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(54) METHOD FOR MANUFACTURING AN ORGANIC ELECTROLUMINESCENT DISPLAY

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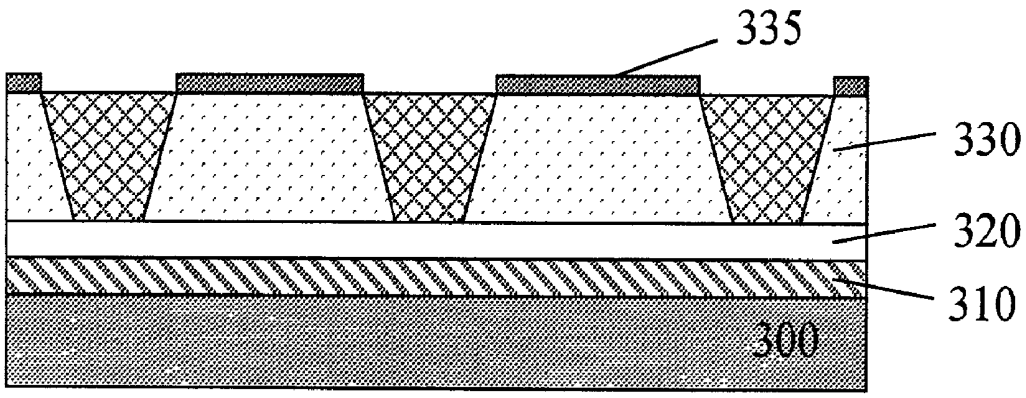
(57) **ABSTRACT**

A method for manufacturing an organic electroluminescent display is disclosed; the method utilizes only one photo mask to produce the cathode ramparts and insulating layer so as to simply the manufacturing procedure, reduce the time and the cost required for manufacture and reduce the inaccuracy of alignment. The manufacturing method according to the present invention firstly forms a plurality of first display electrodes arranged in parallel on a substantially transparent substrate, and forms a non-photosensitive and a photosensitive insulating layer thereon. After proceeding a photolithography process, developing processes, the cathode ramparts and the insulating layer are formed simultaneously and the first display electrodes are exposed partially. An organic electroluminescent material is then formed on the exposed first display electrodes and a plurality of second display electrodes are formed on the organic electroluminescent material to complete an organic electroluminescent display.



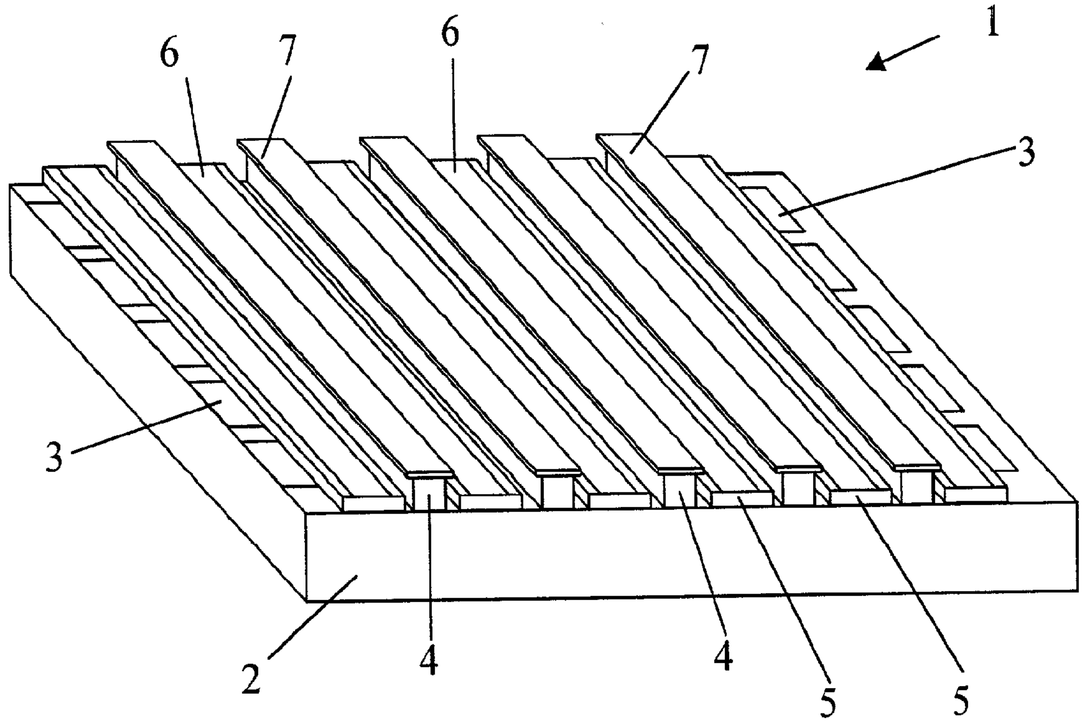


Fig. 1

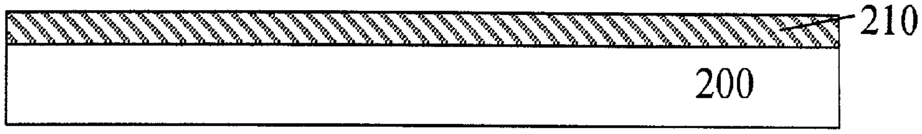


Fig. 2A

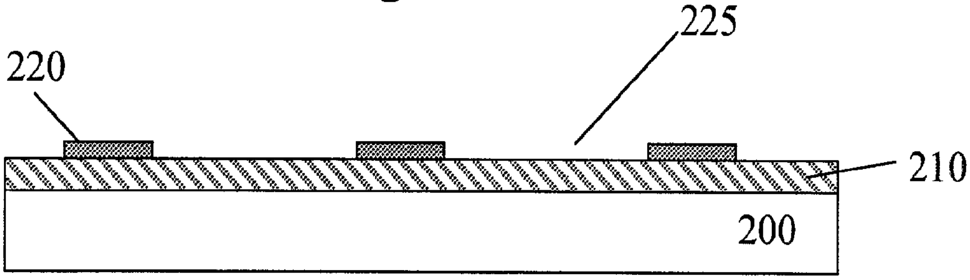


Fig. 2B

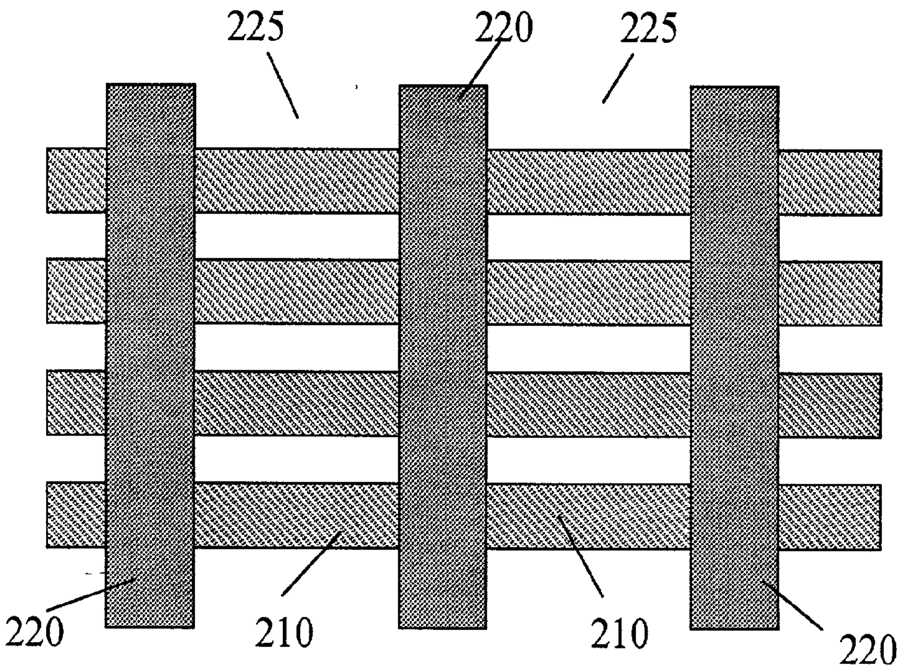


Fig. 2C

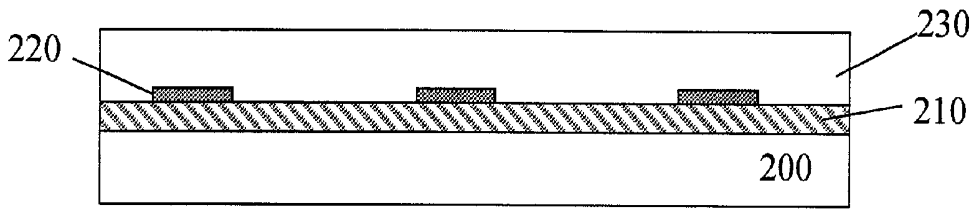


Fig. 2D

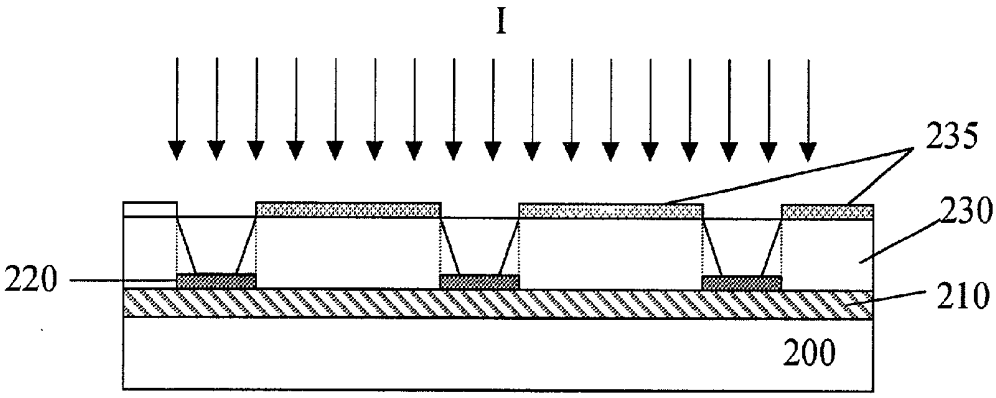


Fig. 2E

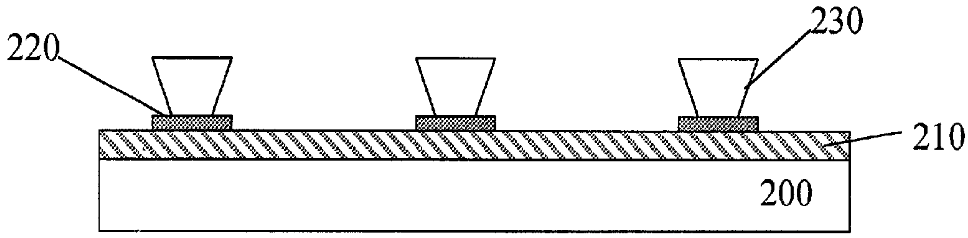


Fig. 2F

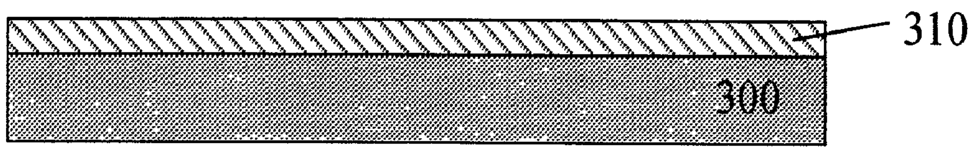


Fig. 3A

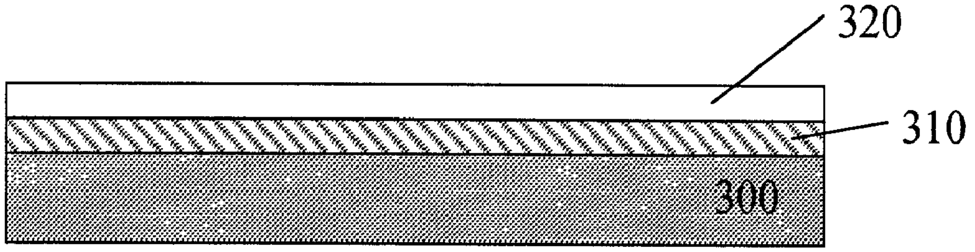


Fig. 3B

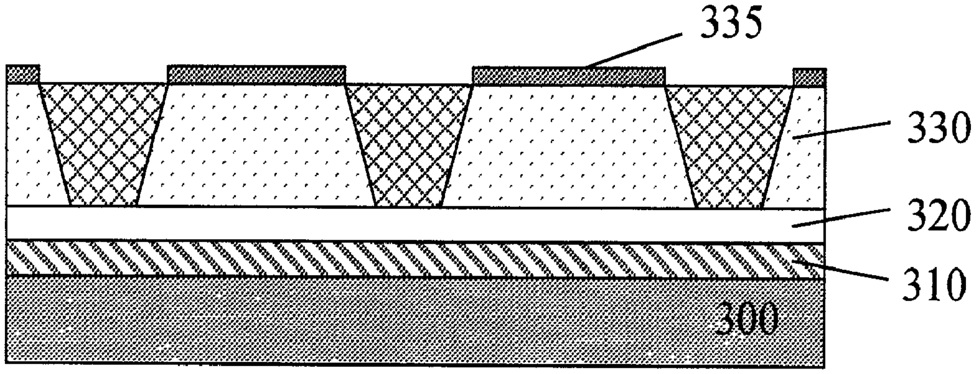


Fig. 3C

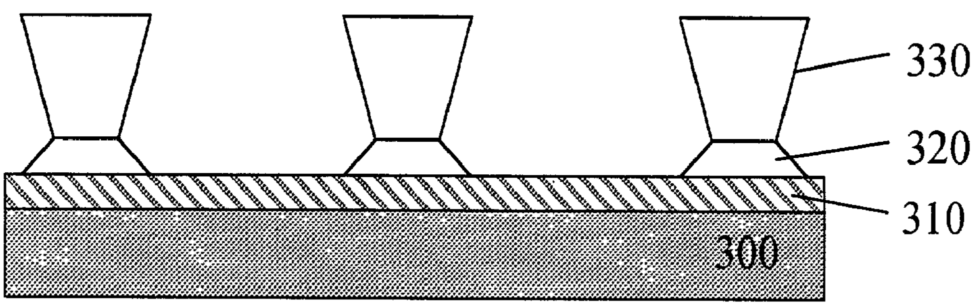


Fig. 3D

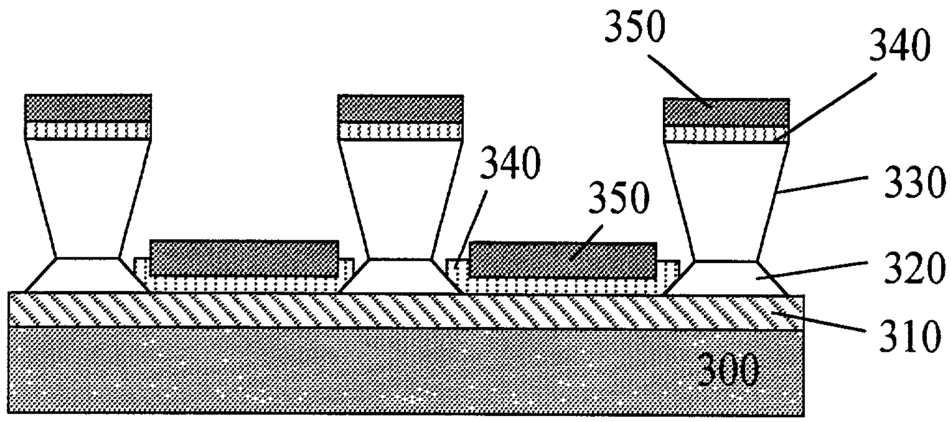


Fig. 3E

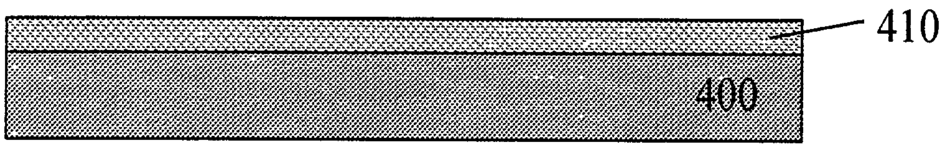


Fig. 4A

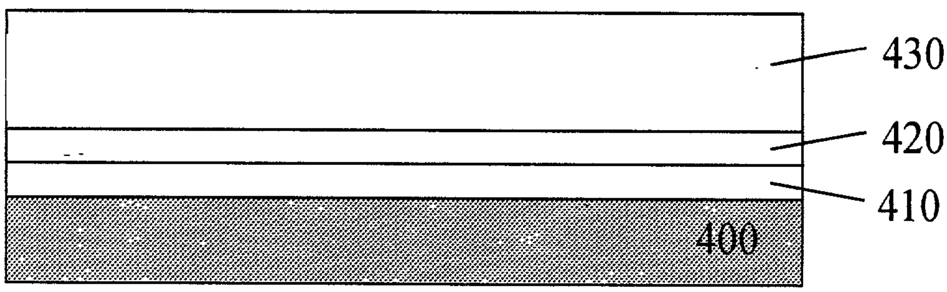


Fig. 4B

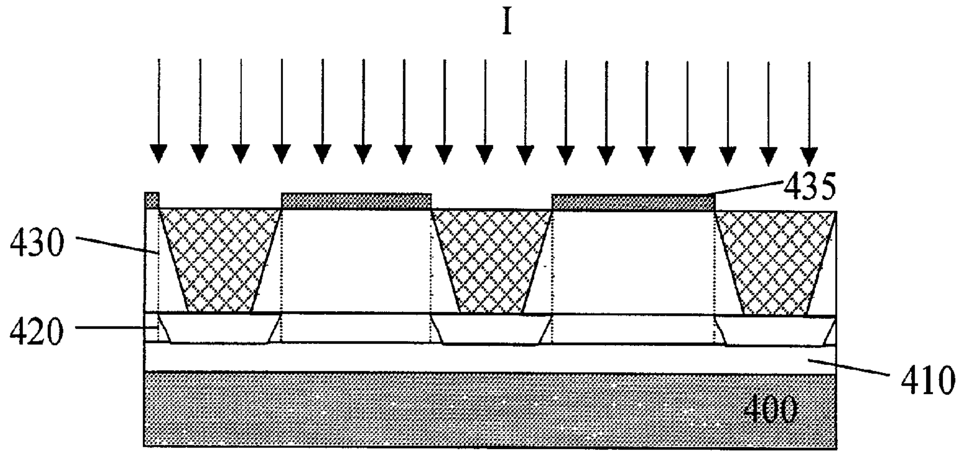


Fig. 4C

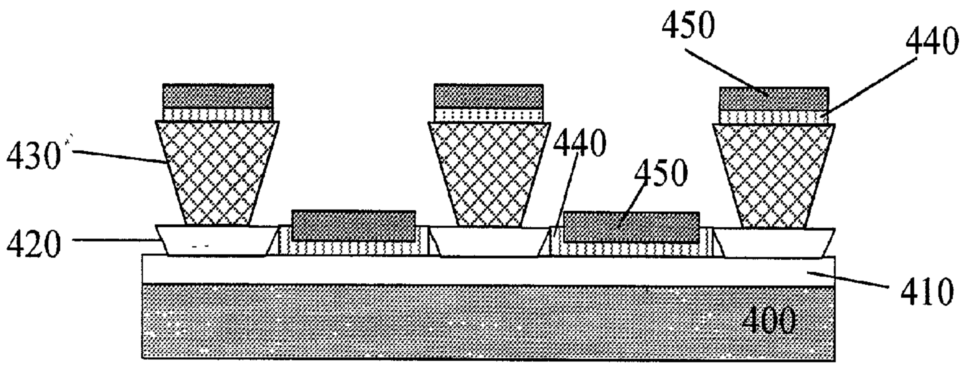


Fig. 4D

METHOD FOR MANUFACTURING AN ORGANIC ELECTROLUMINESCENT DISPLAY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to a method for making organic electroluminescent displays, and more particularly to a method for making cathode ramparts and insulating layer of an organic electroluminescent display through only one photo mask.

[0003] 2. Description of the Related Art

[0004] With the advent of the information technology age, there is an increasing demand for high-quality electro-optical displays, in which liquid crystal displays (LCD) are the most popular. A LCD backlight module comprising a light guide and a reflective plate is utilized for introducing the light beams, emitted from the cold cathode fluorescent lamp, vertically to the liquid crystal display panel, in which the liquid crystal contained therein controls the illuminance of the LCD. Conventional LCDs have a limited view angle and require very complicated manufacturing processes, which result in high manufacturing costs and relatively low yields. However, organic electroluminescent displays (OELD) have larger view angles and can be produced through less complex manufacturing process. These advantages are based on the self-luminance of the organic elements in the organic electroluminescent displays, which results in the unrestricted view visual, more natural colors displayed, increased operational temperature range and shorter response time.

[0005] With reference to **FIG. 1**, the structure of a conventional organic electroluminescent display **1** is shown. A glass substrate **2** carries a plurality of first display electrodes **3** arranged in parallel and a plurality of cathode ramparts **4** made of an electrical insulation material are formed on the substrate **2**. The cathode ramparts **4** are arranged perpendicular to the first display electrodes **3** and apart from each other, and are protruded from the substrate and exposes at least portions of the first display electrodes **3**. Each cathode rampart **4** at the upper part thereof has an overhang portion **7** protruded in a direction parallel to the substrate **2**. Between the cathode ramparts **4**, organic electroluminescent layers **5** are formed on the exposed first display electrodes **3**, and a plurality of second display electrodes **6** are formed on the organic electroluminescent layers **5**.

[0006] With reference to **FIG.** 2A-2G, conventional manufacturing processes of an organic electroluminescent display are shown. A plurality of first display electrodes **210** of stripe shapes arranged in parallel are formed on a glass substrate **200** by a sputtering process, as shown in **FIG. 2A**. A layer of insulating materials **220** are spin-coated on the substrate **200** with the first display electrodes **210** disposed thereon. Then, shadow masks are disposed on the insulating materials **220**, and after a photolithography process, openings **225** having a direction perpendicular to that of the first display electrodes **210** are formed, and thereby exposing the first display electrodes **210** partially, as shown in the top view of **FIG.** 2B and the sectional view of **FIG.** 2C. Next, as shown in **FIG. 2D, a** layer of photoresistant materials **230** are formed on the insulating materials **200** having openings **225**. With reference to **FIG.** 2E, photo masks **235** are formed on the photoresistant materials **230** and are illuminated by parallel light beams I. Due to the mask effect of the photo masks **235**, only the portions of the photoresistant materials **230**, i.e. the mesh areas, are illuminated by the light beams I. Subsequently, a developing process is conducted to the photoresistant materials **230** so as to form a shape of cathode ramparts shown in **FIG. 2F**. Finally, organic electroluminescent material is formed on the exposed first display electrodes and then a plurality of second display electrodes are formed on the organic electroluminescent materials such that an organic electroluminescent display is completed.

[0007] In the prior manufacturing processes of an organic electroluminescent display, two photo masks are required for the formation of the cathode ramparts; the first photo mask is utilized for forming openings in the insulating materials, and the second photo mask is utilized for forming cathode ramparts.

SUMMARY OF THE INVENTION

[0008] The principal object of the present invention is to provide a method for manufacturing an organic electroluminescent display, which simplifies the manufacturing procedure, reduces the time and the cost required for manufacture and reduces the inaccuracy of alignment.

[0009] To achieve this object, the present invention provides a method for manufacturing an organic electroluminescent display, comprising the steps of: forming a substantially transparent substrate; forming a plurality of first display electrodes arranged in parallel on said substrate; forming a non-photosensitive insulating layer on said substrate with first display electrodes disposed thereon; forming a photosensitive insulating layer on said non-photosensitive insulating layer; performing a photolithography process on said photosensitive insulating layer; developing said photosensitive insulating layer and etching said non-photosensitive insulating layer so as to form a plurality of photosensitive insulating layer and the non-photosensitive insulating layer having a shape with its longitudinal axis substantially perpendicular to the that of the first display electrodes, and the first display electrodes being exposed partly; forming an organic electroluminescent material on the exposed first display electrodes; and forming a plurality of second display electrodes on the organic electroluminescent material.

[0010] An alternative method for manufacturing an organic electroluminescent display according to the present invention comprises the steps of providing a substantially transparent substrate; forming a plurality of first display electrodes arranged in parallel on said substrate; forming a non-photosensitive insulating layer on said substrate with first display electrodes disposed thereon; pre-baking and -baking said non-photosensitive insulating layer; forming a photosensitive insulating layer on said non-photosensitive insulating layer, and pre-baking thereto; proceeding a photolithography process to said photosensitive insulating layer so as to define a shape perpendicular to that of the first display electrodes, and proceeding a post-exposure baking thereto; disposing an aggregate composed of said substrate with said first display electrodes, said non-photosensitive insulating layer and said photosensitive insulating layer disposed thereon into developers, whereby said photosensitive insulating layer is partially removed through development and said non-photosensitive insulating layer is partially removed by etching, and thereby said first display electrodes are exposed partially; proceeding a final cure process to said aggregate; forming an organic electroluminescent material on the exposed first display electrodes; and forming a plurality of second display electrodes on the organic electroluminescent material.

[0011] The present invention further provides a method for manufacturing an organic electroluminescent display, comprising the steps of: forming a substantially transparent substrate; forming a plurality of first display electrodes arranged in parallel on said substrate; forming a first photosensitive insulating layer on said substrate with first display electrodes disposed thereon; forming a second photosensitive insulating layer on said first photosensitive insulating layer; performing a photolithography process on said first and second photosensitive insulating layers; developing said first and second photosensitive insulating layers simultaneously so as to form a plurality of first and second photosensitive insulating layers having a shape with its longitudinal axis substantially perpendicular to the that of the first display electrodes, and the first display electrodes being exposed partly; forming an organic electroluminescent material on the exposed first display electrodes; and forming a plurality of second display electrodes on the organic electroluminescent material,

[0012] wherein the photosensitivity of the first photosensitive insulating layer is different from that of the second photosensitive insulating layer.

[0013] Still another method for manufacturing an organic electroluminescent display according to the present invention comprises the steps of providing a substantially transparent substrate; forming a plurality of first display electrodes arranged in parallel on said substrate; forming a first photosensitive insulating layer on said substrate with first display electrodes disposed thereon; forming a second photosensitive insulating layer on said first photosensitive insulating layer; proceeding a photolithography process to said first and second photosensitive insulating layers so as to define a shape perpendicular to that of the first display electrodes; disposing an aggregate composed of said substrate with said first display electrodes, said first photosensitive insulating layer and said second photosensitive insulating layer disposed thereon into developers, whereby said first and second photosensitive insulating layers are partially removed through development, and thereby said first display electrodes are exposed partially; forming an organic electroluminescent material on the exposed first display electrodes; and forming a plurality of second display electrodes on the organic electroluminescent material.

[0014] Additional advantages, objects and features of the present invention will become more apparent from the drawings and description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention will become more apparent from the detailed description given hereinbelow when read in conjunction with the accompanying drawings, which are given by means of illustration only and thus are not limitative of the present invention, in which:

[0016] FIGS. **1** is a perspective view illustrating a structure of a conventional organic electroluminescent display;

[0017] FIGS. **2A-2F** are schematic views illustrating the conventional manufacturing processes of an organic electroluminescent display utilizing two shadow masks for forming cathode ramparts;

[0018] FIGS. **3A-3E** are schematic views illustrating the manufacturing processes of an organic electroluminescent display according to one embodiment of the present invention; and

[0019] FIGS. **4A-4D** are schematic views illustrating the manufacturing processes of an organic electroluminescent display according to another embodiment of the present invention.

Brief Description of the Reference Numerals	
1	organic electroluminescent display
2	glass substrate
3	first display electrode
4	cathode rampart
5	organic electroluminescent layer
6	second display electrode
7	overhang portion
200	substrate
210	first display electrode
220	insulating materials
225	opening
230	photoresistant materials
235	photo mask
300	substrate
310	first display electrode
320	non-photosensitive insulating materials
330	photosensitive insulating materials
335	photo mask
340	organic electroluminescent materials
350	metal conductive materials
400	substrate
410	first display electrode
420	first photosensitive materials
430	second photosensitive materials
435	shadow mask
440	organic electroluminescent materials
450	metal conductive materials

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] With reference to FIGS. **3A-3E**, the method for manufacturing an organic electroluminescent display according to one embodiment of the present invention is shown. First with reference to **FIG. 3A, a** layer of substantially transparent conductive materials, such as indium tin oxide (ITO) or In_2O_3-ZnO, is formed on a substrate **300**, such as a transparent glass substrate or a flexible, light-transmitting plastic substrate, by a sputtering process. Next, photoresists are provided on the conductive material as shadow masks such that a plurality of first display electrodes **310** of stripe shapes arranged in parallel are formed from the conductive materials as anode electrodes of the organic electroluminescent displays after a photolithography process for removing the portions of the conductive materials unmasked by the photoresists.

[0021] With reference to **FIG. 3B, a** blanket of non-photosensitive insulating materials **320**, preferably made of thermal type polyimide, is spin-coated on the substrate **300** with the first display electrodes **310** disposed thereon about 0.5-2 μm thickness for covering both the first display electrodes **310** and the substrate **300** exposed. Then, a pre-baking process is conducted to the non-photosensitive insulating materials **320** to remove the solvent existed therein, and a -baking process is subsequently conducted thereto at a temperature between 120-180 C for 20 minutes to 1 hour to imidize the non-photosensitive insulating materials **320**, and thereby a partial cross-linking effect occurs thereto.

[**0022**] With reference to **FIG. 3C, a** blanket of photosensitive insulating materials **330** is spin-coated on the non-photosensitive insulating materials **320** about 3-5 μm thickness as negative photoresists. Then, a pre-baking process is conducted to the photosensitive insulating materials **330** to remove the solvent existed therein. Subsequently, photo masks **335** are disposed on the photosensitive insulating materials **330**, and after a photolithography process, a shape perpendicular to the first display electrodes **310** are defined in the photosensitive insulating materials **330**, wherein the exposure is proceeded at 30-80 mJ/cm^2. As shown in **FIG.** 3C, the portions of the photosensitive insulating materials **330** illuminated during exposure process is represented as mesh areas. Then, a post-exposure baking process is conducted at a temperature between 90-150 C for 30-120 seconds to remove the solvent in the photosensitive insulating materials **330**.

[**0023**] The whole aggregate is then disposed into or sprayed with developers, such as TMAH 2.38%, at room temperature for 50-100 seconds, such that the photosensitive insulating materials **330** is partially removed through developing effect. After that, the non-photosensitive insulating materials **320** are partially removed through wet-etching by the developers due to the partial cross-linking effect during -baking process. Since the adhesion between the non-photosensitive insulating materials **320** and the photosensitive insulating materials **330** is weaker, the photosensitive insulating materials **330** is developed to be of a reversed trapezoid shape and the non-photosensitive insulating materials **320** is etched to be of a trapezoid shape as shown in **FIG. 3D**. It should be noted that the long side of the reversed trapezoid shape of the photosensitive insulating materials **330** is not shorter than that of the trapezoid shape of the non-photosensitive insulating materials **320**, such that short circuit between the second display electrodes, which will be formed in the subsequent process, and the first display electrodes is avoided. Then, a final curing process is conducted at a temperature between 200-350 C for 30 minutes to 2 hours, and thereby completing the formation of the cathode ramparts.

[**0024**] Next, organic electroluminescent materials **340** are formed on the exposed first display electrodes **310**, as shown in **FIG. 3E**. While producing single-color organic electroluminescent displays, an organic electroluminescent layer is coated through evaporation on the exposed first display electrodes **310**. While producing full-color organic electroluminescent displays, RGB organic electroluminescent layers are formed in turn on the exposed first display electrodes **310** by using shadow masks. Subsequently, metal conductive materials **350**, such as Al, Mg-Al alloy or other suitable metal materials, are formed on the organic electroluminescent materials **340** as cathode electrodes of the organic electroluminescent displays.

[**0025**] **FIG.** 4A-4D are the schematic drawings illustrating the manufacturing processes of an organic electroluminescent display according to another embodiment of the present invention. In this case, a plurality of first display electrodes **410** made of, for example, ITO or In_2O_3-ZnO as anode electrodes of the organic electroluminescent display of stripe shape arranged in parallel are formed on a substrate **400**. Then, first photosensitive insulating materials **420** and second photosensitive insulating materials **430** are in turn formed on the substrate **400** with first display electrodes **410** disposed thereon as negative photoresists, for example, as shown in **FIG. 4B**. It should be noted that the photosensitivity of the first photosensitive insulating materials **420** is greater than that of the second photosensitive insulating materials **430**.

[**0026**] Next, photo masks **435** are disposed on the second photosensitive insulating materials **430** and a photolithography process is conducted to the second photosensitive insulating materials **430** and thus to the first photosensitive insulating materials **420** such that a shape perpendicular to the first display electrodes is defined therein. With reference to **FIG.** 4C, parallel light beams I incident to the second photosensitive insulating materials **430** and thus to the first photosensitive insulating materials **420**. Due to the masking effect of the photo masks **435**, only the portions of the second photosensitive insulating materials **430** and of the first photosensitive insulating materials **420** marked by mesh areas are illuminated by the light beams I. Subsequently, a developing process is conducted to the second photosensitive insulating materials **430** and the first photosensitive insulating materials **420** and thereby forming cathode ramparts of shapes shown in **FIG. 4D**. Finally, organic electroluminescent materials **440** are formed on the exposed first display electrodes **410**, and metal conductive materials **450** are formed on the organic electroluminescent materials **440** as cathode electrodes of the organic electroluminescent displays.

[**0027**] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the present invention as recited in the accompanying claims.

What is claimed is:

1. A method for manufacturing an organic electroluminescent display, comprising the steps of:

forming a substantially transparent substrate;

forming a plurality of first display electrodes arranged in parallel on said substrate;

forming a non-photosensitive insulating layer on said substrate with first display electrodes disposed thereon;

forming a photosensitive insulating layer on said non-photosensitive insulating layer;

performing a photolithography process on said photosensitive insulating layer; developing said photosensitive insulating layer and etching said non-photosensitive insulating layer so as to form a plurality of photosensitive insulating layer and the non-photosensitive insulating layer having a shape with its longitudinal axis substantially perpendicular to the that of the first display electrodes, and the first display electrodes being exposed partly;

forming an organic electroluminescent material on the exposed first display electrodes; and

forming a plurality of second display electrodes on the organic electroluminescent material.

2. The method according to claim 1, wherein the non-photosensitive insulating layer is made of a thermal type polyimide.

3. The method according to claim 1, wherein the thickness of the non-photosensitive insulating layer is in a range of 0.5-2 μm.

4. The method according to claim 1, wherein the step of forming the non-photosensitive insulating layer further comprises a -baking process for providing partial cross-linking to the non-photosensitive insulating layer.

5. The method according to claim 4, wherein the temperature for -baking said non-photosensitive insulating layer is in a range of 120-180 C.

6. The method according to claim 4, wherein the duration time for -baking said non-photosensitive insulating layer is in a range of 20-60 minutes.

7. The method according to claim 1, wherein the thickness of the photosensitive insulating layer is in a range of 3-5 μm.

8. The method according to claim 1, wherein the exposure to the photosensitive insulating layer during the photolithography process is in a range 30-80 mJ/cm^2.

9. The method according to claim 1, wherein the step of developing the photosensitive insulating layer and etching the non-photosensitive insulating layer is proceeded through developers.

10. The method according to claim 9, wherein the developer is TMAH 2.38%.

11. The method according to claim 9, wherein the duration time for developing is in a range of 50-100 seconds.

12. The method according to claim 1, wherein the photosensitive insulating layer is developed into a trapezoid shape.

13. The method according to claim 12, wherein long side of the trapezoid shape of the photosensitive insulating layer is not shorter than that of the reversed trapezoid shape of the non-photosensitive insulating layer.

14. The method according to claim 1, wherein the non-photosensitive insulating layer is etching into a reversed trapezoid shape.

15. The method according to claim 14, wherein long side of the trapezoid shape of the photosensitive insulating layer is not shorter than that of the reversed trapezoid shape of the non-photosensitive insulating layer.

16. The method according to claim 1, wherein the step of developing the photosensitive insulating layer and etching the non-photosensitive insulating layer further comprises a final cure process.

17. The method according to claim 16, wherein the temperature for proceeding the final cure process is in a range of 200-350 C.

18. The method according to claim 16, wherein the duration time for proceeding the final cure process is in a range of 30-120 minutes.

19. A method for manufacturing an organic electroluminescent display, comprising the steps of:

forming a substantially transparent substrate;

forming a plurality of first display electrodes arranged in parallel on said substrate;

forming a non-photosensitive insulating layer on said substrate with first display electrodes disposed thereon;

pre-baking and -baking said non-photosensitive insulating layer;

forming a photosensitive insulating layer on said non-photosensitive insulating layer, and pre-baking thereto;

performing a photolithography process on said photosensitive insulating layer so as to define a shape having a longitudinal axis perpendicular to the that of the first display electrodes, and performing a post-exposure baking process thereto;

dipping an aggregate composed of said substrate with said first display electrodes, said non-photosensitive insulating layer and said photosensitive insulating layer disposed thereon into developers, whereby said photosensitive insulating layer is partially removed through development and said non-photosensitive insulating layer is partially removed by etching, and thereby said first display electrodes are exposed partially;

finally curing said aggregate;

forming an organic electroluminescent material on the exposed first display electrodes; and

forming a plurality of second display electrodes on the organic electroluminescent material.

20. The method according to claim 19, wherein the non-photosensitive insulating layer is made of a thermal type polyimide.

21. The method according to claim 19, wherein the temperature for pre-baking said non-photosensitive insulating layer is in a range of 50-120 C.

22. The method according to claim 19, wherein the temperature for post-exposure baking said photosensitive insulating layer is in a range of 90-150 C.

23. The method according to claim 19, wherein the duration time for post-exposure baking said photosensitive insulating layer is in a range of 30-120 seconds.

24. The method according to claim 19, wherein the photosensitive insulating layer is developed into a trapezoid shape.

25. The method according to claim 24, wherein long side of the trapezoid shape of the photosensitive insulating layer is not shorter than that of the reversed trapezoid shape of the non-photosensitive insulating layer.

26. The method according to claim 19, wherein the non-photosensitive insulating layer is etched into a reversed trapezoid shape.

27. The method according to claim 26, wherein long side of the trapezoid shape of the photosensitive insulating layer is not shorter than that of the reversed trapezoid shape of the non-photosensitive insulating layer.

28. A method for manufacturing an organic electroluminescent display, comprising the steps of:

forming a substantially transparent substrate;

forming a plurality of first display electrodes arranged in parallel on said substrate;

forming a first photosensitive insulating layer on said substrate with first display electrodes disposed thereon;

forming a second photosensitive insulating layer on said first photosensitive insulating layer;

performing a photolithography process on said first and second photosensitive insulating layers;

developing said first and second photosensitive insulating layers simultaneously so as to form a plurality of first and second photosensitive insulating layers having a shape with its longitudinal axis substantially perpendicular to the that of the first display electrodes, and the first display electrodes being exposed partly;

forming an organic electroluminescent material on the exposed first display electrodes; and

forming a plurality of second display electrodes on the organic electroluminescent material,

wherein the photosensitivity of the first photosensitive insulating layer is different from that of the second photosensitive insulating layer.

29. The method according to claim 28, wherein the step of developing said first and second photosensitive insulating layers is proceeded through developers.

30. The method according to claim 28, wherein the photosensitivity of said first photosensitive insulating layer is greater than that of said second photosensitive insulating layer.

31. A method for manufacturing an organic electroluminescent display, comprising the steps of:

forming a substantially transparent substrate;

forming a plurality of first display electrodes arranged in parallel on said substrate;

forming a first photosensitive insulating layer on said substrate with first display electrodes disposed thereon;

forming a second photosensitive insulating layer on said first photosensitive insulating layer;

performing a photolithography process on said first and second photosensitive insulating layers so as to define a shape having a longitudinal axis perpendicular to that of the first display electrodes;

dipping an aggregate composed of said substrate with said first display electrodes, said first photosensitive insulating layer and said second photosensitive insulating layer disposed thereon into developers, whereby said first and second photosensitive insulating layers are partially removed through development, and thereby said first display electrodes are exposed partially;

forming an organic electroluminescent material on the exposed first display electrodes; and

forming a plurality of second display electrodes on the organic electroluminescent material.

32. The method according to claim **31**, wherein the photosensitivity of said first photosensitive insulating layer is greater than that of said second photosensitive insulating layer.

* * * * *

专利名称(译)	制造有机电致发光显示器的方法		
公开(公告)号	US20020090579A1	公开(公告)日	2002-07-11
申请号	US09/730904	申请日	2000-12-05
[标]申请(专利权)人(译)	CHUNG CHIA TIN 张苏JEN HWANG ANDREA 胡琛ZE		
申请(专利权)人(译)	钟嘉TIN 张苏仁 HWANG ANDREA 胡琛泽		
当前申请(专利权)人(译)	钟嘉TIN 张苏仁 HWANG ANDREA 胡琛泽		
[标]发明人	CHUNG CHIA TIN CHANG SU JEN HWANG ANDREA HU CHEN ZE		
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摘要(译)

公开了一种制造有机电致发光显示器的方法;该方法仅利用一个光掩模来制造阴极壁和绝缘层，从而简化制造过程，减少制造所需的时间和成本，并减少对准的不准确性。根据本发明的制造方法首先在基本上透明的基板上形成多个平行排列的第一显示电极，并在其上形成非光敏和光敏绝缘层。在进行光刻工艺，显影工艺之后，同时形成阴极壁和绝缘层，并且部分地暴露第一显示电极。然后在暴露的第一显示电极上形成有机电致发光材料，并在有机电致发光材料上形成多个第二显示电极，以完成有机电致发光显示。