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(54) **OLED TOUCH DISPLAY PANEL**

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(51) **Int. Cl.**

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H01L 51/52	(2006.01)
G06F 3/044	(2006.01)
G06F 3/041	(2006.01)

(52) **U.S. Cl.**

CPC ***H01L 27/323*** (2013.01); ***G06F 3/044*** (2013.01); ***G06F 3/0412*** (2013.01); ***G06F 3/0414*** (2013.01); ***H01L 51/5221*** (2013.01); ***H01L 51/5228*** (2013.01); *G06F 2203/04103* (2013.01); *G06F 2203/04108* (2013.01); *H01L 27/3244* (2013.01)

(58) **Field of Classification Search**

CPC H01L 27/323; H01L 27/3244; H01L 51/5228; G06F 3/0414; G06F 3/044

See application file for complete search history.

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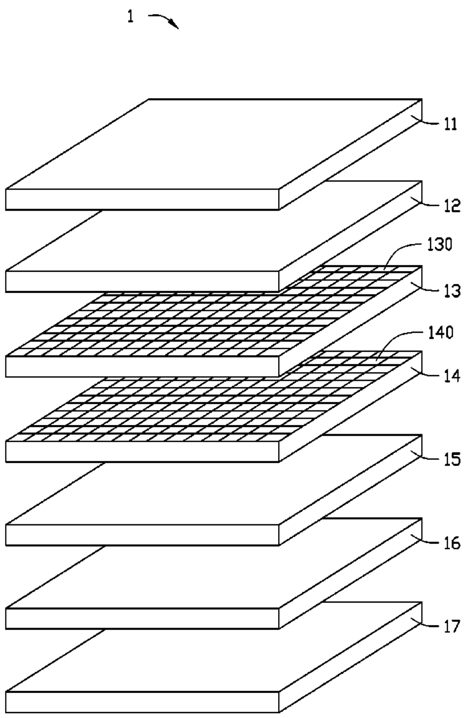
(57) **ABSTRACT**

An OLED touch display device includes a first electrode layer, a second electrode layer facing the first electrode layer, a light-emitting layer between the first electrode layer and the second electrode, and a third electrode layer on a side of the first electrode layer. The first electrode layer functions as a cathode of the light-emitting layer, and the second electrode layer functions as an anode of the light-emitting layer. The first electrode layer and the third electrode layer cooperatively form a capacitive force sensing element. The first electrode layer also functions as touch sensing electrode.

11 Claims, 7 Drawing Sheets



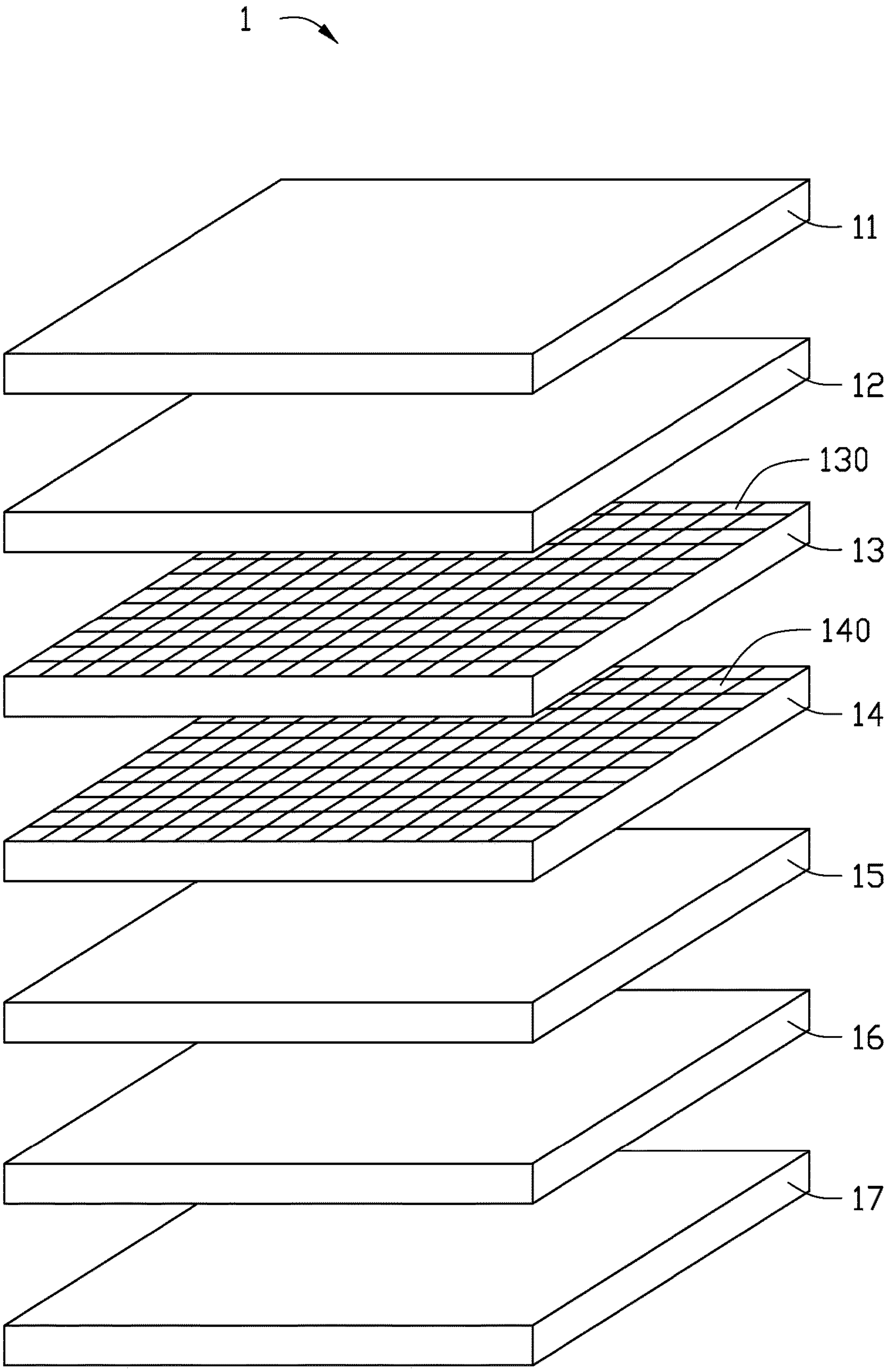


FIG. 1

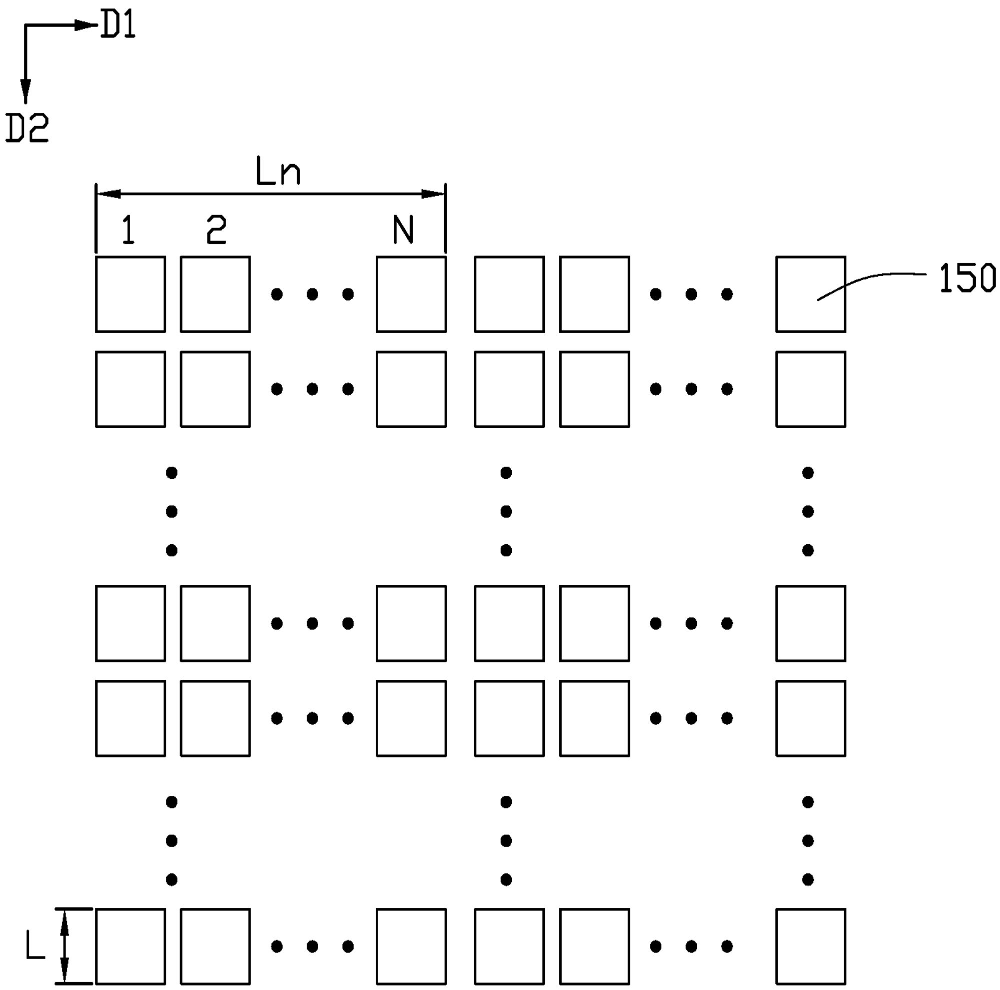


FIG. 2

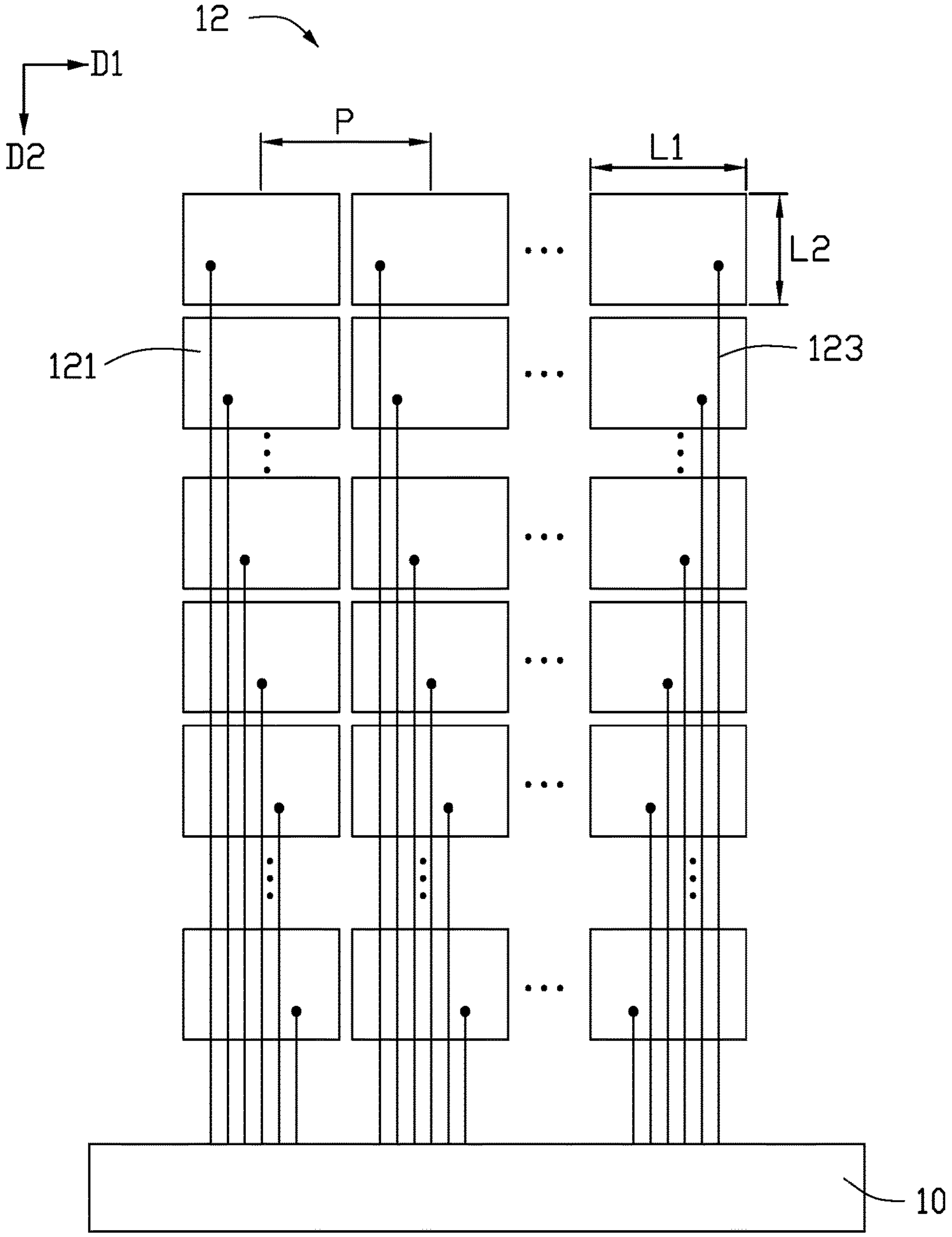


FIG. 3

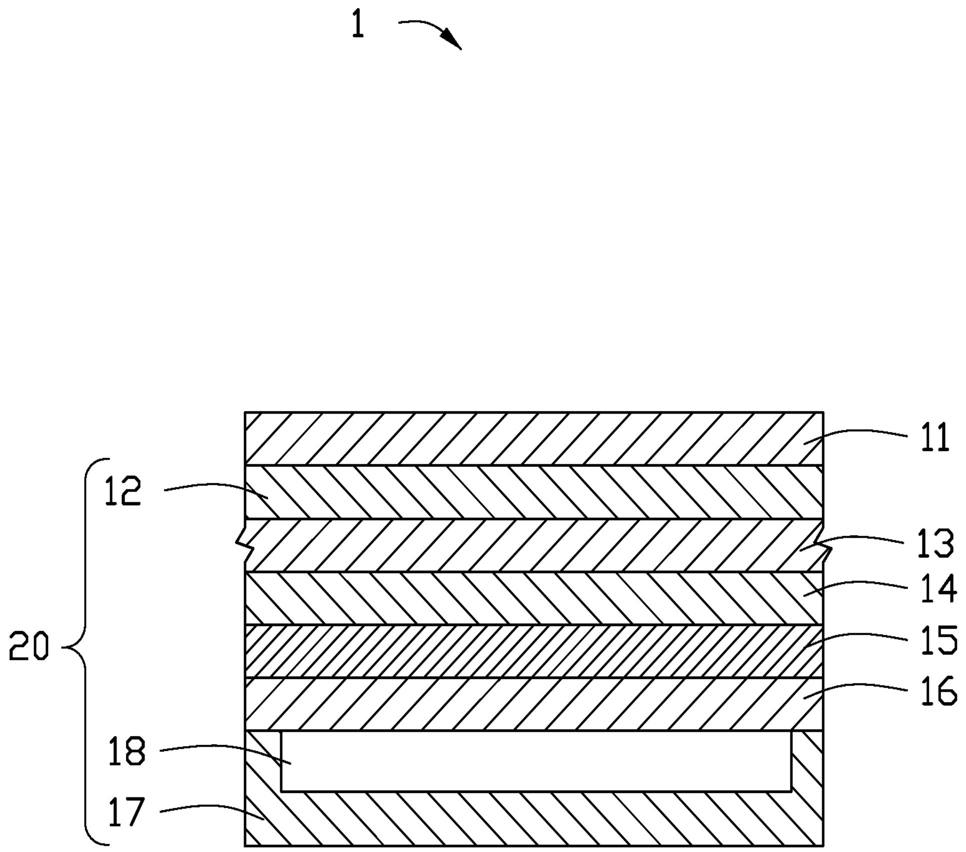


FIG. 4

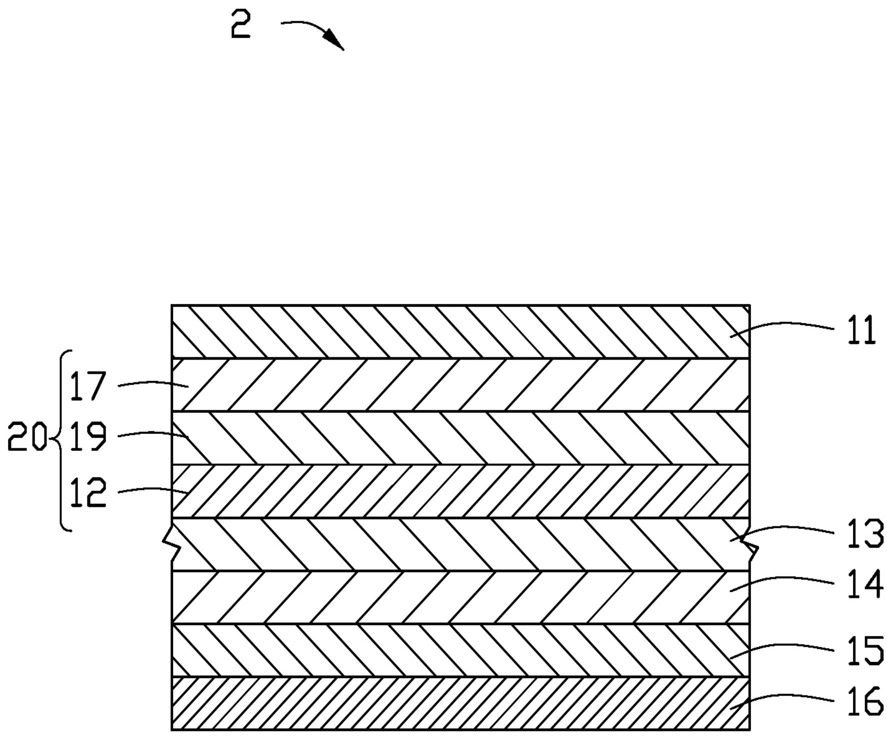


FIG. 5

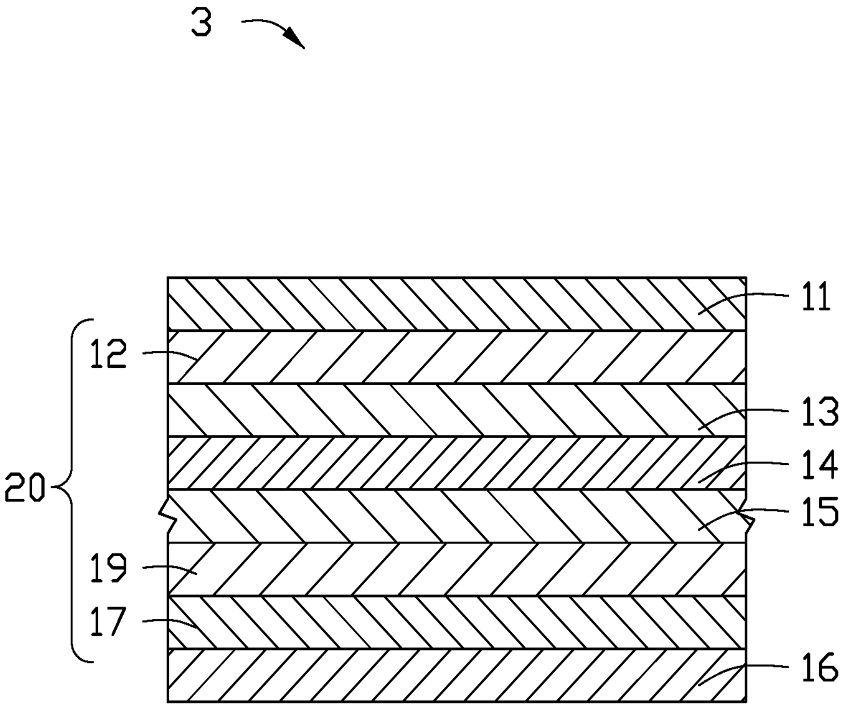


FIG. 6

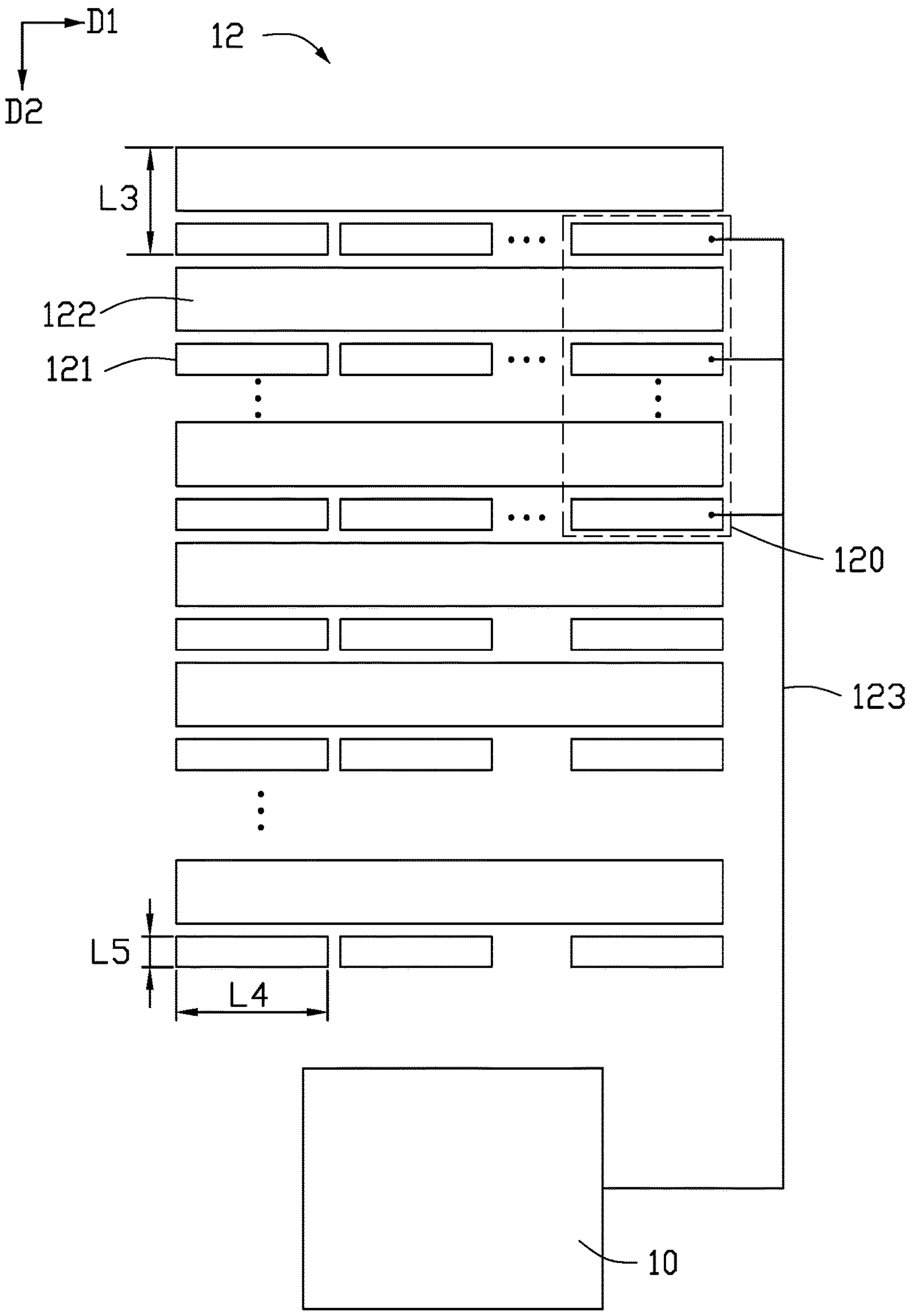


FIG. 7

OLED TOUCH DISPLAY PANEL

FIELD

The subject matter herein generally relates to a touch display panel, particularly to an organic light-emitting diode (OLED) touch display panel.

BACKGROUND

An on-cell or in-cell type touch screen panel can be manufactured by installing a touch panel in a display panel. Such a touch screen panel is used as an output device for displaying images while being used as an input device for receiving a user's touch on a specific area of a displayed image as command. However, the touch screen panel cannot sense the intensity of the touch force.

BRIEF DESCRIPTION OF THE DRAWINGS

Implementations of the present disclosure will now be described, by way of example only, with reference to the attached figures.

FIG. **1** is an exploded view of a first exemplary embodiment of an OLED touch display panel.

FIG. **2** is a planar view showing a layout of pixel units of the OLED touch display panel of FIG. **1**.

FIG. **3** is a planar view of a first exemplary embodiment of a first electrode layer of the OLED touch display panel of FIG. **1**.

FIG. **4** is a cross-sectional view of a first exemplary embodiment of the OLED touch display panel of FIG. **1**.

FIG. **5** is a cross-sectional view of a second exemplary embodiment of the OLED touch display panel of FIG. **1**.

FIG. **6** is a cross-sectional view of a third exemplary embodiment of the OLED touch display panel of FIG. **1**.

FIG. **7** is a planar view of a second exemplary embodiment of a first electrode layer of the OLED touch display panel of FIG. **1**.

DETAILED DESCRIPTION

It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the exemplary embodiments described herein. However, it will be understood by those of ordinary skill in the art that the exemplary embodiments described herein may be practiced without these specific details. In other instances, methods, procedures, and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the exemplary embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The connection can be such that the objects are permanently connected or releasably connected. The term "comprising" when utilized, means "including, but not necessarily limited

to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series, and the like.

FIG. **1** illustrates a display panel **1** according to a first exemplary embodiment. The display panel **1** is an OLED display panel. The display panel **1** includes a first substrate **11**, a first electrode layer **12**, a light-emitting layer **13**, a second electrode layer **14**, a thin film transistor layer **15**, a second substrate **16**, and a third electrode layer **17** stacked in that order. The first electrode layer **12** functions as a cathode of the light-emitting layer **13**, and the second electrode layer **14** functions as an anode of the light-emitting layer **13**. The light-emitting layer **13** may include an electron-injecting layer (not shown), an electron-transporting layer (not shown), an organic light-emitting layer (not shown), a hole-transporting layer (not shown), and a hole-injecting layer (not shown) stacked in that order, wherein the electron-injecting layer is adjacent to the first electrode layer **12**; and the hole-injecting layer is adjacent to the second electrode layer **14**.

The light-emitting layer **13** is divided into a plurality of light-emitting units **130** spaced apart from each other. The second electrode layer **14** comprises a plurality of pixel electrodes **140** spaced apart from each other. Each light-emitting unit **130** corresponds to and overlaps with one of the pixel electrodes **140**. In the present exemplary embodiment, the light-emitting units **130** are arranged in an array; and the pixel electrodes **140** are arranged in an array.

The thin film transistor layer **15** comprises a plurality of thin film transistors (not shown) formed on the second substrate **16**. Each thin film transistor may be electrically coupled to one of the pixel electrodes **140** to provide driving current for the pixel electrode **140**.

The display panel **1** defines a plurality of pixel units **150**. As shown in FIG. **2**, the pixel units **150** are arranged in a matrix of rows and columns; and each row of the pixel units **150** extends along a first direction D**1** and each column of the pixel units **150** extends along a second direction D**2**. The first direction D**1** is perpendicular to the second direction D**2**. In the present exemplary embodiment, each pixel unit **150** includes three adjacent pixel electrodes **140** and three adjacent light-emitting units **130** corresponding to the three adjacent pixel electrodes **140**. The three adjacent light-emitting units **130** in each pixel unit **150** emit red light, green light, and blue light, respectively. In other embodiments, a number of the light-emitting units **130** and a number of the pixel electrodes **140** contained in each pixel unit **150** may be adjusted, not being limited to three. For example, each pixel unit **150** may include four adjacent light-emitting units **130** emitting red light, green light, blue light, and white light, respectively.

As shown in FIG. **3**, the first electrode layer **12** includes a plurality of first electrodes **121** spaced apart from each other. The first electrodes **121** functions as a cathode of the light-emitting layer **13**, touch sensing electrodes, and force sensing electrodes. The first electrodes **121** may alternatively function as the cathode of the light-emitting layer **13**, the touch sensing electrodes, and the force sensing electrodes in a time-division manner. The first electrodes **12** and the third electrode layer **17** cooperatively form a capacitive force sensing structure. The first electrodes **121** may be made of a transparent conductive material, such as indium tin oxide.

The first electrodes **121** are arranged in a matrix of rows and columns. Each row of the first electrodes **121** extends along the first direction D**1** and each column of the first electrodes **121** extends along the second direction D**2**.

The arrangement of the first electrodes **121** as shown in FIG. **3** has a relationship with the arrangement of the pixel units **150** as shown in FIG. **2**. Each first electrode **121** corresponds to N adjacent pixel units **150** along the first direction D**1**, where N is a natural number. A length L**1** of each first electrode **121** along the first direction D**1** is substantially equal to a total span length Ln spanning N adjacent pixel units **150** along the first direction Dl. A length L**2** of each first electrode **121** along the second direction D**2** is substantially equal to a length L of one pixel unit **150** along the second direction D**2**. The value of N depends on the touch resolution of the OLED display device **1**, the higher the touch resolution, the greater the distribution concentration of the first electrode **121** and the lower the value of N. The value of N may determine an area of each first electrode **121** and a distance P between the central points of two adjacent first electrodes **121**. Where N is greater, the area of each first electrode **121** and the distance P are greater. In the present exemplary embodiment, N is a number in a range from about 40 to about 60.

In the present exemplary embodiment, the display panel **1** uses a single-layer self capacitive touch sensing technique. Each first electrode **121** is electrically coupled to a controlling integrated circuit **10** by a conductive line **123**. When a conductor (such as a finger) touches the display panel **1**, electrical signals of the first electrodes **121** corresponding to the touch position vary and the electrical signal is outputted to the controlling integrated circuit **10**, thus touch position can be detected.

As shown in FIG. **4**, in the present exemplary embodiment, the third electrode layer **17** is a metal frame. An air gap **18** is formed between the third electrode layer **17** and the second substrate **16**. The first electrode layer **12**, the third electrode layer **17**, and the air gap **18** cooperatively form a capacitive force sensing element **20**. When a finger touches the display panel **1**, the first substrate **11**, the first electrode layer **12**, the light emitting layer **13**, the second electrode layer **14**, the thin film transistor layer **15**, and the second substrate **16** may be deformed towards the third electrode layer **17**. The air gap **18** may be compressed, and a distance between the first electrode layer **12** and the third electrode layer **17** may be reduced, which varies the capacitance between the first electrode layer **12** and the third electrode layer **17**. Thus, the force sensing element **20** outputs force sensing signals according to the variation of the capacitance, and the touch force can be detected and calculated.

It is understood that the position of the force sensing element **20** can be modified. In particular, the positions of the first electrode layer **12** and the third electrode layer **17** can be modified.

FIG. **5** illustrates a display panel **2** according to a second exemplary embodiment. The display panel **2** is also an OLED display panel. The display panel **2** includes a first substrate **11**, a third electrode layer **17**, an insulating layer **19**, a first electrode layer **12**, a light-emitting layer **13**, a second electrode layer **14**, a thin film transistor layer **15**, and a second substrate **16** stacked in that order. The first substrate **11**, the first electrode layer **12**, the light-emitting layer **13**, the second electrode layer **14**, the thin film transistor layer **15**, and the second substrate **16** are substantially the same as those of the display panel **1** of the first exemplary embodiment.

The third electrode layer **17** is made of a transparent and conductive material, such as indium tin oxide. The insulating layer **19** is elastic and is between the third electrode layer **17** and the first electrode layer **12**. The third electrode layer **17**, the insulating layer **19**, and the first electrode layer **12** cooperatively form a force sensing element **20** of the display panel **2**. When a finger touches the display panel **2**, a distance between the first electrode layer **12** and the third electrode layer **17** may be reduced so that a capacitance between the first electrode layer **12** and the third electrode layer **17** may vary. Thus, the force sensing element **20** outputs force sensing signals according to the variation of the capacitance, and the touch force can be detected and calculated.

FIG. **6** illustrates a display panel **3** according to a third exemplary embodiment. The display panel **3** is an OLED display panel. The display panel **3** includes a first substrate **11**, a first electrode layer **12**, a light-emitting layer **13**, a second electrode layer **14**, a thin film transistor layer **15**, an insulating layer **19**, a third electrode layer **17**, and a second substrate **16** stacked in that order. The first substrate **11**, the first electrode layer **12**, the light-emitting layer **13**, the second electrode layer **14**, the thin film transistor layer **15**, and the second substrate **16** are substantially the same as those of the display panel **1** of the first embodiment.

The third electrode layer **17** is made of a conductive material, such as indium tin oxide. The insulating layer **19** is elastic and is between the third electrode layer **17** and the first electrode layer **12**. The third electrode layer **17**, the insulating layer **19**, and the first electrode layer **12** cooperatively form the force sensing element **20** of the display panel **3**.

FIG. **7** illustrates a first electrode layer **12** according to a modified exemplary embodiment. The first electrode layer **12** of this embodiment is different from the first electrode layer **12** shown in FIG. **2**. The first electrode layer **12** includes a plurality of first electrodes **121** spaced apart from each other and a plurality of second electrodes **122** spaced apart from each other. The first electrodes **121** function as touch sensing electrodes and force sensing electrodes, and the second electrodes **122** function as the cathode of the light-emitting layer **13**. The first electrodes **121** may alternatively function as touch sensing electrodes and force sensing electrodes, in a time-division manner.

The first electrodes **121** and the second electrodes **122** are formed on a same plane. The first electrodes **121** and the second electrodes **122** may be defined by a same conductive material layer and formed by a single pattern process. The first electrodes **121** and the second electrodes **122** may be made of a same transparent conductive material, such as indium tin oxide.

Each second electrode **122** extends along the first direction D**1** in a long strip shape. The plurality of second electrodes **122** is arranged in one column along the second direction D**2**. A row of the first electrodes **121** is between every two adjacent second electrodes **122**. Each row of the first electrodes **121** includes a plurality of first electrodes **121** spaced apart from each other and arranged along the first direction D**1**. The second electrodes **122** and the first electrodes **121** are alternately arranged along the second direction D**2**. Each first electrode **121** is electrically insulated from the second electrodes **122**.

The arrangement of the first electrodes **121** and the second electrodes **122** as shown in FIG. **7** has a relationship with the arrangement of the pixel units **150** as shown in FIG. **2**. Each first electrode **121** corresponds to N adjacent pixel units **150** along the first direction D**1**, where N is a natural number. A length L**4** of each first electrode **121** along the first direction D**1** is substantially equal to a total span length Ln spanning N adjacent pixel units **150** along the first direction D**1**. A total span length L**3** spanning one first electrode **121** and one second electrode **122** adjacent to each other along the second direction D2 is substantially equal to of the length L of each pixel unit 150 along the second direction D2. Particularly, a length L5 of one first electrode 121 along the second direction D2 is substantially equal to one third of the length L of each pixel unit 150 along the second direction D2. The value of N depends on the touch resolution of the OLED display device, the higher the touch resolution, the greater the distribution concentration of the first electrode 121 and the less the value of N. The value of N may determine an area of each first electrode 121. Where N is greater, the area of each first electrode 121 is greater. In the present exemplary embodiment, N is a number in a range from about 40 to about 60.

As shown in FIG. 7, in the present exemplary embodiment, several adjacent first electrodes 121 along the second direction D2 are electrically coupled by conductive lines 123 to form a touch sensing electrode 120. Each touch sensing electrode 120 is electrically coupled to a controlling integrated circuit 10 by conductive lines 123.

It is to be understood, even though information and advantages of the present exemplary embodiments have been set forth in the foregoing description, together with details of the structures and functions of the present exemplary embodiments, the disclosure is illustrative only. Changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the present exemplary embodiments to the full extent indicated by the plain meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. An OLED touch display device comprising:

a first electrode layer;

a second electrode layer facing the first electrode layer;

a light-emitting layer between the first electrode layer and the second electrode; and

a third electrode layer on a side of the first electrode layer;

the first electrode layer functioning as a cathode of the light-emitting layer, and the second electrode layer functioning as an anode of the light-emitting layer;

wherein the first electrode layer and the third electrode layer cooperatively form a capacitive force sensing element;

wherein the first electrode layer includes a plurality of first electrodes spaced apart from each other; wherein the plurality of first electrodes are arranged in rows and columns; and wherein each of the rows of the first electrodes extends along a first direction D1 and each of the columns of the first electrodes extends along a second direction D2; wherein the first direction D1 is perpendicular to the second direction;

wherein the first electrode layer further comprises a plurality of second electrodes spaced apart from each other; wherein each of the plurality of first electrodes are electrically insulated from the plurality of second electrodes; wherein the plurality of first electrodes function as touch sensing electrodes and force sensing electrodes by a time-division manner, and the plurality of second electrodes function as the cathode of the light-emitting layer;

wherein each of the plurality of second electrodes extends along the first direction D1 to be a strip; wherein the plurality of second electrodes are arranged in one column along the second direction; wherein one of the rows of the first electrodes is between every two adjacent of the plurality of second electrodes.

2. The OLED touch display device of claim 1, wherein the light-emitting layer comprises a plurality of light-emitting units spaced apart from each other; wherein the second electrode layer comprises a plurality of pixel electrodes spaced apart from each other; wherein each of the plurality of light-emitting units corresponds to one of the plurality of pixel electrodes; wherein the OLED touch display panel defines a plurality of pixel units arranged in rows and columns; wherein each of the plurality of pixel units comprises at least one of the plurality of pixel electrodes and at least one of the plurality of light-emitting units corresponding to the at least one of the plurality of pixel electrodes.

3. The OLED touch display device of claim 2, wherein each of the plurality of first electrodes corresponds to N adjacent pixel units along the first direction D1, wherein N is a natural number; wherein a length L4 of each of the plurality of first electrodes along the first direction D1 is equal to a total span length Ln spanning N adjacent pixel units along the first direction Dl; and wherein a total span length L3 spanning one of the plurality of first electrodes and one of the plurality of second electrodes adjacent to each other along the second direction D2 is equal to a length L of each of the plurality of pixel units along the second direction D2.

4. The OLED touch display device of claim 3, wherein a length L5 of one of the plurality of first electrodes along the second direction D2 is equal to one third of the length L of each of the plurality of pixel units along the second direction D2.

5. The OLED touch display device of claim 1, wherein the third electrode layer is a metal frame and is on a side of the second electrode layer away from the first electrode layer; wherein an air gap is formed between the third electrode layer and the electrode layer; wherein the first electrode layer, the third electrode layer, and the air gap cooperatively form a capacitive force sensing element of the OLED touch display panel.

6. The OLED touch display device of claim 1, further comprising an insulating layer, wherein the third electrode layer is on a side of the first electrode layer away from the second electrode layer; wherein the insulating layer is elastic and between the third electrode layer and the first electrode layer; wherein the third electrode layer, the insulating layer, and the first electrode layer cooperatively form a force sensing element of the OLED touch display panel.

7. The OLED touch display device of claim 1 further comprising an insulating layer, wherein the third electrode layer is on a side of the second electrode layer away from the first electrode layer; wherein the insulating layer is elastic and between the third electrode layer and the second electrode layer; wherein the third electrode layer, the insulating layer, and the first electrode layer cooperatively form a force sensing element of the OLED touch display panel.

8. An OLED touch display device comprising:

a first electrode layer;

a second electrode layer facing the first electrode layer;

a light-emitting layer between the first electrode layer and the second electrode; and

a third electrode layer;

the first electrode layer functioning as a cathode of the light-emitting layer, and the second electrode layer functioning as an anode of the light-emitting layer;

wherein the first electrode layer functions as touch sensing electrode;

wherein the third electrode layer is a metal frame and is on a side of the second electrode layer away from the first electrode layer; wherein an air gap is formed between the third electrode layer and the electrode layer; wherein the first electrode layer, the third electrode layer, and the air gap cooperatively form a capacitive force sensing element of the OLED touch display panel.

9. An OLED touch display device comprising:

a first electrode layer;

a second electrode layer facing the first electrode layer; and

a light-emitting layer between the first electrode layer and the second electrode;

the first electrode layer functioning as a cathode of the light-emitting layer, and the second electrode layer functioning as an anode of the light-emitting layer;

wherein the first electrode layer includes a plurality of first electrodes spaced apart from each other; wherein the plurality of first electrodes are arranged in rows and columns; and wherein each of the rows of the first electrodes extends along a first direction D**1** and each of the columns of the first electrodes extends along a second direction D**2**; wherein the first direction D**1** is perpendicular to the second direction; the plurality of first electrodes function as cathode of the light-emitting layer, touch sensing electrodes, and force sensing electrodes by a time-division manner;

wherein the light-emitting layer comprises a plurality of light-emitting units spaced apart from each other; wherein the second electrode layer comprises a plurality of pixel electrodes spaced apart from each other; wherein each of the plurality of light-emitting units corresponds to one of the plurality of pixel electrodes; wherein the OLED touch display panel defines a plurality of pixel units arranged in rows and columns; wherein each of the plurality of pixel units comprises at least one of the plurality of pixel electrodes and at least one of the plurality of light-emitting units corresponding to the at least one of the plurality of pixel electrodes;

wherein each of the rows of the pixel units extends along the first direction D**1** and each of the columns of the pixel units extends along the second direction D**2**; wherein each of the plurality of first electrodes corresponds to N adjacent pixel units along the first direction D**1**, wherein N is a natural number;

wherein a length L**1** of each of the plurality of first electrodes along the first direction D**1** is equal to a total span length Ln spanning N adjacent pixel units along the first direction D**1**; wherein and a length L**2** of each of the plurality of first electrodes along the second direction D**1** is equal to a length L of each of the plurality of pixel units along the second direction D**2**.

10. The OLED touch display device of claim **9**, wherein N is a number in a range from about 40 to about 60.

11. The OLED touch display device of claim **9**, further comprising a third electrode layer, wherein the third electrode layer is a metal frame and is on a side of the second electrode layer away from the first electrode layer; wherein an air gap is formed between the third electrode layer and the electrode layer; wherein the first electrode layer, the third electrode layer, and the air gap cooperatively form a capacitive force sensing element of the OLED touch display panel.

* * * * *

专利名称(译)	OLED触控显示面板		
公开(公告)号	US10332942	公开(公告)日	2019-06-25
申请号	US15/656127	申请日	2017-07-21
[标]申请(专利权)人(译)	鸿海精密工业股份有限公司		
申请(专利权)人(译)	鸿海精密工业股份有限公司.		
当前申请(专利权)人(译)	鸿海精密工业股份有限公司.		
[标]发明人	WENG YU FU LIN CHIEN WEN LIU CHIA LIN		
发明人	WENG, YU-FU LIN, CHIEN-WEN LIU, CHIA-LIN		
IPC分类号	H01L27/32 H01L51/52 G06F3/044 G06F3/041		
CPC分类号	H01L27/323 G06F3/044 G06F3/0412 G06F3/0414 H01L51/5228 H01L51/5221 H01L27/3244 G06F2203/04103 G06F2203/04108		
优先权	62/374081 2016-08-12 US		
其他公开文献	US20180047794A1		
外部链接	Espacenet		

摘要(译)

一种OLED触控显示装置，包括第一电极层，面对第一电极层的第二电极层，第一电极层与第二电极之间的发光层，以及第一电极层一侧的第三电极层。第一电极层用作发光层的阴极，第二电极层用作发光层的阳极。第一电极层和第三电极层共同形成电容力感测元件。第一电极层还用作触摸感测电极。