US 20190019850A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0019850 A1**

XU et al. (43) **Pub. Date: Jan. 17, 2019**

(54) **FINGERPRINT RECOGNITION DEVICE AND OLED DISPLAY DEVICE**

(71) Applicant: **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(72) Inventors: **Rui XU**, Beijing (CN); **Haisheng WANG**, Beijing (CN); **Yingming LIU**, Beijing (CN); **Pengpeng WANG**, Beijing (CN); **Chih-Jen CHENG**, Beijing (CN); **Yunke QIN**, Beijing (CN); **Yuzhen GUO**, Beijing (CN); **Wei LIU**, Beijing (CN)

(21) Appl. No.: **15/754,248**

(22) PCT Filed: **Sep. 15, 2017**

(86) PCT No.: **PCT/CN2017/101961**

§ 371 (c)(1),
(2) Date: **Feb. 21, 2018**

(30) **Foreign Application Priority Data**

Feb. 24, 2017 (CN) 201710105957.6

Publication Classification

(51) **Int. Cl.**

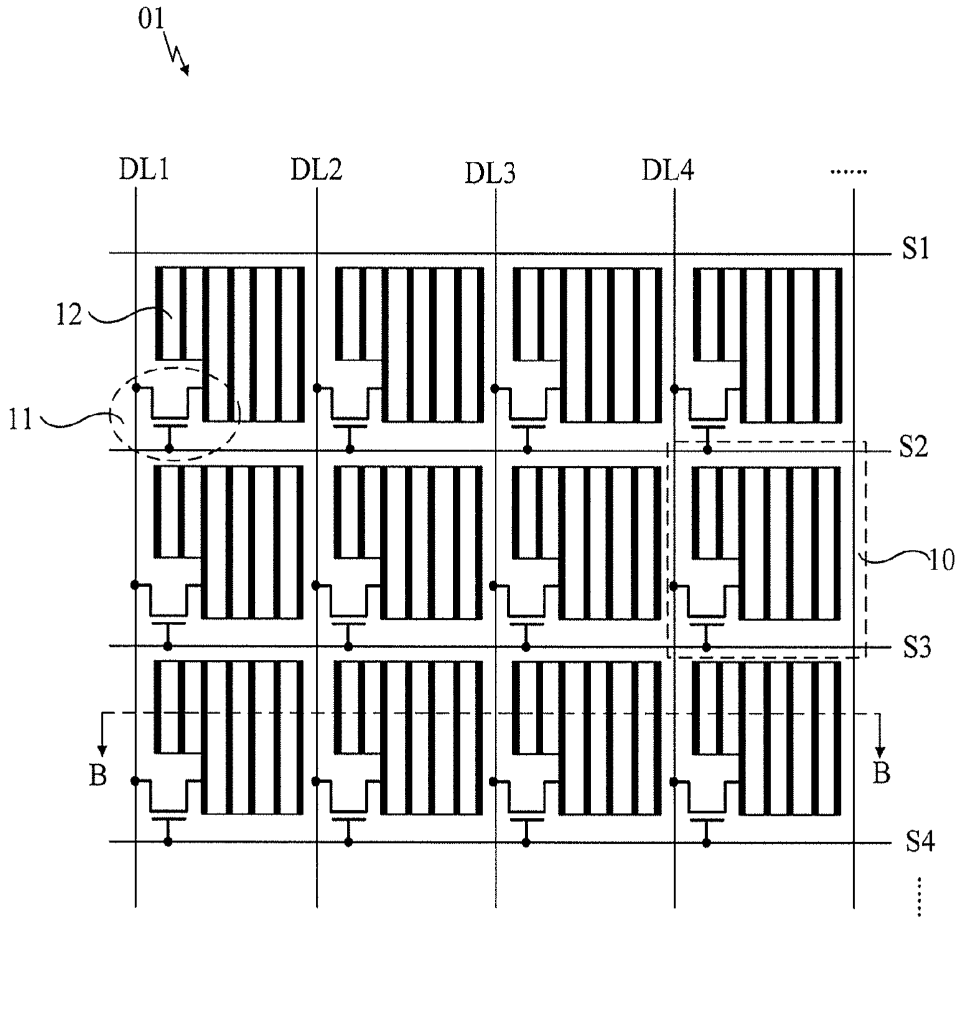
H01L 27/32 (2006.01)
G02B 27/30 (2006.01)
G06K 9/00 (2006.01)

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

CPC ***H01L 27/3225*** (2013.01); ***H01L 27/3211*** (2013.01); ***G06K 9/00006*** (2013.01); ***G02B 27/30*** (2013.01)

(57) **ABSTRACT**

A fingerprint recognition device and an OLED display device, which relate to the technical field of display and can solve the problems of a low recognition accuracy due to a large distance from a finger to a fingerprint recognition device. The fingerprint recognition device comprises recognition units alternately defined by a plurality of scanning lines and signal reading lines which are crisscrossed with each other. Each recognition unit is provided with a switching transistor and a photosensitive element. The photosensitive element comprises a photoelectric conversion layer and a collimator filter layer which are stacked successively. The collimator filter layer is used for irradiating incident light onto the photoelectric conversion layer in parallel, and the photoelectric conversion layer is used for performing photoelectric conversion on the incident light.



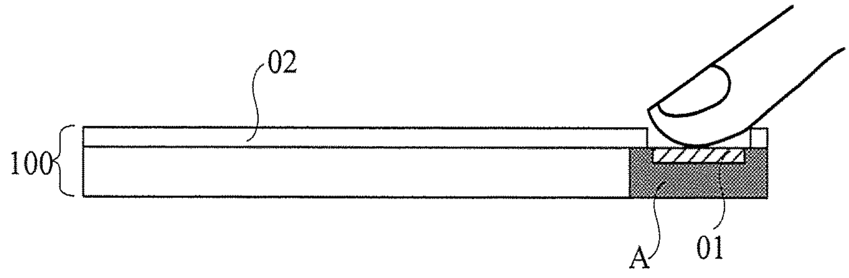


FIG. 1 (Prior art)

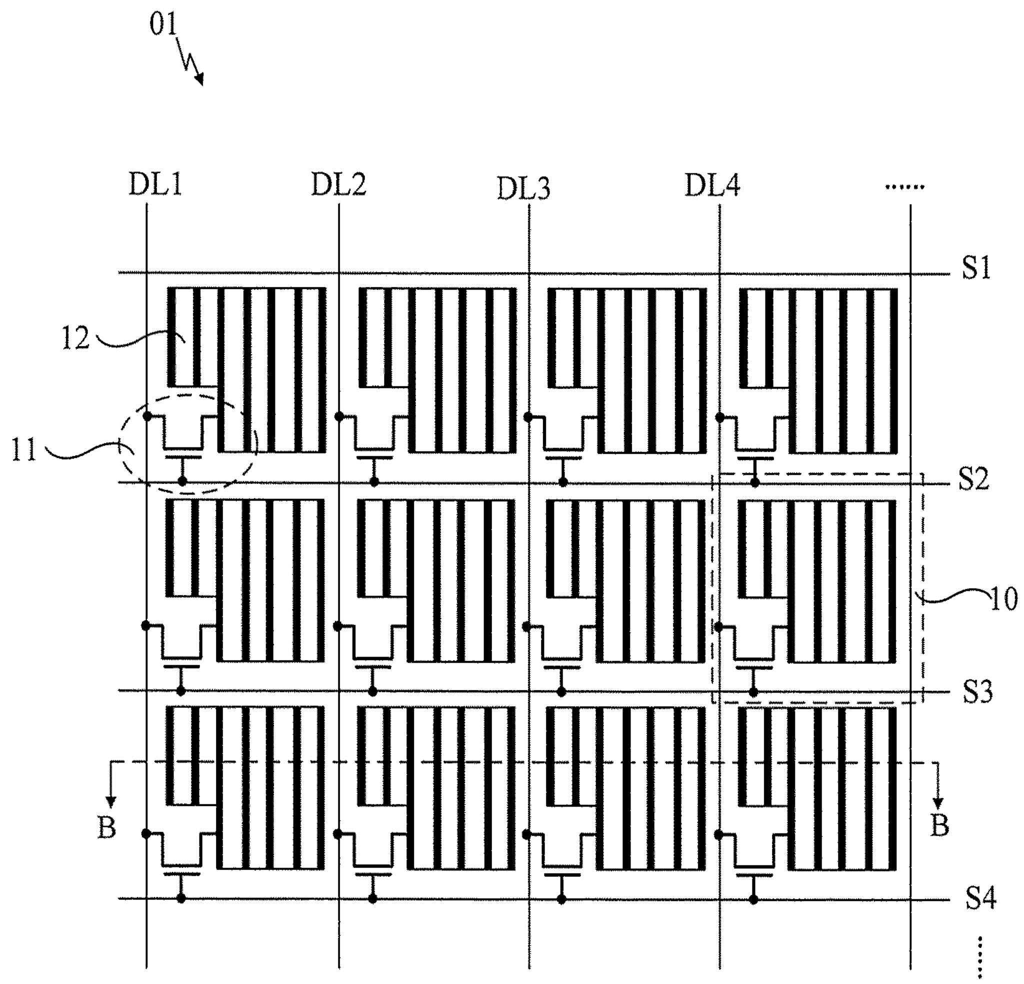
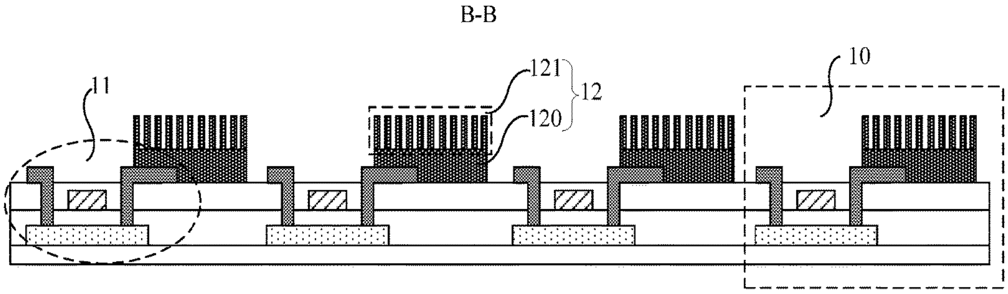


FIG. 2



FIFIG. 3

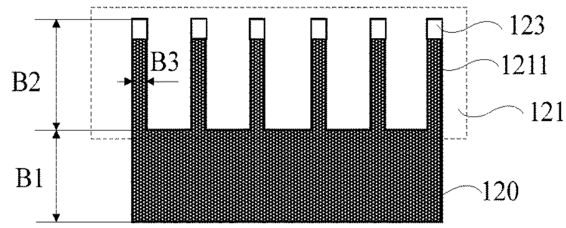


FIG. 4

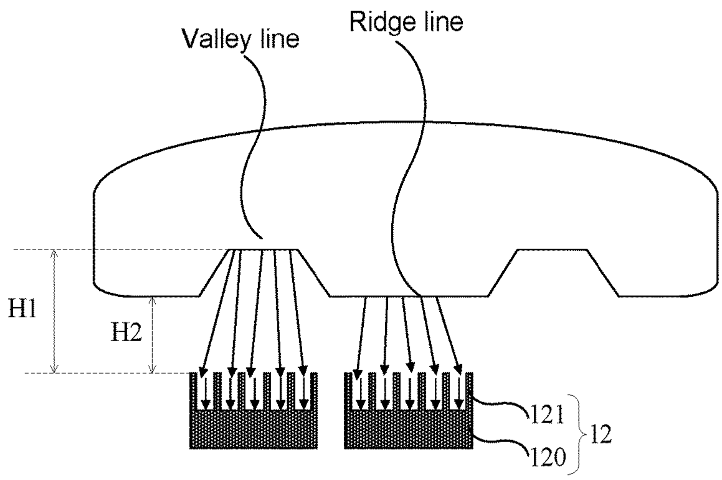


FIG. 5

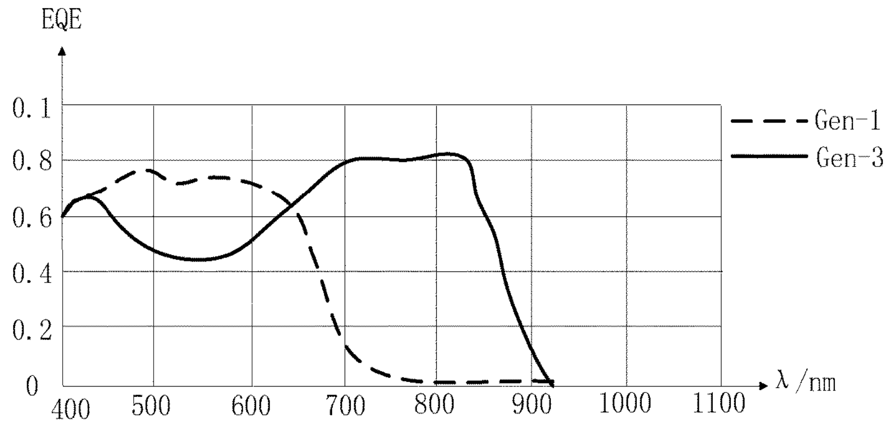

EQE
0. 1
0. 8
0. 6
0. 4
0. 2
0
400
500
600
700
800
900
1000
1100
λ /nm
Gen-1
Gen-3

FIG. 6

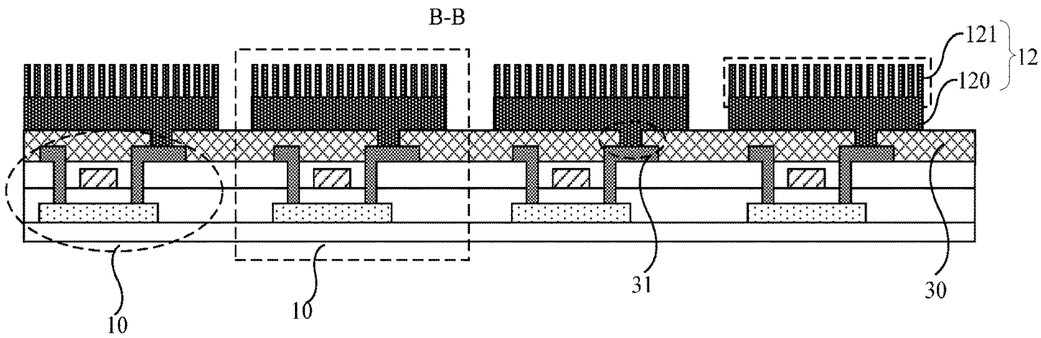

B-B
121
120
12
10
10
31
30

FIG. 7

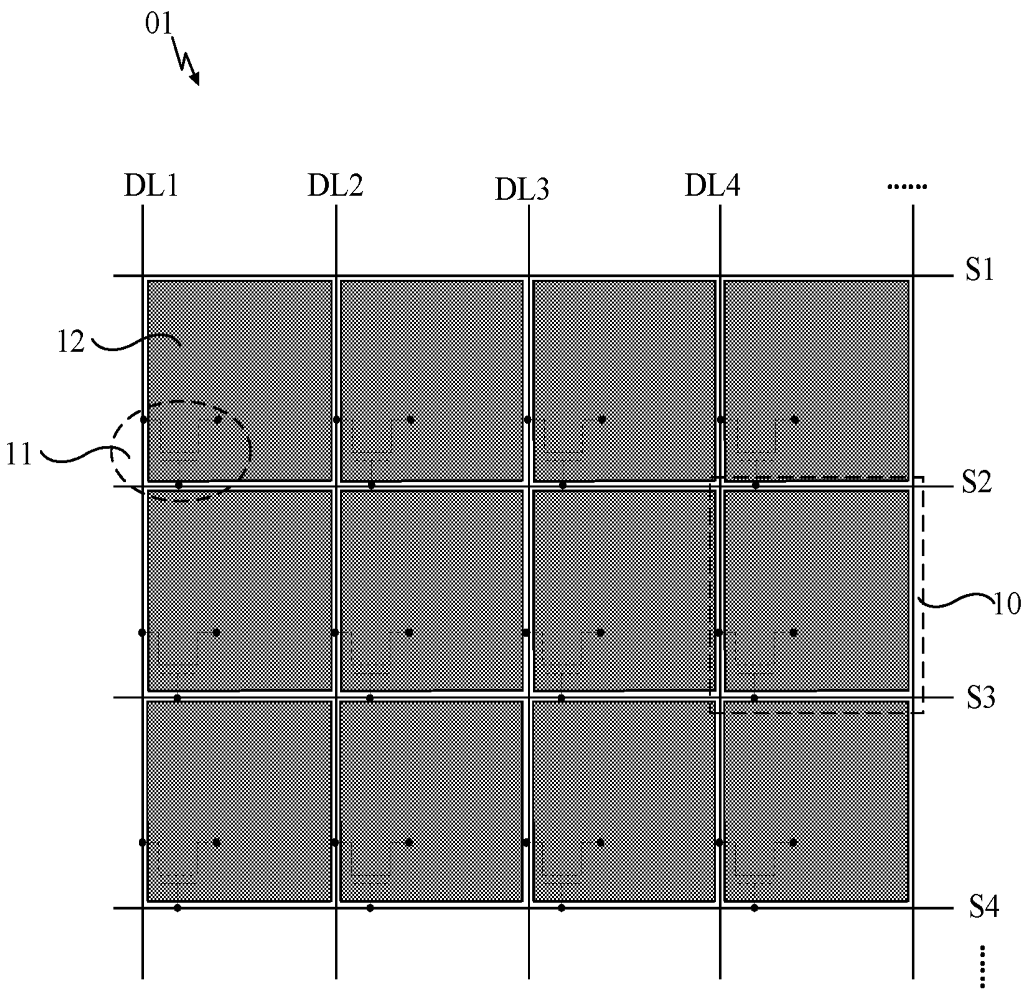


FIG. 8

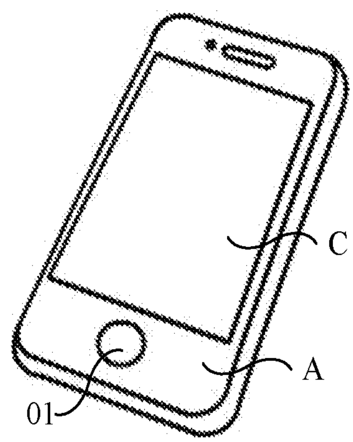


FIG. 9

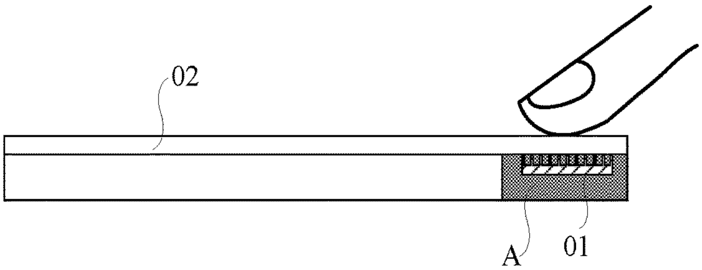


FIG. 10

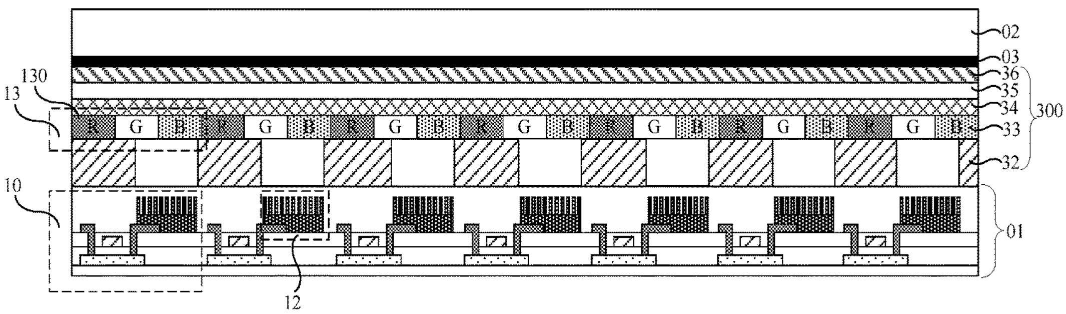


FIG. 11

FINGERPRINT RECOGNITION DEVICE AND OLED DISPLAY DEVICE

[0001] The present application claims priority to Chinese Patent Application No. 201710105957.6 filed to the China Patent Bureau on Feb. 24, 2017 and entitled "FINGERPRINT RECOGNITION DEVICE AND OLED DISPLAY DEVICE", the disclosure of which is hereby incorporated by reference in its entirety.

FIELD OF TECHNOLOGY

[0002] The present disclosure relates to the technical field of display, and in particular to a fingerprint recognition device and an OLED display device.

BACKGROUND OF THE INVENTION

[0003] Due to the uniqueness and immutability of the somatic fingerprint, the fingerprint recognition technology is good in security, high in reliability and simple and convenient to use, so that the fingerprint recognition technology has been widely applied in various fields for protecting personal information security, particularly in display devices, for example, mobile phones, notebook computers, tablet computers, digital photo frames and the like.

[0004] To enable a display device to have a fingerprint recognition function, as shown in FIG. **1**, a fingerprint recognition device **01** is generally provided within a non-display region A of the display device **100**. When a finger comes into contact with cover glass **02** of the display device at a position corresponding to the fingerprint recognition device **01**, the fingerprint recognition device **01** can recognize the fingerprint of a user.

[0005] Since the distance from the finger to the fingerprint recognition device **01** is increased by the cover glass **02**, the recognition accuracy will be reduced. In order to solve this problem, a touch hole is generally formed on the cover glass **02** at a position corresponding to the fingerprint recognition device, so that the finger comes into contact with the fingerprint recognition device **01** through the tough hole and the recognition accuracy is thus improved. However, in this case, it is necessary to add a cutting process during the preparation of the display device, so that the defective rate and the production cost are increased.

SUMMARY OF THE INVENTION

[0006] Embodiments of the present disclosure provide a fingerprint recognition device and an OLED display device, which can solve the problems of a low recognition accuracy due to a large distance from a finger to a fingerprint recognition device.

[0007] For this purpose, the embodiments of the present disclosure employ the following technical solutions.

[0008] In one aspect of the embodiments of the present disclosure, a fingerprint recognition device is provided. The fingerprint recognition device includes a plurality of recognition units alternately defined by a plurality of scanning lines and a plurality of signal reading lines which are crisscrossed with each other. One of the plurality of recognition units is provided with a switching transistor and a photosensitive element, wherein, a first electrode of the switching transistor is connected to a corresponding one of the plurality of signal reading lines defining this recognition unit and a gate of the switching transistor is connected to a corresponding one of the plurality of scanning lines defining this recognition unit. The photosensitive element includes a photoelectric conversion layer and a collimator filter layer which are stacked successively, with the photoelectric conversion layer being connected to a second electrode of the switching transistor. The collimator filter layer is used for making incident light irradiate onto the photoelectric conversion layer in parallel, and the photoelectric conversion layer is used for performing photoelectric conversion on the incident light.

[0009] Preferably, the collimator filter layer and the photoelectric conversion layer are of an integral structure, and the collimator filter layer and the photoelectric conversion layer are made of the same material, i.e., black organic photoelectric material.

[0010] Preferably, the photosensitive element completely covers the switching transistor; and, an insulating layer is provided between the photoelectric conversion layer and the switching transistor, a via hole is formed on the insulating layer at a position corresponding to the second electrode of the switching transistor, and the photoelectric conversion layer is connected to the second electrode of the switching transistor through the via hole.

[0011] Preferably, the area of the photosensitive element is the same as the area of an opening of the recognition unit, and the shape of the photosensitive element is the same as the shape of the opening of the recognition unit.

[0012] Preferably, the collimator filter layer includes a plurality of light guide strips which are arranged at intervals in parallel, and the plurality of light guide strips are made of light shielding material; and, the photoelectric conversion layer is planar, and each of the plurality of light guide strips is perpendicular to the photoelectric conversion layer.

[0013] Preferably, the collimator filter layer further includes light shielding strip(s) located on an upper surface of at least one of the plurality of light guide strips, and the light shielding strip(s) is used for blocking incidence of light onto the upper surface of this light guide strip; and, the upper surface of this light guide strip is a surface of the light guide strip on a side away from the photoelectric conversion layer.

[0014] Preferably, the collimator filter layer has a thickness of 1-5 μm, and the light guide strips each have a width of 0.8-1.2 μm.

[0015] Preferably, the photoelectric conversion layer has a thickness of 0.8-1.2 μm.

[0016] In another aspect of the embodiments of the present disclosure, an OLED display device is provided. The OLED display includes the fingerprint recognition device described above.

[0017] Preferably, the fingerprint recognition device is arranged within a non-display region of the OLED display device.

[0018] Preferably, the OLED display device is of a top-emitting type and includes a display module; and, the fingerprint recognition device is arranged within a display region of the OLED display device and located on a side opposite to a light outgoing side of the display module, and the display module transmits light at a position corresponding to a photosensitive element.

[0019] Preferably, the display module includes a plurality of pixel units which are crisscrossed with each other; each of the plurality of pixel units includes at least three sub-pixels; and, each of the plurality of pixel unit corresponds to one recognition unit.

[0020] The present disclosure provides a fingerprint recognition device and an OLED display device. The fingerprint recognition device includes a plurality of recognition units alternately defined by a plurality of scanning lines and a plurality of signal reading lines which are crisscrossed with each other. One of the plurality of recognition units is provided with a switching transistor and a photosensitive element. A first electrode of the switching transistor is connected to a corresponding one of the plurality of signal reading lines defining this recognition unit, and a gate of the switching transistor is connected to a corresponding one of the plurality of scanning lines defining this recognition unit. The photosensitive element includes a photoelectric conversion layer and a collimator filter layer. The photoelectric conversion layer is connected to a second electrode of the switching transistor. The collimator filter layer is used for make incident light irradiate onto the photoelectric conversion layer in parallel, and the photoelectric conversion layer is used for performing photoelectric conversion on the incident light.

[0021] During the fingerprint recognition process, the plurality of scanning lines is input with activation signals line by line, so as to activate the plurality of recognition units line by line. After light reflected by a finger is irradiated onto the photosensitive element, the incident light can be irradiated onto the photoelectric conversion layer in parallel through the collimator filter layer, which performs photoelectric conversion on the incident light. Since the light reflected by a valley line of the finger and the light reflected by a ridge line of the finger are different in intensity, different photosensitive units for receiving the light reflected by the ridge line and the light reflected by the valley line can output, through respective photoelectric conversion layers, different electric signals to the signal reading lines connected to the photoelectric conversion layers. Thus, the purpose of recognizing the fingerprint of the finger is realized.

[0022] In this way, when the fingerprint recognition device is applied to a display device, even if the distance from a finger to the fingerprint recognition device is increased due to other components (e.g., cover glass) provided between the finger and the fingerprint recognition device, the collimator filter layer can make incident light irradiate onto the photoelectric conversion layer in parallel, so that the degree of scattering of the light reflected by the finger is reduced. Therefore, by the collimator filter layer, the probability of allowing the light reflected by the finger to be transmitted onto the photoelectric conversion layer can be increased, and the accuracy of fingerprint recognition by the photosensitive element can thus be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] To describe the technical solutions in the embodiments of the present disclosure or in the prior art more clearly, the accompanying drawings to be used in the descriptions of the embodiments or the prior art will be briefly described below. Apparently, the accompanying drawings described hereinafter are some of embodiments of the present disclosure, and a person of ordinary skill in the art can obtain other accompanying drawings according to these drawings without paying any creative effort.

[0024] FIG. **1** is a structure diagram of a display device equipped with a fingerprint recognition device in the prior art;

[0025] FIG. **2** is a structure diagram of a fingerprint recognition device according to an embodiment of the present disclosure;

[0026] FIG. **3** is a sectional view of FIG. **2** taken along B-B;

[0027] FIG. **4** is a structure diagram of a photosensitive element in FIG. **3**;

[0028] FIG. **5** is a schematic diagram of a fingerprint test on the photosensitive element shown in FIG. **3** or FIG. **4**;

[0029] FIG. **6** is a schematic diagram of the photoelectric conversion rate of the material forming a photoelectric conversion layer of the photosensitive element shown in FIG. **3** or FIG. **4**;

[0030] FIG. **7** is a sectional view of FIG. **2** taken along B-B;

[0031] FIG. **8** is a structure diagram of another fingerprint recognition device according to an embodiment of the present disclosure;

[0032] FIG. **9** is a schematic diagram of a way of arranging a fingerprint recognition device in an OLED display device according to an embodiment of the present disclosure;

[0033] FIG. **10** is a schematic diagram of arrangement of the fingerprint recognition device in FIG. **9** within a non-display region; and

[0034] FIG. **11** is a schematic diagram of another way of arranging a fingerprint recognition device in an OLED display device according to an embodiment of the present disclosure;

[0035] in which:

[0036] **100**: display device; **01**: fingerprint recognition device; **02**: cover glass; **03**: optical adhesive; **10**: recognition unit; **11**: switching transistor; **12**: photosensitive element; **13**: pixel unit; **130**: sub-pixel; **120**: photoelectric conversion layer; **121**: collimator filter layer; **1211**: light guide strip; **123**: light shielding strip; **30**: insulating layer; **31**: via hole; **300**: display module; **32**: display backplane; **33**: organic functional layer; **34**: cathode; **35**: polarizer; **36**: encapsulation thin film layer; A: non-display region; and, C: display region.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] The technical solutions in the embodiments of the present disclosure will be clearly and completely described below with reference to the accompanying drawings in the embodiments of the present disclosure. Apparently, the embodiments described herein are merely a part but not all of the embodiments of the present disclosure. All other embodiments obtained by a person of ordinary skill in the art without paying any creative effort on the basis of the embodiments in the present disclosure shall fall into the protection scope of the present disclosure.

[0038] A fingerprint recognition device **01** is provided, as shown in FIG. **2**, including a plurality of recognition units **10** alternately defined by a plurality of scanning lines (S**1**, S**2**, S**3**, S**4** . . .) and a plurality of signal reading lines (DL**1**, DL**2**, DL**3**, DL**4** . . .) which are crisscrossed with each other. One of the plurality of recognition units **10** is provided with a switching transistor **11** and a photosensitive element **12**. A first electrode of the switching transistor **11** is connected to a corresponding one (e.g., DL**1**) of the plurality of signal reading lines defining this recognition unit, and a gate of the switching transistor is connected to a corresponding one (e.g., S2) of the plurality of scanning lines defining this recognition unit.

[0039] On this basis, as shown in FIG. **3**, the photosensitive element **12** includes a photoelectric conversion layer **120** and a collimator filter layer **121** which are stacked successively. The photoelectric conversion layer **120** is connected to a second electrode of the switching transistor **11**. In this case, the collimator filter layer **121** is used for making incident light irradiate onto the photoelectric conversion layer **120** in parallel. The photoelectric conversion layer **120** is used for performing photoelectric conversion on the incident light.

[0040] It is to be noted that, for the switching transistor **11**, the first electrode is a source, and the second electrode is a drain; alternatively, the first electrode is a drain, and the second electrode is a source.

[0041] In addition, the type of the switching transistor **11** will be not limited in the present disclosure. The switching transistor may be a top-gate thin film transistor or a bottom-gate thin film transistor. In addition, the switching transistor may be a N-type thin film transistor or a P-type thin film transistor.

[0042] In this way, when the fingerprint recognition device **01** is applied to a display device, even if the distance from a finger to the fingerprint recognition device is increased due to other components (e.g., cover glass) provided between the finger and the fingerprint recognition device **01**, the collimator filter layer **121** can make incident light irradiate onto the photoelectric conversion layer **120** in parallel, so that the degree of scattering of the light reflected by the finger is reduced. Therefore, by the collimator filter layer **120**, the probability of allowing the light reflected by the finger to be transmitted onto the photoelectric conversion layer can be increased, and the accuracy of fingerprint recognition by the photosensitive element **12** can thus be improved.

[0043] Optionally, as shown in FIG. **4**, the collimator filter layer **121** includes a plurality of light guide strips **1211** which are arranged at intervals in parallel. The plurality of light guide strips **1211** are made of light shielding material. In this case, after light reflected by the finger enters a gap between two adjacent light guide strips **1211** among the plurality of light guide strips, the light will be transmitted onto the photoelectric conversion layer **120** in an extension direction of the gap. In addition, since the light guide strips **1211** are made of light shielding material, crosstalk will not occur on light in two adjacent gaps.

[0044] On this basis, each of the plurality of light guide strips **1211** is perpendicular to the photoelectric conversion layer **120**. In this way, the direction in which the gap extends between two adjacent light guide strips **1211** is also perpendicular to the photoelectric conversion layer **120**, so that the light reflected by the finger can be transmitted in a direction perpendicular to the photoelectric conversion layer **120** through the collimator filter layer **121** and eventually transmitted onto the photoelectric conversion layer **120**. It can be known from the above that, due to the plurality of light guide strips **1211**, the light reflected by the finger can be perpendicularly transmitted onto the photoelectric conversion layer **120**, so that the degree of scattering of the light reflected by the finger can be further reduced and the utilization of light can be improved.

[0045] On this basis, the fingerprint detection can be realized as long as it can be ensured that the photoelectric conversion layer **120** is provided at a position of at least one of the gaps. However, in order to increase the light receiving area and the accuracy of photoelectric conversion, preferably, the photoelectric conversion layer **120** is planar.

[0046] The process of the photosensitive element **12** performing fingerprint recognition will be described below in detail.

[0047] As shown in FIG. **5**, there are ridge lines and valley lines on the surface of the finger. The distance from a valley line to the photosensitive element **12** is H1, the distance from a ridge line to the photosensitive element **12** is H2, and H1>H2. Therefore, light reflected to the collimator filter layer **121** by the valley lines has a lower intensity due to a larger transmission distance, while light reflected to the collimator filter layer **121** by the ridge lines has a higher intensity due to a smaller transmission distance. In this case, light, after being collimated by the collimator filter layer **121**, perpendicularly transmits onto the photoelectric conversion layer **120** at a position corresponding to a valley line. Conversion layer **120** at this position receives light with a lower intensity, so that the converted current transmitted to the signal reading line (e.g., DL**1**) through the switching transistor connected to the photoelectric conversion layer **120** at this position is low. Meanwhile, light perpendicularly transmits onto the photoelectric conversion layer **120** at a position corresponding to a ridge line. Conversion layer **120** at this position receives light with a higher intensity, so that the converted current transmitted to the signal reading line (e.g., DL**2**) through the switching transistor connected to photoelectric conversion layer **120** at this position is high. In this way, by detecting the magnitude of current at different recognition units **10** output by different signal reading lines, the detection of valley lines or ridge lines of the fingerprint can be realized.

[0048] To realize the photoelectric conversion and to be advantageous for fabrication, the photoelectric conversion layer **120** may be preferably made of black organic photoelectric material. Optionally, the black organic photoelectric material includes all-organic semiconductor photoelectric material represented by polythiophene (POPT) derivatives or polyfluorene (PFO) derivatives. Optionally, the black organic photoelectric material may further include polymer doped fullerene (C60) and its derivatives, represented by double-layer heterojunction and bulk heterojunction material of polymer-fullerence and the like.

[0049] On this basis, by taking the photoelectric conversion layer **120** being mainly made of o-phenylenediamine (OPD) as example, the curve Gen_**1** of the conversion rate of the first generation of OPD and the curve Gen_**3** of the conversion rate of the third generation of OPD are shown in FIG. **6**. It can be known from FIG. **6** that, when the photoelectric conversion layer **120** is made of the first generation of OPD, the conversion rate of the photoelectric conversion layer **120** converting light having a wavelength of 450 nm to 650 nm is greater than 0.6; and, when the photoelectric conversion layer **120** is made of the third generation of OPD, the conversion rate of the photoelectric conversion layer **120** converting light having a wavelength of 700 nm to 800 nm is greater than 0.8. Therefore, the photoelectric conversion layer **120** may be made of material having a high conversion rate according to the wavelength of light that needs to be reflected by the finger, thereby improving the photoelectric conversion efficiency.

[0050] On this basis, in order to simplify the fabrication process, as shown in FIG. **4**, the collimator filter layer **121** and the photoelectric conversion layer **120** may be of an integral structure, and the collimator filter layer **121** and the photoelectric conversion layer **120** are made of the same material, i.e., the black organic photoelectric material. In this case, during the fabrication of the photosensitive element **12**, first a black organic photoelectric material layer can be formed on a substrate, and then one patterning process can be proceeded, so as to form the planar photoelectric conversion layer **120** and the plurality of light guide strips **1211** that are arranged at intervals in parallel on a side of a light incident surface of the photoelectric conversion layer **120** and perpendicular to the light incident surface of the photoelectric conversion layer **120**.

[0051] It is to be noted that, in the present disclosure, the patterning process may include a photoetching process, or include a photoetching process and an etching step, or may further include other processes for forming a predetermined pattern, such as printing or inkjet printing. The photoetching process is a process for forming a pattern using photoresists, masks, exposure machines or the like, including film forming, exposure, development or other processes. The corresponding patterning process may be selected according to the structure to be formed in the present disclosure.

[0052] In an embodiment, the one patterning process of the present disclosure is described by the following example: forming different exposure regions by one mask exposure process and then performing removal processes such as etching or ashing on the different exposure regions for multiple times to eventually obtain a desired pattern.

[0053] Further, optionally, as shown in FIG. **4**, the photoelectric conversion layer **120** prepared by the above preparation method or other methods may have a thickness B**1** of 0.8-1.2 μm. In an embodiment, the photoelectric conversion layer **120** has a thickness B1 of 0.8 μm. In another embodiment, the photoelectric conversion layer **120** has a thickness B1 of 1 μm. In another embodiment, the photoelectric conversion layer **120** has a thickness B1 of 1.2 μm. When the thickness of the photoelectric conversion layer **120** is less than 0.8 μm, the photoelectric conversion rate will be reduced due to a too small thickness. When the thickness of the photoelectric conversion layer **120** is greater than 1.2 μm, although the photoelectric conversion rate can be improved, the increase of the overall thickness of the photosensitive element **12** is disadvantageous for the design trend of ultra-thin display devices. On this basis, the photoelectric conversion layer **120** preferably has a thickness of 1 μm.

[0054] In addition, on one hand, the collimator filter layer **121** prepared by the above preparation method or other methods has a thickness B**2** of 1-5 μm. In an embodiment, the collimator filter layer **121** has a thickness B**2** of 1 μm. In another embodiment, the collimator filter layer **121** has a thickness B**2** of 3 μm. In another embodiment, the collimator filter layer **121** has a thickness B**2** of 5 μm. When the thickness of the collimator filter layer **121** is less than 1 μm, due to a too small height of the gap formed between two adjacent light guide strips **1211**, the light guidance effect is poor, so that it is disadvantageous for collimating the incident light. When the thickness of the collimator filter layer **121** is greater than 5 μm, although the collimation and guidance effect on the incident light can be improved, it is disadvantageous for the design trend of ultra-thin display devices.

[0055] On the other hand, the light guide strips **1211** each have a width B3 of 0.8-1.2 μm. In an embodiment, the light guide strips **1211** each have a width B3 of 0.8 μm. In another embodiment, the light guide strips **1211** each have a width B**3** of 1 μm. In another embodiment, the light guide strips **1211** each have a width B3 of 1.2 μm. Preferably, the light guide strips **1211** each have a width B**3** of 1 μm, reducing the probability of interference of the incident light. In addition, during the fabrication process, in order to prevent one light beam from entering two adjacent gaps, the width of the gaps can be adjusted, so that the probability of interference of light in two adjacent gaps is reduced.

[0056] On this basis, as shown in FIG. **4**, the collimator filter layer **121** further includes light shielding strip(s) **123** located on an upper surface of at least one of the plurality of light guide strips **1211**. The light shielding strip(s) **123** is used for blocking incidence of light onto the upper surface of this light guide strip **1211**. The upper surface of this light guide strip **1211** is a surface of the light guide strip **1211** on a side away from the photoelectric conversion layer **120**. In this way, the incident light can be prevented from entering the inside of the light guide strips **1211** to result in the loss of light.

[0057] Preferably, the light shielding strips **123** may be made of metal material, black inorganic material capable of blocking light or the like.

[0058] Further, in order to increase area of the photosensitive element **12** which receives light and thus achieve the purpose of improving the photoelectric conversion efficiency, preferably, as shown in FIG. **7**, the photosensitive element **12** may completely cover the switching transistor **11** connected to this photosensitive element **12**.

[0059] In an embodiment, an insulating layer **30** is provided between the photoelectric conversion layer **120** in the photosensitive element **12** and the switching transistor **11**. A via hole **31** is formed through the insulating layer **30** at a position corresponding to the second electrode of the switching transistor **11**. The photoelectric conversion layer **120** is connected to the second electrode of the switching transistor **11** through the via hole **31**.

[0060] On this basis, in order to further increase the area of the photosensitive element **12** which receives light, as shown in FIG. **8**, the area of the photosensitive element **12** is the same as the area of an opening of the recognition unit **10**. In addition, the shape of the photosensitive element **12** is the same as the shape of the opening of the recognition unit **10**. The opening of the recognition unit **10** refers to a region surrounded by scanning lines (e.g., S1 and S2) and signal reading lines (e.g., DL1 and DL2) which are criss-crossed to define this recognition unit **10**. In this case, when the plurality of scanning lines are arranged in parallel, the plurality of signal reading lines are arranged in parallel and any one scanning line is perpendicular to any one signal reading line, the shape of the opening of the recognition unit **10** is a rectangle, as shown in FIG. **8**.

[0061] An embodiment of the present disclosure provides an OLED display device, including the fingerprint recognition device **01** described above. The OLED display device has the same structure and beneficial effects as those of the fingerprint recognition device **01**, and they will not be repeated here since the structure and beneficial effects of the fingerprint recognition device **01** have been described in the foregoing embodiments.

[0062] The specific arrangement of the fingerprint recognition device **01** in the OLED device will be illustrated below in detail.

[0063] For example, as shown in FIG. **9**, the fingerprint recognition device **01** may be arranged within a non-display region A of the OLED display device, for example, at a position of the key Home. In this case, since the photosensitive element **12** of the fingerprint recognition device **01** has a collimator filter layer **121** capable of allowing light irradiated onto the photoelectric conversion layer **120** to be transmitted perpendicularly and in parallel, the degree of scattering of light reflected by a finger can be reduced. In this way, even if the finger does not directly come into contact with the fingerprint recognition device **01**, majority of the light reflected by the finger can still enter the fingerprint recognition device **01**, so that the efficiency and accuracy of fingerprint recognition can be ensured and the definition of acquired fingerprint images can be improved. In addition, the key Home can also be directly omitted to reduce the cost.

[0064] In this case, since the finger is not required to directly come into contact with the fingerprint recognition device **01**, as shown in FIG. **10**, it is unnecessary to form a touch hole on cover glass **02** of the OLED device at a position corresponding to the fingerprint recognition device **01**. In this way, the manufacturing process of the cover glass **02** can be simplified, the product yield can be improved, and the flatness of the surface of the display device can be ensured.

[0065] Or, for another example, when the OLED display device is of a top-emitting type, as shown in FIG. **11**, the fingerprint recognition device **01** may be arranged within a display region C of the OLED display device.

[0066] Specifically, the OLED display device includes a display module **300**. The display module **300** includes a display backplane **32**, organic function layers **33** (including a hole injection layer, a hole transmission layer, a luminescent layer, an electron transmission layer, an electron injection layer, a color filter layer and the like) successively located above the display backplane **32**, a cathode **34**, a polarizer **35** and an encapsulation thin film layer **36** (or an encapsulation cover plate). In addition, the OLED display device further includes cover glass **02**. The cover glass **02** is fitted with the display module **300** through an optical adhesive **03**.

[0067] On this basis, the fingerprint recognition device **01** is arranged on a side opposite to a light outgoing side of the display module **300**. In order to ensure that the light reflected by the finger can be irradiated onto the photosensitive element **12** of the fingerprint recognition device **01**, the display module **300** transmits light at a position corresponding to the photosensitive element **12**. Optionally, it is possible to set the wiring mode of a pixel circuit in the display backplane **32** in such a way that a data lead and electronic elements such as transistors or capacitors will not be distributed on the display backplane **32** at a position corresponding to the photosensitive element **12**. Or, it is also possible to form a via hole through the display backplane **32** at a position corresponding to the photosensitive element **12**, so that the light reflected by the finger can transmit through a position where no electronic element is provided or the via hole is formed and then irradiates into the photosensitive element **12**.

[0068] During the fingerprint recognition process, the top-emitting OLED display device emits display light on a side away from the fingerprint recognition device **01**. When the finger touches the cover glass **02**, the finger can reflect the display light. Although the finger cannot directly come into contact with the fingerprint recognition device **01** since the fingerprint recognition device **01** is arranged on a side opposite to the light outgoing side of the display module **300**, the photosensitive element **12** of the fingerprint recognition device **01** can enable the reflected light to be perpendicularly transmitted to the photoelectric conversion layer **120** in parallel after transmitting through the collimator filter layer **121**, so that the degree of scattering of the light reflected by the finger can be reduced. In this way, majority of the light reflected by the finger can still enter the fingerprint recognition device **01**, so that the efficiency and accuracy of fingerprint recognition can be ensured and the definition of acquired fingerprint images can be improved.

[0069] On this basis, the display module **300** includes a plurality of pixel units **13** which are crisscrossed with each other. Each pixel unit **13** among the plurality of pixel units includes at least three sub-pixels **130**, for example, a red sub-pixel, a blue sub-pixel and a green sub-pixel. Each pixel unit **13** corresponds to one recognition unit **10**. In this way, after the resolution of the OLED display device is improved, the Pixels Per Inch (PPI) of the OLED display device increases, and the number of the pixel units **13** also increases, so that the number of the recognition units **10** increases. Accordingly, the accuracy of fingerprint recognition can be improved.

[0070] Alternatively, in order to reduce the fabrication accuracy and cost, each recognition unit **10** may correspond to an integral number of pixel units **13**, for example, three pixel units **13** or four pixel units **13**.

[0071] The foregoing descriptions merely show specific implementations of the present disclosure, and the protection scope of the present disclosure is not limited thereto. Any person of skill in the art can readily conceive of variations or replacements within the technical scope disclosed by the embodiments of the present disclosure, and these variations or replacements shall fall into the protection scope of the present disclosure. Accordingly, the protection scope of the present disclosure shall be subject to the protection scope of the claims.

1. A fingerprint recognition device, comprising a plurality of recognition units alternately defined by a plurality of scanning lines and a plurality of signal reading lines which are crisscrossed with each other, wherein one of the plurality of recognition units is provided with a switching transistor and a photosensitive element, with a first electrode of the switching transistor being connected to a corresponding one of the plurality of signal reading lines defining this recognition unit and a gate of the switching transistor being connected to a corresponding one of the plurality of scanning lines defining this recognition unit; and

the photosensitive element comprises a photoelectric conversion layer and a collimator filter layer which are stacked successively, with the photoelectric conversion layer being connected to a second electrode of the switching transistor, the collimator filter layer being used for making incident light irradiate onto the photoelectric conversion layer in parallel, and the photoelectric conversion layer being used for performing photoelectric conversion on the incident light.

2. The fingerprint recognition device according to claim **1**, wherein the collimator filter layer and the photoelectric conversion layer are of an integral structure, and the collimator filter layer and the photoelectric conversion layer are made of the same material, i.e., black organic photoelectric material.

3. The fingerprint recognition device according to claim **1**, wherein the photosensitive element completely covers the switching transistor; and

an insulating layer is provided between the photoelectric conversion layer and the switching transistor, a via hole is formed on the insulating layer at a position corresponding to the second electrode of the switching transistor, and the photoelectric conversion layer is connected to the second electrode of the switching transistor through the via hole.

4. The fingerprint recognition device according to claim **1**, wherein the area of the photosensitive element is the same as the area of an opening of the recognition unit; and

the shape of the photosensitive element is the same as the shape of the opening of the recognition unit.

5. The fingerprint recognition device according to claim **1**, wherein the collimator filter layer comprises a plurality of light guide strips which are arranged at intervals in parallel, and the plurality of light guide strips are made of light shielding material; and

the photoelectric conversion layer is planar, and each of the plurality of light guide strips is perpendicular to the photoelectric conversion layer.

6. The fingerprint recognition device according to claim **5**, wherein the collimator filter layer further comprises light shielding strip(s) located on an upper surface of at least one of the plurality of light guide strips, and the light shielding strip(s) is used for blocking incidence of light onto the upper surface of this light guide strip; and

the upper surface of this light guide strip is a surface of the light guide strip on a side away from the photoelectric conversion layer.

7. The fingerprint recognition device according to claim **5**, wherein the collimator filter layer has a thickness of 1-5 μm, and the light guide strips each have a width of 0.8-1.2 μm.

8. The fingerprint recognition device according to claim **5**, wherein the photoelectric conversion layer has a thickness of 0.8-1.2 μm.

9. An OLED display device, comprising the fingerprint recognition device according to claim **1**.

10. The OLED display device according to claim **9**, wherein the fingerprint recognition device is arranged within a non-display region of the OLED display device.

11. The OLED display device according to claim **9**, wherein the OLED display device is of a top-emitting type and comprises a display module; and

the fingerprint recognition device is arranged within a display region of the OLED display device and located on a side opposite to a light outgoing side of the display module, wherein, the display module transmits light at a position corresponding to the photosensitive element.

12. The OLED display device according to claim **11**, wherein the display module comprises a plurality of pixel units which are crisscrossed with each other, and each of the plurality of pixel units comprises at least three sub-pixels; and

each of the plurality of pixel unit corresponds to one recognition unit.

* * * * *

patsnap

专利名称(译)	指纹识别设备和OLED显示设备		
公开(公告)号	US20190019850A1	公开(公告)日	2019-01-17
申请号	US15/754248	申请日	2017-09-15
[标]申请(专利权)人(译)	京东方科技集团股份有限公司		
申请(专利权)人(译)	京东方科技集团股份有限公司.		
当前申请(专利权)人(译)	京东方科技集团股份有限公司.		
[标]发明人	XU RUI WANG HAISHENG LIU YINGMING WANG PENGPENG CHENG CHIH JEN QIN YUNKE GUO YUZHEN LIU WEI		
发明人	XU, RUI WANG, HAISHENG LIU, YINGMING WANG, PENGPENG CHENG, CHIH-JEN QIN, YUNKE GUO, YUZHEN LIU, WEI		
IPC分类号	H01L27/32 G02B27/30 G06K9/00		
CPC分类号	H01L27/3225 H01L27/3211 G06K9/00006 G02B27/30 G06K9/0004 G06K9/0008 G06K9/00087 H01L27/307 H01L27/3234		
优先权	201710105957.6 2017-02-24 CN		
其他公开文献	US10622415		
外部链接	Espacenet USPTO		

摘要(译)

一种指纹识别装置和OLED显示装置，涉及显示技术领域，可以解决由于手指到指纹识别装置的距离大而导致识别精度低的问题。指纹识别装置包括由多条扫描线和信号读取线交替限定的识别单元，所述扫描线和信号读取线彼此交叉。每个识别单元设置有开关晶体管和光敏元件。光敏元件包括依次堆叠的光电转换层和准直滤光器层。准直滤光器层用于平行地将入射光照射到光电转换层上，并且光电转换层用于对入射光进行光电转换。