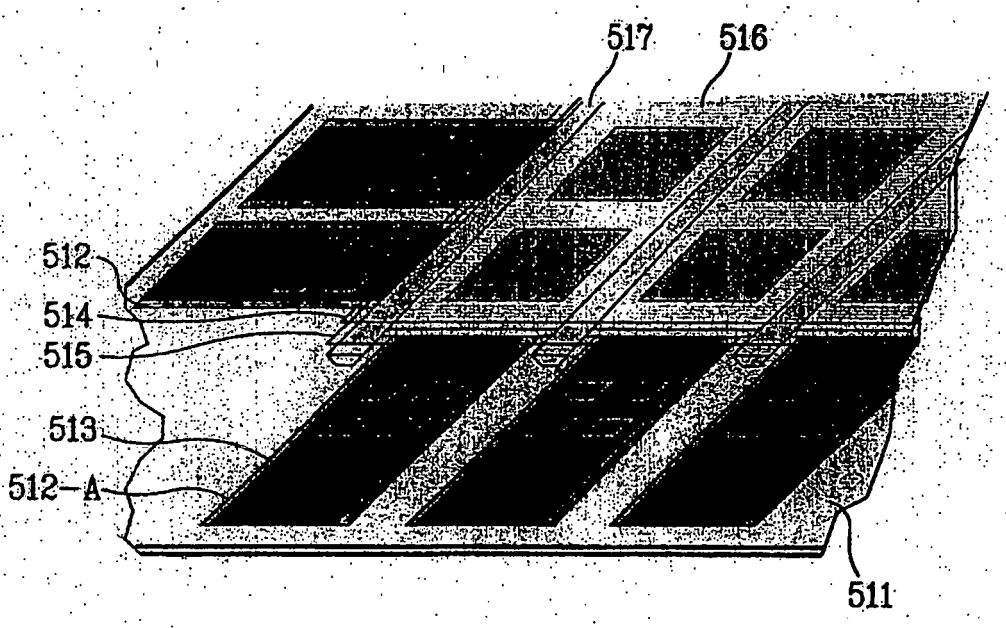



FIG. 5F

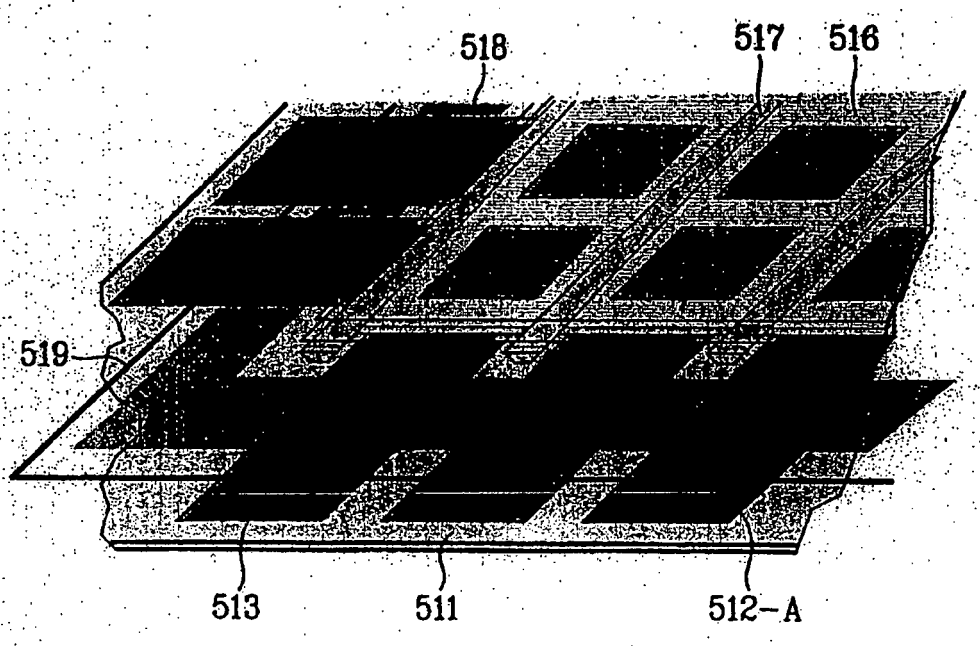


FIG. 6

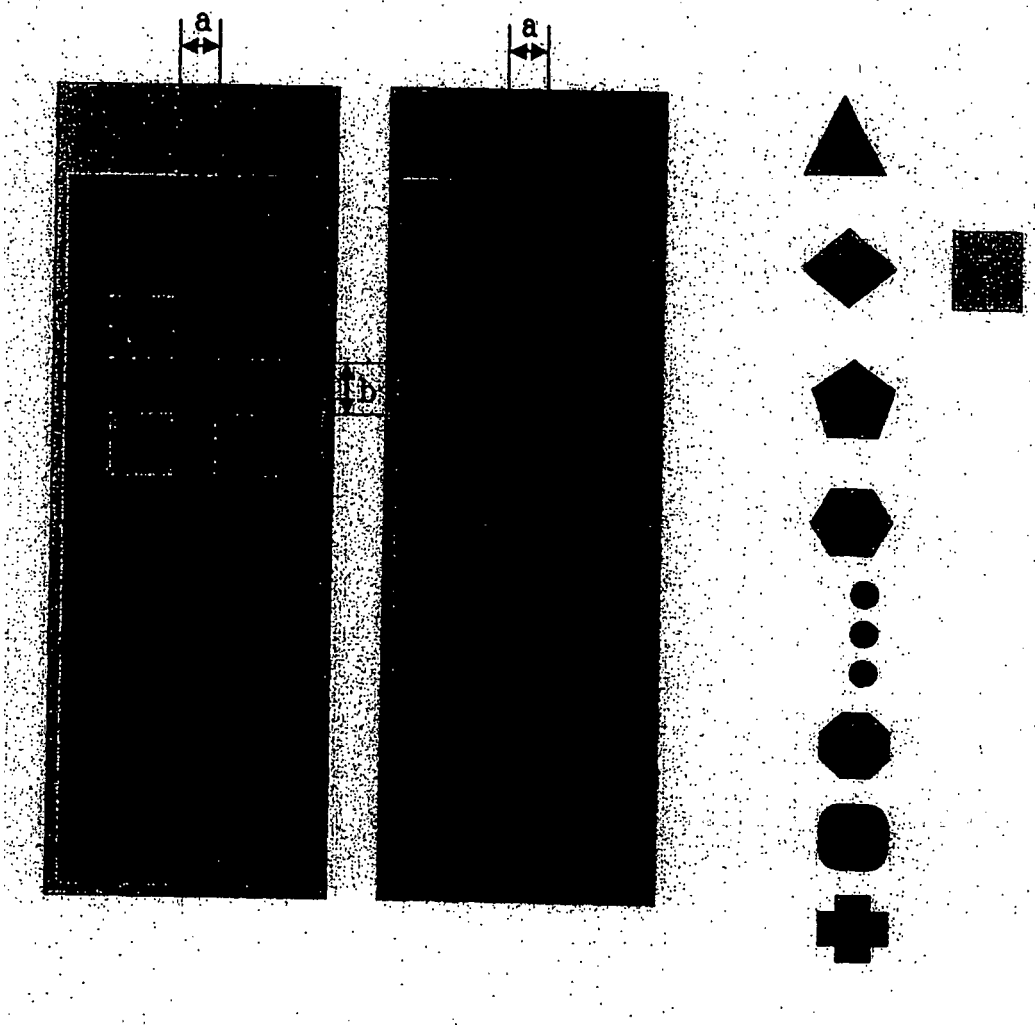
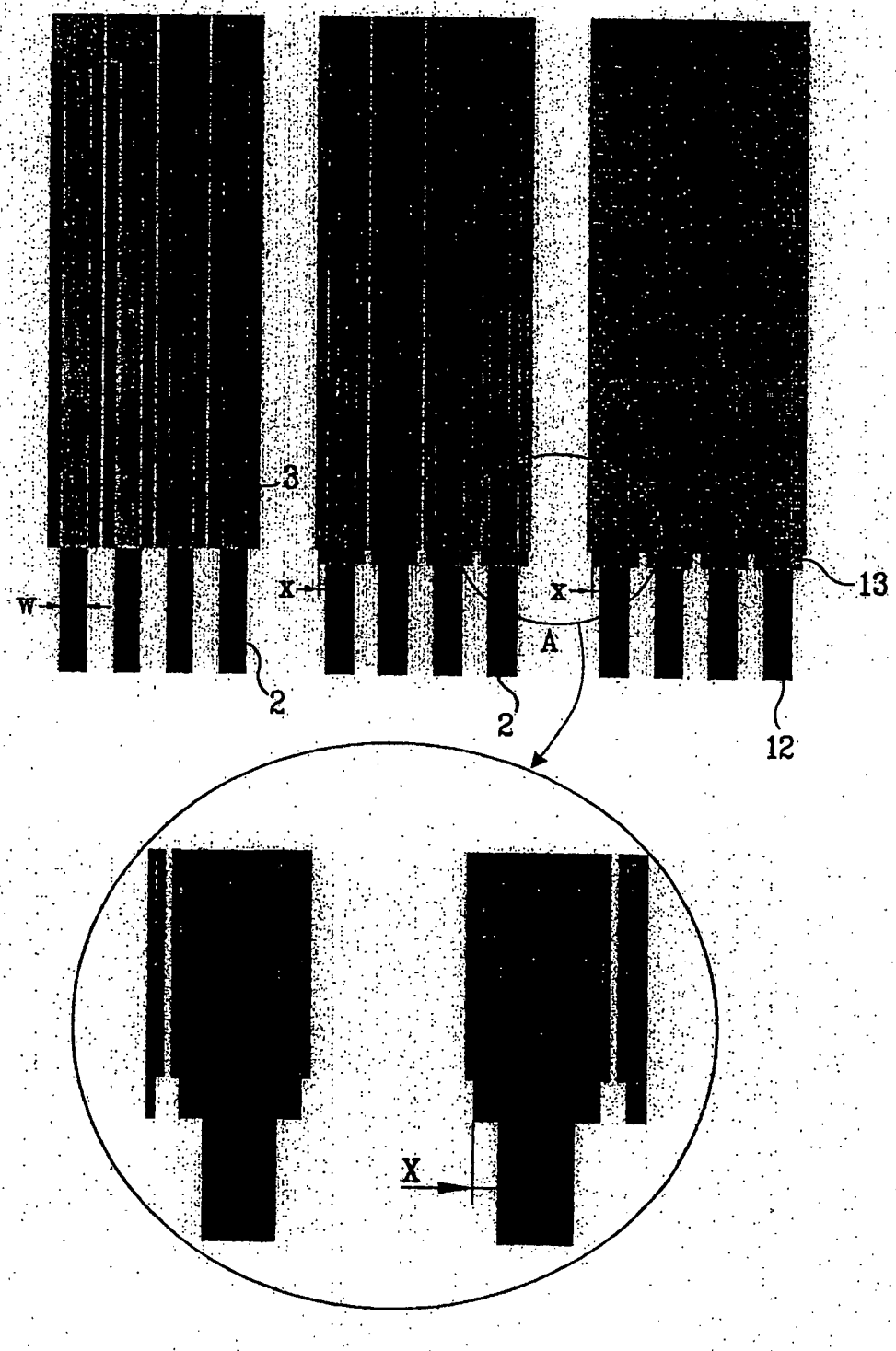


FIG. 7A FIG. 7B FIG. 7C



## REFERENCES CITED IN THE DESCRIPTION

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|---|---|---|---|
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摘要(译)

公开了一种有机电致发光显示板及其制造方法，其中线电阻降低，并且玻璃基板（511）和密封盖（519）之间的粘附性增强。该方法包括形成作为透明电极的氧化铟锡条（512），以便将阳极施加到玻璃基板上，形成栅格形式的反电极（513），以使其宽度小于氧化铟锡条形成第一绝缘层（516）和阻挡肋（517），连续形成电致发光层（514）和阴极条（515），并粘合密封盖（519）通过使用密封剂（518）将玻璃基板（511）。