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Kuo et al.

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(54) **DISPLAY DEVICE HAVING A PLURALITY OF BANK STRUCTURES**

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H01L 25/07 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01L 25/167*** (2013.01); ***H01L 33/48*** (2013.01); ***H01L 33/502*** (2013.01); ***H01L 33/56*** (2013.01);
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(58) **Field of Classification Search**
CPC H01L 33/48; H01L 33/502; H01L 33/56; H01L 33/58; H01L 33/60;
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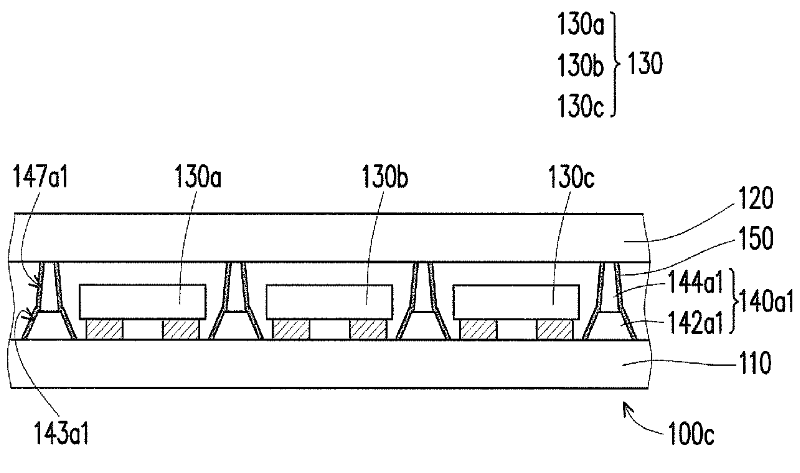
(57) **ABSTRACT**

The embodiment provides a display device including an array substrate, an opposite substrate, a plurality of micro light-emitting diodes and a plurality of bank structures. The opposite substrate is disposed opposite to the array substrate. The micro light-emitting diodes are arranged in an array on the array substrate, wherein the micro light-emitting diodes are electrically connected to the array substrate. The bank structures are located between the array substrate and the opposite substrate, wherein the bank structures form a plurality of accommodating regions, and one of the micro light-emitting diodes is located in one of the accommodating regions. A height of the bank structures is more than or equal to a height of the micro light-emitting diodes.

14 Claims, 11 Drawing Sheets



(51) **Int. Cl.**

H01L 25/13	(2006.01)
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H01L 33/48	(2010.01)
H01L 33/50	(2010.01)
H01L 33/56	(2010.01)
H01L 33/58	(2010.01)
H01L 33/60	(2010.01)
H01L 25/075	(2006.01)

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

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(58) **Field of Classification Search**

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See application file for complete search history.

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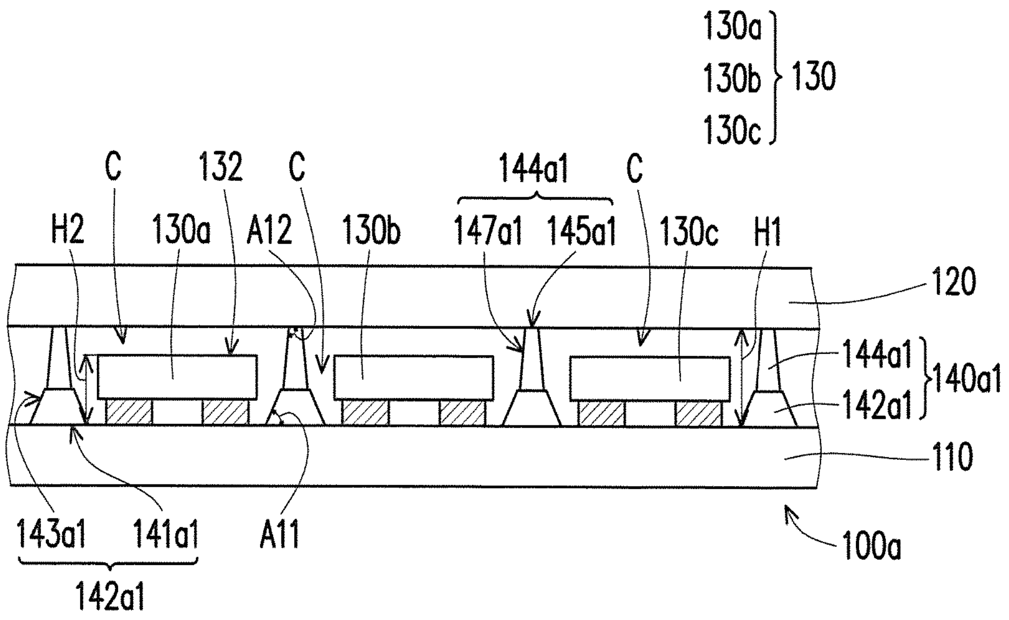
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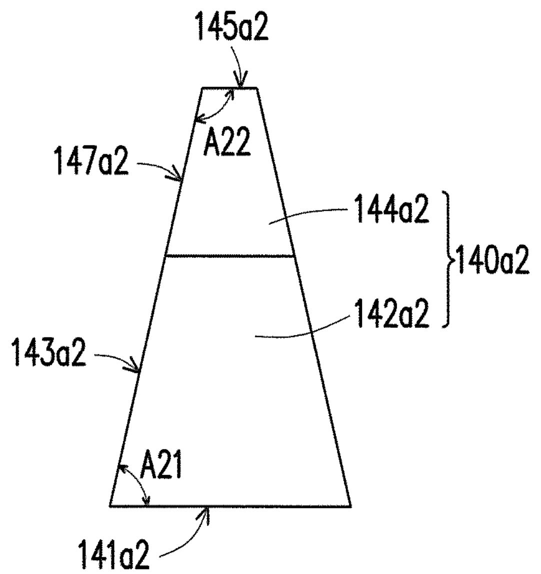
130b
130c
130
C
132
C
144a1
C
H2
130a
A12
130b
147a1
145a1
130c
H1
120
144a1
140a1
142a1
110
143a1
141a1
A11
142a1
100a

FIG. 1A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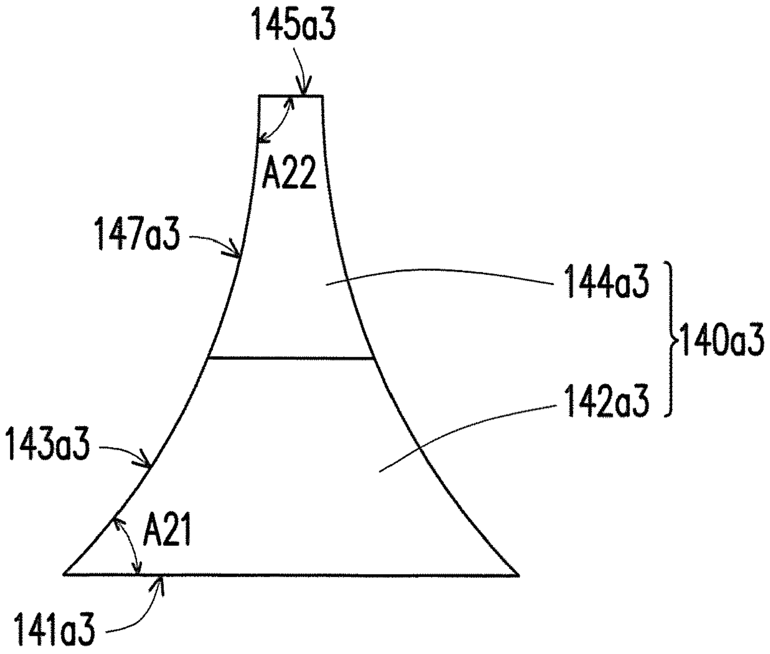
A22
147a2
144a2
140a2
142a2
143a2
A21
141a2

FIG. 1B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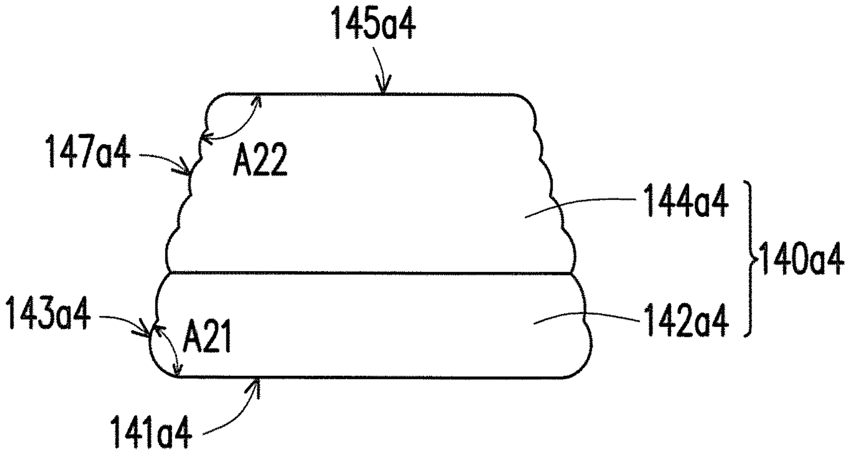
A22
147a3
144a3
140a3
142a3
143a3
A21
141a3

FIG. 1C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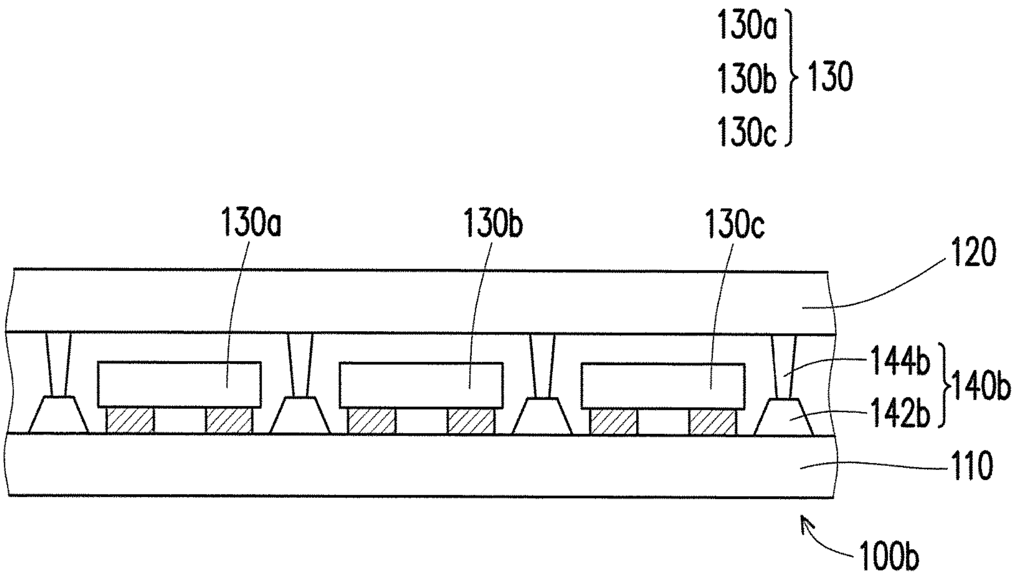
147a4
A22
144a4
140a4
143a4
A21
142a4
141a4

FIG. 1D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130b
130c
130
130a
130b
130c
120
144b
140b
142b
110
100b

FIG. 2

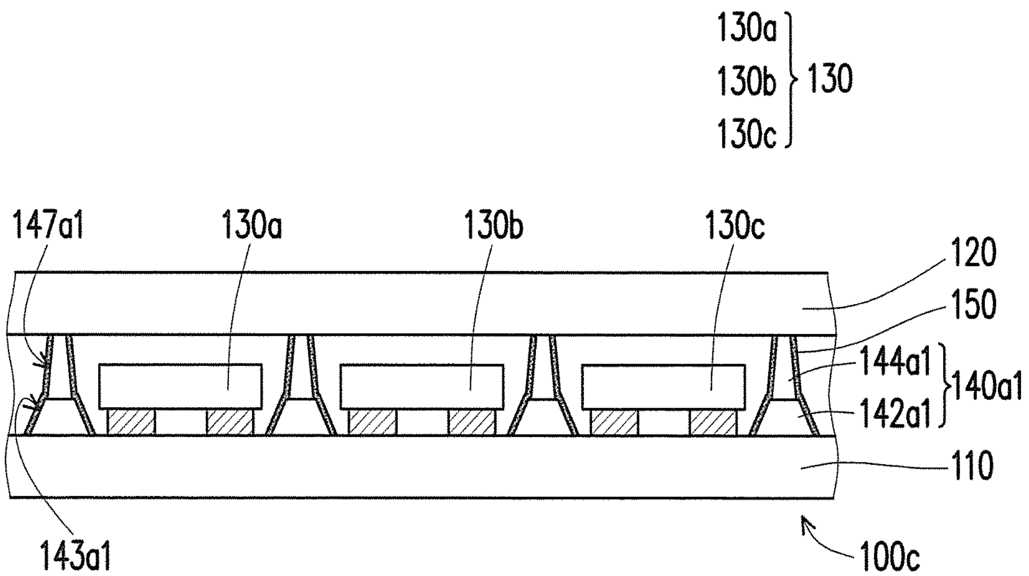

130a
130b
130c
130
147a1
130a
130b
130c
120
150
144a1
140a1
142a1
110
143a1
100c

FIG. 3

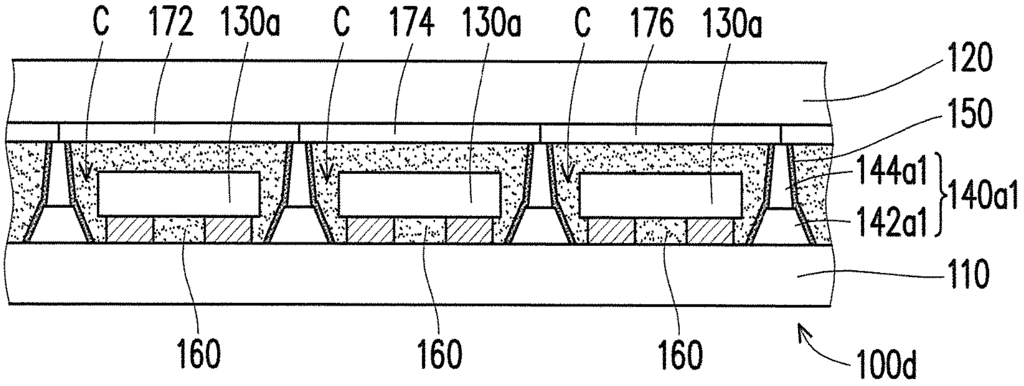

C
172
130a
C
174
130a
C
176
130a
120
150
144a1
140a1
142a1
110
160
160
160
100d

FIG. 4

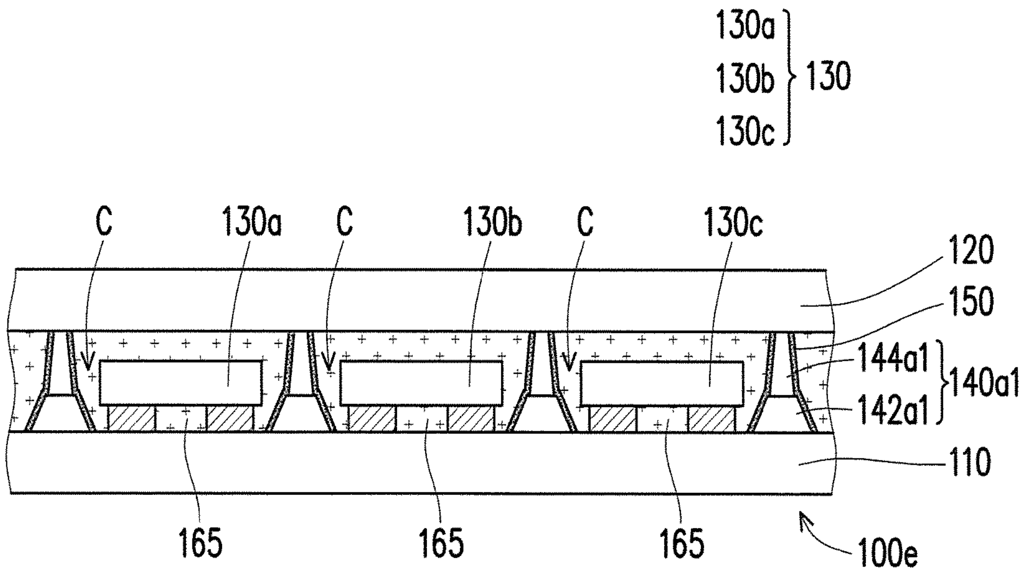

130a
130b
130c
130
C
130a
C
130b
C
130c
120
150
144a1
140a1
142a1
110
165
165
165
100e

FIG. 5

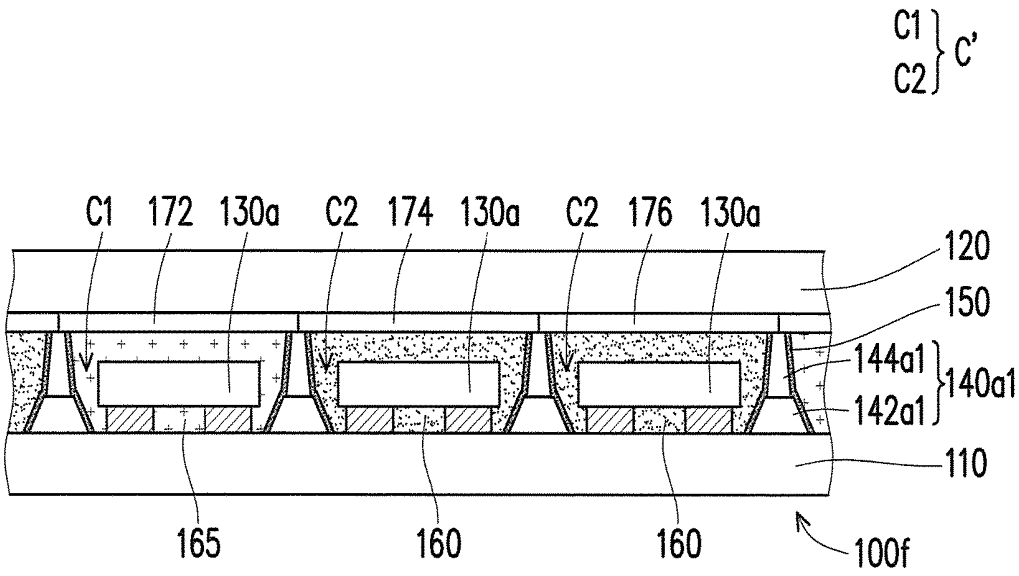

C1
C2
C'
C1
172
130a
C2
174
130a
C2
176
130a
120
150
144a1
140a1
142a1
110
165
160
160
100f

FIG. 6

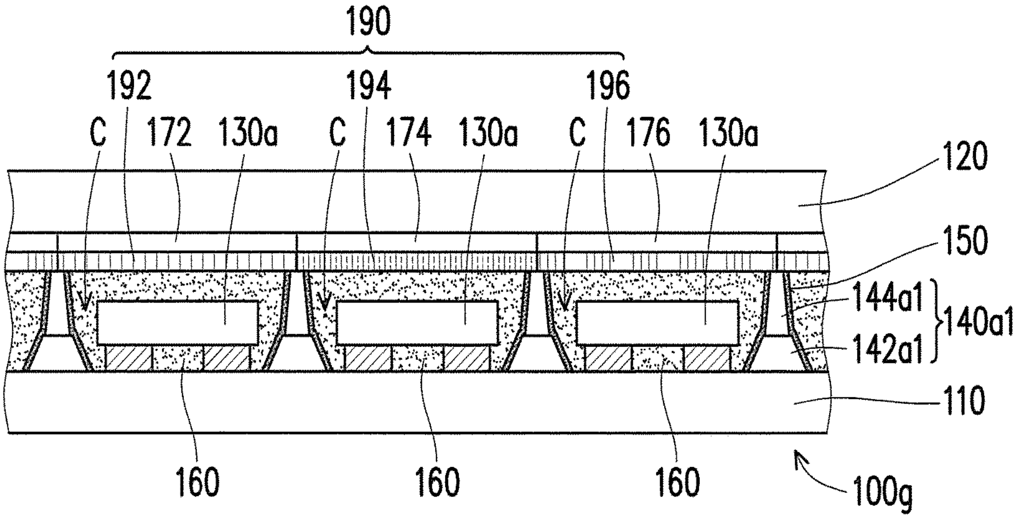
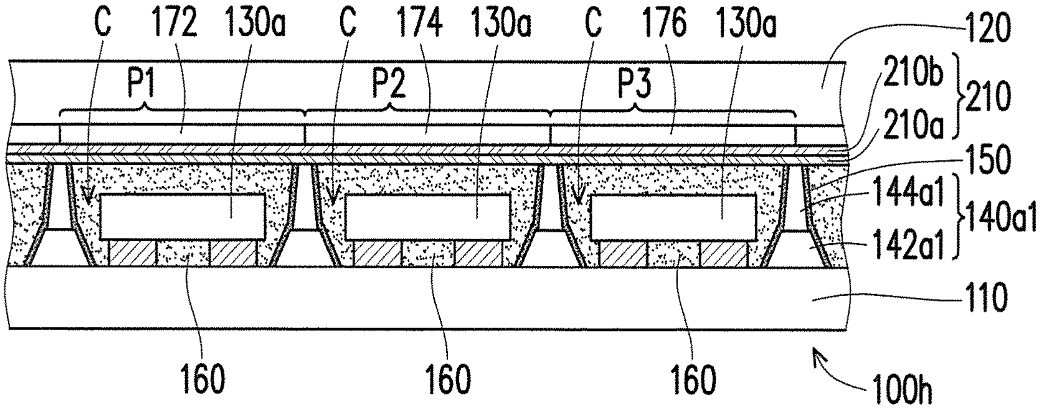
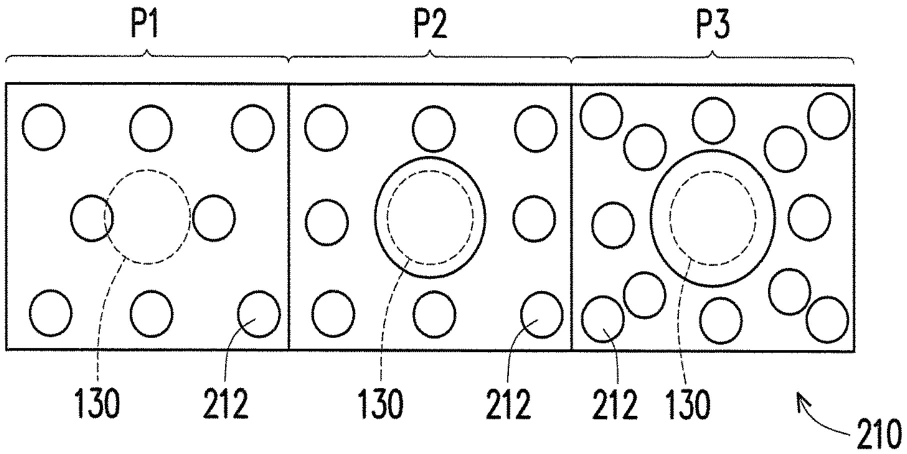

190
192
194
196
C
172
130a
C
174
130a
C
176
130a
120
150
144a1
140a1
142a1
110
160
160
160
100g

FIG. 7



C
172
130a
C
174
130a
C
176
130a
120
P1
P2
P3
210b
210
210a
150
144a1
140a1
142a1
110
160
160
160
100h

FIG. 8A



P1
P2
P3
130
212
130
212
212
130
210

FIG. 8B

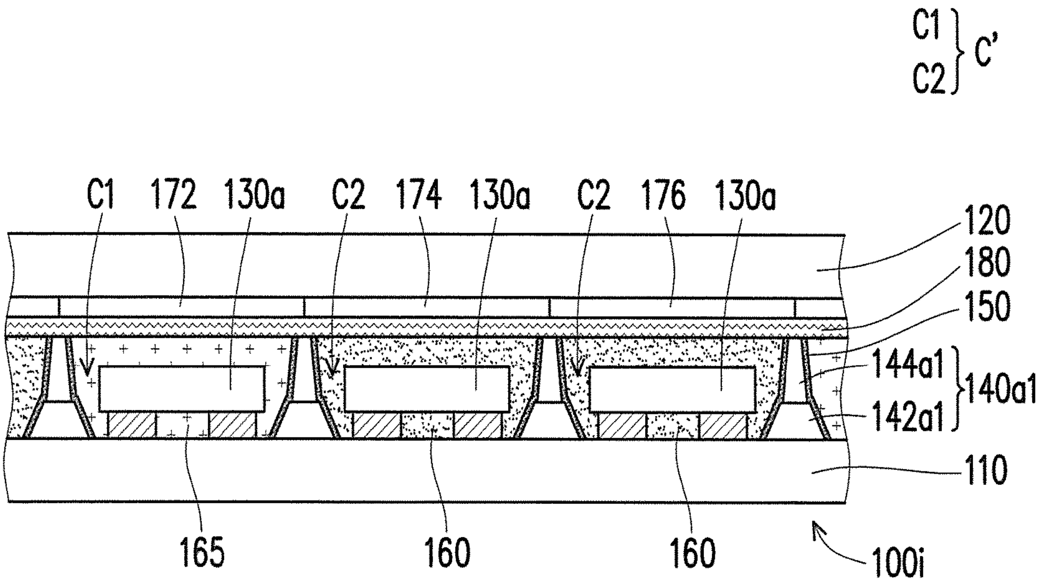

C1
C2
C'
C1
172
130a
C2
174
130a
C2
176
130a
120
180
150
144a1
140a1
142a1
110
165
160
160
100i

FIG. 9A

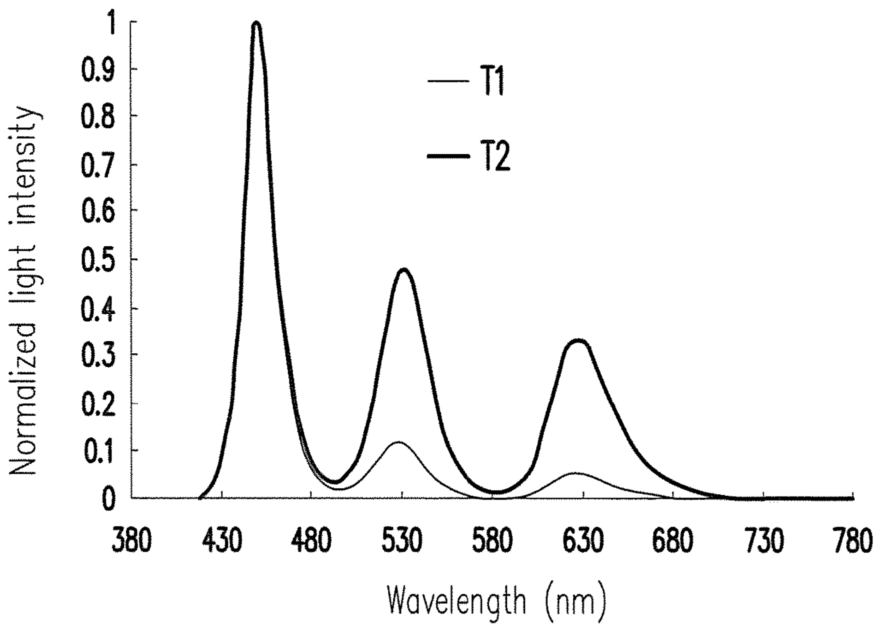

Normalized light intensity
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
T1
T2
380
430
480
530
580
630
680
730
780
Wavelength (nm)

FIG. 9B

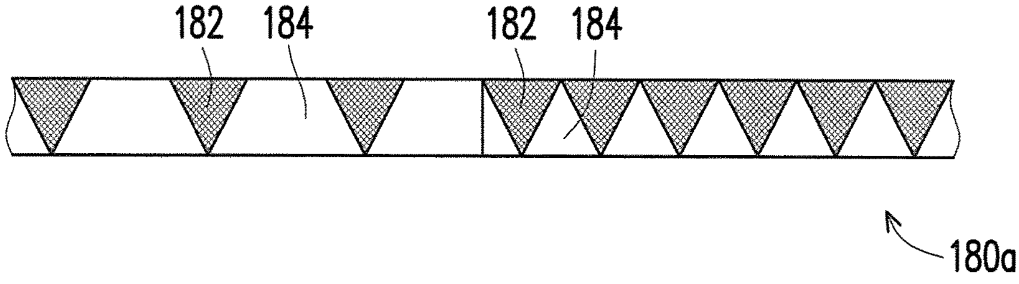


FIG. 9C

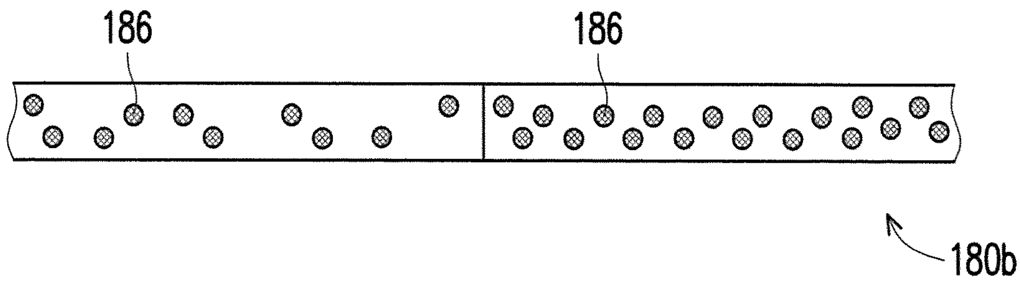


FIG. 9D

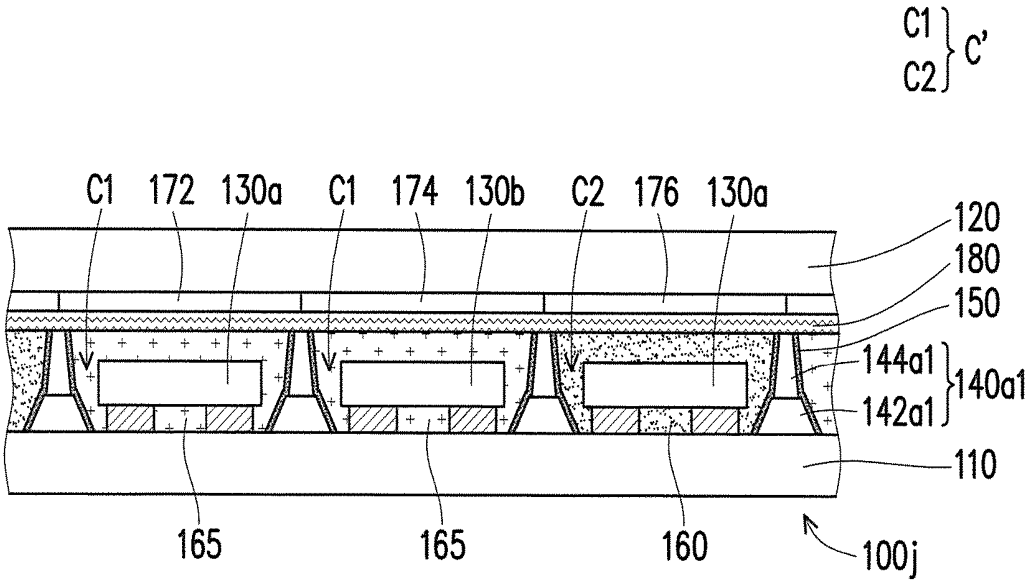

C1
C2
C'
C1
172
130a
C1
174
130b
C2
176
130a
120
180
150
144a1
140a1
142a1
110
165
165
160
100j

FIG. 10

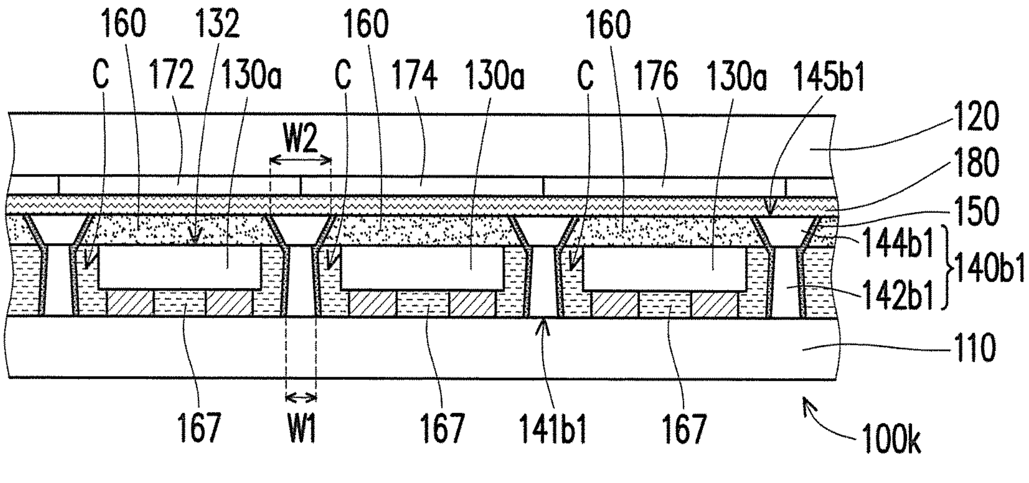

160
132
160
160
C
172
130a
C
174
130a
C
176
130a
145b1
W2
120
180
150
144b1
140b1
142b1
110
167
W1
167
141b1
167
100k

FIG. 11

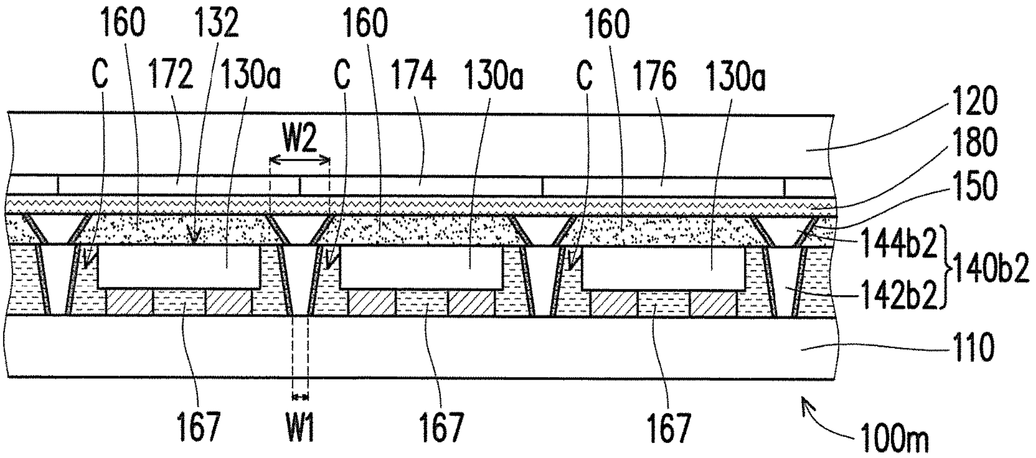

160
132
160
160
C
172
130a
C
174
130a
C
176
130a
W2
120
180
150
144b2
140b2
142b2
110
167
W1
167
167
100m

FIG. 12

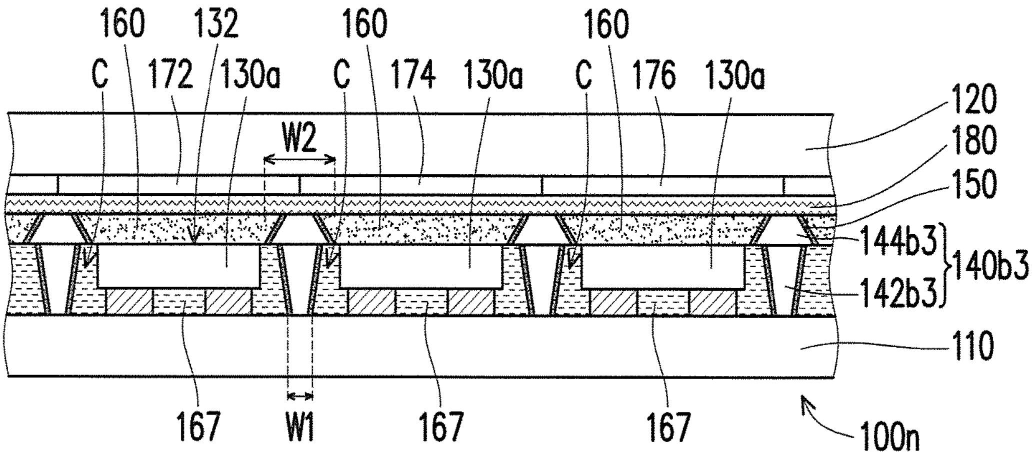
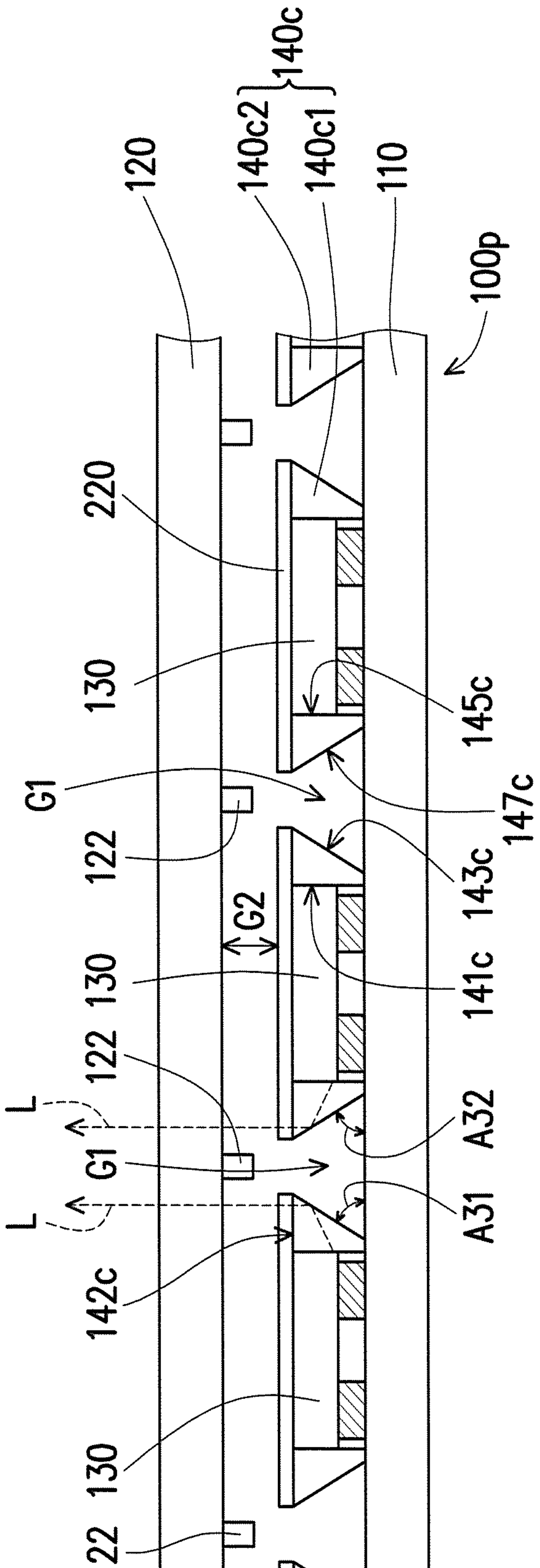

160
132
160
160
C
172
130a
C
174
130a
C
176
130a
W2
120
180
150
144b3
140b3
142b3
110
167
W1
167
167
100n

FIG. 13



120
140c2
140c1
140c
110
100p
220
130
145c
147c
G1
122
143c
G2
141c
130
122
L
G1
A32
L
A31
142c
130
122

FIG. 14

DISPLAY DEVICE HAVING A PLURALITY OF BANK STRUCTURES

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefits of U.S. provisional application Ser. No. 62/251,132, filed on Nov. 5, 2015 and China application serial no. 201610395404.4, filed on Jun. 6, 2016. The entirety of each of the above-mentioned patent applications is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Field of the Disclosure

The embodiment relates to a display device, and particularly relates to a light-emitting diode display device.

Description of Related Art

Since a light-emitting diode (LED) display device has advantages such as active light emitting, high brightness, high contrast, and low power consumption, and has a longer lifetime compared to an organic light-emitting diode (OLED) display device, it has become one of the technologies of new type displays to develop in recent years. Specifically, the light-emitting diode display device is mainly composed of a thin film transistor array substrate and light-emitting diodes arranged in an array. The optical performance of the light-emitting diode display device depends on the design of the light-emitting diodes and the optical structure design of the periphery of the light-emitting diodes. Since the light-emitting diode is a multi-surface light-emitting light source, lateral light of the light-emitting diode emitting onto the adjacent light-emitting diode is likely to result in an optical cross-talk phenomenon after the light-emitting diodes are closely arranged in an array, which may cause disadvantages, such as color mixing, halo, reduction of screen contrast or fuzziness. Also, it is possible to reduce color saturation of the light-emitting diode display device when including a wavelength converting material.

SUMMARY

The embodiment provides a display device which has a better optical display performance.

The display device of the embodiment includes an array substrate, a plurality of micro light-emitting diodes and a plurality of bank structures. The micro light-emitting diodes are arranged in an array on the array substrate. The bank structures are located on the array substrate, wherein the micro light-emitting diodes are electrically connected to the array substrate. The bank structures form a plurality of accommodating regions, and one of the micro light-emitting diodes is located in one of the accommodating regions. A height of one of the bank structures is more than or equal to a height of one of the micro light-emitting diodes.

The display device of the embodiment includes an array substrate, an opposite substrate, a plurality of micro light-emitting diodes and a plurality of bank structures. The opposite substrate is disposed opposite to the array substrate. The micro light-emitting diodes are arranged in an array on the array substrate. The bank structures are located between the array substrate and the opposite substrate. The micro light-emitting diodes are electrically connected to the array substrate. The bank structures form a plurality of accommodating regions, and one of the micro light-emitting diodes is located in one of the accommodating regions. A height of

one of the bank structures is more than or equal to a height of the one of the micro light-emitting diodes.

The display device of the embodiment includes an array substrate, an opposite substrate, a plurality of micro light-emitting diodes, a wavelength converting enhancement layer, a color filter layer and a plurality of bank structures. The opposite substrate is disposed opposite to the array substrate. The micro light-emitting diodes are arranged in an array on the array substrate. The wavelength converting enhancement layer is disposed above the opposite substrate. The color filter layer is disposed above the opposite substrate and has a plurality of color filter patterns. The bank structures are located between the array substrate and the opposite substrate. The micro light-emitting diodes are electrically connected to the array substrate. The bank structures form a plurality of accommodating regions, and one of the micro light-emitting diodes is located in one of the accommodating regions. A height of one of the bank structures is more than or equal to a height of the one of the micro light-emitting diodes.

Based on the above, since the display device of the embodiment has the design of the bank structures, the optical cross-talk phenomenon generated by the micro light-emitting diodes arranged in an array on the array substrate can be effectively reduced. Thereby, the optical display performance of the display device of the embodiment can be effectively improved.

In order to make the aforementioned features and advantages of the disclosure more comprehensible, embodiments accompanied with figures are described in detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the embodiments, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments and, together with the description, serve to explain the principles of the embodiments.

FIG. **1**A is a schematic cross-sectional view of a display device according to an embodiment.

FIG. **1**B is a schematic view of a bank structure of an embodiment of the display device of FIG. **1**A.

FIG. **1**C is a schematic view of a bank structure of another embodiment of the display device of FIG. **1**A.

FIG. **1**D is a schematic view of a bank structure of another embodiment of the display device of FIG. **1**A.

FIG. **2** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **3** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **4** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **5** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **6** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **7** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **8**A is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **8**B is a schematic top view of a patterned reflective layer of FIG. **8**A.

FIG. **9**A is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **9**B is a curve diagram illustrating a relationship between wavelength and normalized light intensity of the display device with the wavelength converting enhancement layer and without the wavelength enhancement converting layer of FIG. **9**A.

FIG. **9**C and FIG. **9**D are schematic views of the wavelength converting enhancement layers according to two different embodiments in FIG. **9**A.

FIG. **10** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **11** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **12** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **13** is a schematic cross-sectional view of a display device according to another embodiment.

FIG. **14** is a schematic cross-sectional view of a display device according to another embodiment.

DESCRIPTION OF THE EMBODIMENTS

In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

FIG. **1**A is a schematic cross-sectional view of a display device according to an embodiment. Referring to FIG. **1**A, in the embodiment, a display device **100***a* includes an array substrate **110**, an opposite substrate **120**, a plurality of micro light-emitting diodes **130** and a plurality of bank structures **140***a***1**. The array substrate **110** is a thin film transistor (TFT) array substrate, for example. In other words, a plurality of thin film transistors can be arranged on the array substrate **110**. The opposite substrate **120** is disposed opposite to the array substrate **110**. The micro light-emitting diodes **130** are arranged in an array on the array substrate **110**, wherein the micro light-emitting diodes **130** are electrically connected to the array substrate **110**. Specifically, the micro light-emitting diodes **130** are electrically connected to the thin film transistors on the array substrate **110**. The bank structures **140***a***1** are located between the array substrate **110** and the opposite substrate **120**, wherein the bank structures **140***a***1** form a plurality of accommodating regions C. In other words, the plurality of accommodating regions C can be separated by the adjacent bank structures **140***a***1**, and at least one of the micro light-emitting diodes **130** is located in at least one of the accommodating regions C. A height H1 of at least one of the bank structures **140***a***1** is more than a height H2 of at least one of the micro light-emitting diodes **130**, and a width of at least one of the bank structures **140***a***1** can be different. The height H2 of at least one of the micro light-emitting diodes **130** may be a distance between a top surface of the array substrate **110** and an upper surface **132** of at least one of the micro light-emitting diodes **130** as shown in FIG. **1**A.

Specifically, referring to FIG. **1**A, at least one of the micro light-emitting diodes **130** can be electrically connected to a source or a drain (not shown) of at least one of the thin film transistors (not shown) on the array substrate **110** by a conductive structure (not shown), and at least one of the micro light-emitting diodes **130** can be electrically connected to a common electrode (not shown) of the array substrate **110** by a conductive structure (not shown). Here, the micro light-emitting diodes **130** are flip-chip micro light-emitting diodes, for example, and the micro light-emitting diodes **130** specifically includes a blue light micro light-emitting diode **130***a*, a green light micro light-emitting diode **130***b*, and a red light micro light-emitting diode **130***c*. The size of the micro light-emitting diodes **130** from top view is between 1 micrometer and 1000 micrometers. In an embodiment, the size is between 1 micrometer and 100 micrometers. The shape of the micro light-emitting diodes **130** might be a rectangle, a circle or other shapes, and is not limited thereto. The size of the micro light-emitting diodes **130** from top view can be the longest distance within a profile of one of the micro light-emitting diodes **130**. The profile is defined by an outline of a projected image of one of the micro light-emitting diodes **130** from top view. The height H2 of at least one of the micro light-emitting diodes **130** is between 0.5 micrometers and 500 micrometers, for example. In an embodiment, the height H2 of at least one of the micro light-emitting diodes **130** is between 0.5 micrometers and 30 micrometers, for example. That is to say, the micro light-emitting diodes **130** of the embodiment can emit light with different colors specifically. However, in other embodiments, the micro light-emitting diodes **130** may also emit light with the same color, and is not limited thereto. The opposite substrate **120** may be a cover plate (e.g., transparent substrate) or a color filter substrate, for example. However, in other embodiments, the opposite substrate **120** may also be a thin film encapsulation or a protective layer with protective and supporting effects. The protective layer may be a planarization layer, which can be disposed on the array substrate **110** such that the surface of the array substrate **110** is planarized. For example, the protective layer may be disposed around the micro light-emitting diodes **130**, or may be disposed above a top surface of the micro light-emitting diodes **130**, or further cover on a top surface of the bank structure **140***a***1** away from the array substrate **110**. Disposing of the protective layer around the micro light-emitting diodes **130** might leave some space in at least one of the accommodating regions C, or the protective layer might filled in at least one of the accommodating regions C, and is not limited thereto. The protective layer may also prevent the invasion of moisture and oxygen. A material of the protective layer comprises a transparent photoresist, a transparent ultraviolet gel, etc., and is not limited thereto. The bank structures **140***a***1** of the embodiment are disposed above the array substrate **110**, and at least one of the bank structures **140***a***1** includes at least a first bank portion **142***a***1** and a second bank portion **144***a***1**, wherein the first bank portion **142***a***1** and the second bank portion **144***a***1** are connected to each other. The second bank portion **144***a***1** is stacked on the first bank portion **142***a***1**, and a width of at least one of the bank structures **140***a***1** gradually decreases from the first bank portion **142***a***1** to the second bank portion **144***a***1**. That is to say, the width of the bank structures **140***a***1** of the embodiment can be different, and gradually decreases from the array substrate **110** to the opposite substrate **120**. In other embodiments, the first bank portion **142***a***1** may be disposed above the array substrate **110**, and the second bank portion **144***a***1** may be disposed above the opposite substrate **120**. Alternatively, both the first bank portion **142***a***1** and the second bank portion **144***a***1** are disposed above the opposite substrate **120**, and is not limited thereto. When preparing the display device **100***a*, the micro light-emitting diodes **130**, the first bank portion **142***a***1**, and the second bank portion **144***a***1** might be formed on the array substrate **110** with no specific disposing order.

More specifically, as shown in FIG. **1**A, the first bank portion **142***a***1** has a first bottom surface **141***a***1** and a first side surface **143***a***1** connected to the first bottom surface **141***a***1**, and a first included angle A11 is formed between the first side surface **143**_a_**1** and the first bottom surface **141**_a_**1**. The first bottom surface **141**_a_**1** is a surface of the first bank portion **142**_a_**1** adjacent to the array substrate **110**. The second bank portion **144**_a_**1** has a second bottom surface **145**_a_**1** and a second side surface **147**_a_**1** connected to the second bottom surface **145**_a_**1**, the second bottom surface **145**_a_**1** is a surface of the second bank portion **144**_a_**1** away from the array substrate **110**, and a second included angle A**12** is formed between the second side surface **147**_a_**1** and the second bottom surface **145**_a_**1**. In an embodiment, the first included angle A**11** and the second included angle A**12** are between 30 degrees and 150 degrees but not equal to 90 degrees respectively, for example. As shown in FIG. **1**A, exterior contours of both the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1** are trapezoids, and the first included angle A**11** is different from the second included angle A**12**. For example, the first included angle A**11** is less than the second included angle A**12**. In other embodiments, referring to FIG. **1**B, a bank structure **140**_a_**2** includes at least a first bank portion **142**_a_**2** and a second bank portion **144**_a_**2**. The first bank portion **142**_a_**2** has a first bottom surface **141**_a_**2** and a first side surface **143**_a_**2** connected to the first bottom surface **141**_a_**2**, and a first included angle A**21** is formed between the first side surface **143**_a_**2** and the first bottom surface **141**_a_**2**. The second bank portion **144**_a_**2** has a second bottom surface **145**_a_**2** and a second side surface **147**_a_**2** connected to the second bottom surface **145**_a_**2**, and a second included angle A**22** is formed between the second side surface **147**_a_**2** and the second bottom surface **145**_a_**2**. In an embodiment, the first included angle A**21** may also be equal to the second included angle A**22**. In other embodiments, if the first bank portion **142**_a_**2** and the second bank portion **144**_a_**2** are formed by the same material, the bank structure **140**_a_**2** may also be an integrally formed structure (namely, there is no boundary between the first bank portion **142**_a_**2** and the second bank portion **144**_a_**2**). A height of at least one the bank structure **140**_a_**2** may be more than or equal to the height of at least one of the micro light-emitting diodes **130**, and is not limited thereto.

It should be noted that, the exterior contours of the bank structures **140**_a_**1** and **140**_a_**2** are not limited by the embodiment, even though the first bank portions **142**_a_**1**, **142**_a_**2** and the second bank portions **144**_a_**1**, **144**_a_**2** depicted here are all regular trapezoids and have the first side surfaces **143**_a_**1**, **143**_a_**2** and the second side surfaces **147**_a_**1**, **147**_a_**2** respectively. However, in other embodiments, referring to FIG. **1**C, a first bank portion **142**_a_**3** of a bank structure **140**_a_**3** has a first bottom surface **141**_a_**3** and a first curved surface **143**_a_**3** connected to the first bottom surface **141**_a_**3**, and a second bank portion **144**_a_**3** has a second bottom surface **145**_a_**3** and a second curved surface **147**_a_**3** connected to the second bottom surface **145**_a_**3**, wherein the first curved surface **143**_a_**3** and the second curved surface **147**_a_**3** are connected to each other. Alternatively, referring to FIG. **1**D, a first bank portion **142**_a_**4** of a bank structure **140**_a_**4** has a first bottom surface **141**_a_**4** and a first concave-convex surface **143**_a_**4** connected to the first bottom surface **141**_a_**4**, and a second bank portion **144**_a_**4** has a second bottom surface **145**_a_**4** and a second concave-convex surface **147**_a_**4** connected to the second bottom surface **145**_a_**4**, wherein the first concave-convex surface **143**_a_**4** and the second concave-convex surface **147**_a_**4** are connected to each other. In short, outer surfaces of the bank structures **140**_a_**1**, **140**_a_**2**, **140**_a_**3** and **140**_a_**4** may be an inclined surface, a curved surface (or arc surface) or an irregular surface, and is not limited thereto.

It should be mentioned that, as shown in FIG. **1**A, FIG. **1**B, FIG. **1**C and FIG. **1**D, the first side surfaces **143**_a_**1**, **143**_a_**2**, **143**_a_**3** and **143**_a_**4** and the second side surfaces **147**_a_**1**, **147**_a_**2**, **147**_a_**3** and **147**_a_**4** have the same contour specifically. For example, they are all flat surfaces, curved surfaces or concave-convex surfaces. However, in other embodiments not shown, the first side surfaces and the second side surfaces may have different contours respectively. For example, the first side surface is a flat surface while the second side surface is a curved surface, and is not limited thereto. Additionally, the first included angles A**11** and A**21** and the second included angles A**12** and A**22** are between 30 degrees and 150 degrees but not equal to 90 degrees respectively, for example. Also, the first included angles A**11**, A**21** and the second included angles A**12**, A**22** may be the same or different, and is not limited thereto.

Additionally, a material of the first bank portions **142**_a_**1**, **142**_a_**2**, **142**_a_**3** and **142**_a_**4** and the second bank portions **144**_a_**1**, **144**_a_**2**, **144**_a_**3** and **144**_a_**4** of the bank structures **140**_a_**1**, **140**_a_**2**, **140**_a_**3** and **140**_a_**4** may be the same or different, which can be comprised of any patternable gel material, wherein the material comprises, for example, a black photoresist, a white photoresist, a transparent material doped with a scattering material, a transparent material coated with a reflective film, or a photo spacer. For instance, referring to FIG. **1**A, if the first bank portion **142**_a_**1** comprises a black photoresist and the second bank portion **144**_a_**1** comprises a white photoresist, the first bank portion **142**_a_**1** can absorb the light with larger angle emitted from the micro light-emitting diodes **130** to the array substrate **110**, so as to prevent the light with larger angle from generating a specific angle reflection after reflecting from the array substrate **110**, thereby affecting visual effects. The second bank portions **144**_a_**1** can guide lights emitted from side walls of the micro light-emitting diodes **130** to be transmitted along a normal direction so as to improve the light-emitting efficiency of the micro light-emitting diodes **130** and adjust the light-emitting viewing angle of the micro light-emitting diodes **130**.

In short, since the display device **100**_a_ of the embodiment comprises the bank structures **140**_a_**1**, the optical cross-talk phenomenon generated by the micro light-emitting diodes **130** arranged in an array on the array substrate **110** can be effectively reduced. Thereby, the optical display performance of the display device **100**_a_ of the embodiment can be effectively improved. Additionally, the bank structures **140**_a_**1** are composed of the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1** connected to each other, and thus the material of the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1**, the angle design of the first included angle A**11** and the second included angle A**12** and the position where the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1** disposed can be chosen by users according to their needs. For example, the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1** are both disposed above the array substrate **110** or the opposite substrate **120**. Alternatively, at least one of the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1** is disposed above the array substrate **110**, and at least another one of the first bank portion **142**_a_**1** and the second bank portion **144**_a_**1** is disposed above the opposite substrate **120**. In other words, the bank structures **140**_a_**1** of the embodiment has a wider flexibility of the design, and the micro light-emitting diodes **130** may have better light-emitting efficiency by the design of the bank structures **140**_a_**1**, such that the display device **100**_a_ of the embodiment has a better optical display performance.

It should be noted that, the component notations and partial details of the structures hereinafter provided in the embodiments can be the same as or similar to the previous embodiment, wherein the same notations represent the same or similar components while the repeated same details are omitted, which can refer to the previous embodiment.

FIG. **2** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **2**, a display device **100***b* of the embodiment is similar to the display device **100***a* of FIG. **1**A, and the difference therebetween is that, at least one of bank structures **140***b* of the embodiment includes at least a first bank portion **142***b* and a second bank portion **144***b*, wherein the first bank portion **142***b* is disposed above the array substrate **110**, and the second bank portion **144***b* is disposed above the opposite substrate **120**. The first bank portion **142***b* and the second bank portion **144***b* are connected to each other. A width of the first bank portion **142***b* gradually decreases from the array substrate **110** to the opposite substrate **120**, and a width of the second bank portion **144***b* gradually decreases from the opposite substrate **120** to the array substrate **110**. Also, after the combination of the array substrate **110** and the opposite substrate **120**, the first bank portion **142***b* is connected to the second bank portion **144***b*. Thus, the optical cross-talk phenomenon generated by the micro light-emitting diodes **130** can be significantly reduced, so as to effectively improve the optical display performance of the display device **100***b* of the embodiment.

FIG. **3** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **3**, a display device **100***c* of the embodiment is similar to the display device **100***a* of FIG. **1**A, and the difference therebetween is that, the display device **100***c* of the embodiment further includes an optical coating layer **150** disposed above an outer surface of at least one of the bank structures **140***a***1**. As shown in FIG. **3**, the optical coating layer **150** covers the first side surface **143***a***1** of the first bank portion **142***a***1** and the second side surface **147***a***1** of the second bank portion **144***a***1**. If the optical coating layer **150** comprises a reflective material (e.g., silver, aluminum or chromium, and is not limited thereto), the light-emitting efficiency of the micro light-emitting diodes **130** can be effectively increased. However, if the optical coating layer **150** comprises a light absorbing material (e.g., chromium, chromium nitride, chromium oxide, aluminum alloy or aluminum nitride, and is not limited thereto), stray light can be effectively reduced. In other embodiments, the optical coating layer **150** may also cover on a portion of the outer surface of at least one of the bank structures **140***a***1**, and is not limited thereto.

FIG. **4** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **4**, a display device **100***d* of the embodiment is similar to the display device **100***c* of FIG. **3**, and the difference therebetween is that, the micro light-emitting diodes of the embodiment can emit light with the same color, such as blue light micro light-emitting diodes **130***a*. Furthermore, the display device **100***d* of the embodiment further includes a wavelength converting material **160** and a plurality of color filter patterns **172**, **174** and **176**. The wavelength converting material **160** is disposed in at least one of the accommodating regions C, and covers at least the blue light micro light-emitting diodes **130***a*, wherein the wavelength converting material **160** comprises phosphors or quantum dots (QD), for example. Specifically, the wavelength converting material **160** might be composed of the phosphors or the quantum dots dispersed in a matrix, or the wavelength converting material **160** might be composed of only the phosphors or the quantum dots without a matrix, and is not limited thereto. The phosphors may be yellow phosphors, a mixture of green phosphors and red phosphors, or a green phosphor layer stacked with a red phosphor layer, and is not limited thereto. The quantum dots may be yellow quantum dots, a mixture of green quantum dots and red quantum dots, or a green quantum dot layer stacked with a red quantum dot layer, and is not limited thereto. The color filter patterns **172**, **174** and **176** are disposed above the opposite substrate **120** and have at least two different colors, such as blue, green or red, wherein at least one of the color filter patterns **172**, **174** and **176** may also be transparent, and is not limited thereto. That is to say, the display device **100***d* of the embodiment is the use of the blue light micro light-emitting diodes **130***a* with the blue color filter pattern **172**, the green color filter pattern **174** and the red color filter pattern **176** to achieve full-color display effects. The blue color filter pattern **172** of the embodiment may be a color filter pattern which exhibits blue color, or may be a transparent material. Additionally, since the optical coating layer **150** (herein, a reflective material) covering the outer surface of the bank structures **140***a***1** can increase the light path of blue light emitted from the blue light micro light-emitting diodes **130***a* in the wavelength converting material **160**, the conversion efficiency of blue light can be increased. Also, the combination of the optical coating layer **150** and the wavelength converting material **160** can prevent lateral light of the blue light micro light-emitting diodes **130***a* from absorbing to reduce an amount of emitted-light of the blue light micro light-emitting diodes **130***a*. In short, the display device **100***d* of the embodiment may have a better optical display performance.

FIG. **5** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **5**, a display device **100***e* of the embodiment is similar to the display device **100***c* of FIG. **3**, and the difference therebetween is that, the display device **100***e* of the embodiment further includes a scattering material **165** disposed in at least one of the accommodating regions C and covering at least the micro light-emitting diodes **130**. Here, the scattering material **165** comprises titanium dioxide, for example, and the purpose thereof is to adjust the light shape (light-emitting angle) of the micro light-emitting diodes **130**, or to increase the light-emitting angle of the micro light-emitting diodes **130**.

FIG. **6** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **6**, a display device **100***f* of the embodiment is similar to the display device **100***c* of FIG. **3**, and the difference therebetween is that, the micro light-emitting diodes of the embodiment can emit light with the same color, such as the blue light micro light-emitting diodes **130***a*. Furthermore, accommodating regions C' of the embodiment include a plurality of first accommodating regions C**1** and a plurality of second accommodating regions C**2**. The display device **100***f* further includes the plurality of color filter patterns **172**, **174** and **176**, the scattering material **165** and the wavelength converting material **160**. The color filter patterns **172**, **174** and **176** are disposed above the opposite substrate **120** and have at least two different colors, such as blue, green or red. It may also be transparent. For instance, the color filter pattern **172** of the embodiment may be a color filter pattern which exhibits blue color, or may be a transparent material. The scattering material **165** is disposed in the first accommodating regions C**1**, and the wavelength converting material **160** is disposed in the second accommodating regions C**2**, wherein the scattering material **165** and the wavelength converting material **160** cover the blue light micro light-emitting diodes **130***a*. Here, the purpose of the scattering material **165** is to adjust the light shape (light-emitting angle) of the blue light micro light-emitting diodes **130***a*, or to increase the light-emitting angle of the blue light micro light-emitting diodes **130***a*. The wavelength converting material **160** comprises phosphors or quantum dots, for example. Blue light emitted from the blue light micro light-emitting diodes **130***a* may enable the display device **100***f* to have a high color saturation performance by the wavelength converting material **160** and the color filter patterns **174** and **176** with different colors (e.g., green and red).

FIG. **7** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **7**, a display device **100***g* of the embodiment is similar to the display device **100***d* of FIG. **4**, and the difference therebetween is that, the display device **100***g* of the embodiment further includes a filter pattern layer **190** disposed above the opposite substrate **120** and having a plurality of filter patterns **192**, **194** and **196**, wherein the filter patterns **192**, **194** and **196** are disposed corresponding to the color filter patterns **172**, **174** and **176** respectively. Specifically, the filter pattern **192** is disposed between the blue color filter pattern **172** and the blue light micro light-emitting diodes **130***a*, the filter pattern **194** is disposed between the green color filter pattern **174** and the blue light micro light-emitting diodes **130***a*, and the filter pattern **196** is disposed between the red color filter pattern **176** and the blue light micro light-emitting diodes **130***a*. The color filter pattern **172** is disposed between the filter pattern **192** and the opposite substrate **120**, the color filter pattern **174** is disposed between the filter pattern **194** and the opposite substrate **120**, and the color filter pattern **176** is disposed between the filter pattern **196** and the opposite substrate **120**. The filter patterns of the embodiment may be band pass filters. Specifically, the filter patterns **192**, **194** and **196** allow light in a specific wavelength range to pass, and light in other non-specific wavelength range will be reflected. For instance, the filter pattern **192** allows blue light to penetrate, the filter pattern **194** allows green light to penetrate, and the filter pattern **196** allows red light to penetrate. When light in a specific wavelength range passes the filter patterns **192**, **194** and **196**, and light in non-specific wavelength range is reflected back to the wavelength converting material **160**, reflected light will excite the wavelength converting material **160** again such that excitation light will pass the filter patterns **192**, **194** and **196** again. Thereby, light conversion ratio of the blue light micro light-emitting diodes **130***a* can be improved, and the required thickness of the wavelength converting material **160** can be reduced. In other embodiments, the filter patterns **192**, **194** and **196** may also be high pass filters or low pass filters, and is not limited thereto.

FIG. **8**A is a schematic cross-sectional view of a display device according to another embodiment. FIG. **8**B is a schematic top view of a patterned reflective layer of FIG. **8**A. Referring to FIG. **8**A and FIG. **8**B at the same time, a display device **100***h* of the embodiment is similar to the display device **100***d* of FIG. **4**, and the difference therebetween is that, the display device **100***h* of the embodiment further includes a patterned reflective layer **210** disposed above the opposite substrate **120** and having a plurality of reflective patterns **212**, wherein the color filter patterns **172**, **174** and **176** are located between the patterned reflective layer **210** and the opposite substrate **120**. A distribution density of the reflective patterns **212** changes with the color filter patterns **172**, **174** and **176** corresponding to different colors. More specifically, the blue color filter pattern **172**, the green color filter pattern **174** and the red color filter pattern **176** are located in a first sub-pixel region **P1**, a second sub-pixel region **P2** and a third sub-pixel region **P3** respectively. The reflective patterns **212** reflect the blue light emitted from the blue light micro light-emitting diodes **130***a* back to the at least one of the accommodating regions C, and the blue light will further be reflected towards the patterned reflective layer **210**. Regions around the reflective patterns **212** allow the blue light emitted from the blue light micro light-emitting diodes **130***a* to pass through the patterned reflective layer **210**. The distribution density of the reflective pattern **212** located in the third sub-pixel region **P3** is more than the distribution density of the reflective pattern **212** located in the second sub-pixel region **P2**, and the distribution density of the reflective pattern **212** located in the second sub-pixel region **P2** is more than the distribution density of the reflective pattern **212** located in the first sub-pixel region **P1**. That is to say, the distribution density of the reflective pattern **212** gradually increases from the blue color filter pattern **172** to the green color filter pattern **174** and the red color filter pattern **176**. That is, blue light emitted from the blue light micro light-emitting diodes **130***a* has different light paths in different sub-pixel regions by the distribution density of the reflective pattern **212**, thereby improving the optical display performance of the display device **100***h*.

Additionally, referring to FIG. **8**A, the patterned reflective layer **210** of the embodiment specifically includes a first patterned reflective layer **210***a* and a second patterned reflective layer **210***b*. The second patterned reflective layer **210***b* is located between the first patterned reflective layer **210***a* and the color filter patterns **172**, **174** and **176**. A material of the first patterned reflective layer **210***a* comprises a metal material having a reflectivity more than 70%, such as silver, aluminum or chromium, and a material of the second patterned reflective layer **210***b* comprises a light absorbing material, such as chromium oxide, chromium nitride, aluminum oxide or aluminum nitride, and is not limited thereto. That is to say, the patterned reflective layer **210** of the embodiment is composed of a structural layer stacked by a plurality of layers. However, in other embodiments not shown, the patterned reflective layer may also be a single-layer structural layer, and the material thereof comprises, for example, a high reflectivity material of silver layers or aluminum layers, which is still within the scope of the embodiment. Here, the purpose of the first patterned reflective layer **210***a* is to enable the blue light micro light-emitting diodes **130***a* to be reflected so as to excite the wavelength converting material **160** again, and the purpose of the second patterned reflective layer **210***b* is to prevent the first patterned reflective layer **210***a* from irradiating by external light directly which may cause a reduction of contrast.

FIG. **9**A is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **9**A, a display device **100***i* of the embodiment is similar to the display device **100***f* of FIG. **6**, and the difference therebetween is that, the display device **100***i* of the embodiment further includes a wavelength converting enhancement layer **180** disposed between the color filter patterns **174** and **176** and the wavelength converting material **160**, and between the color filter pattern **172** and the scattering material **165**, which can effectively improve light conversion ratio of light emitted from the blue light micro light-emitting diodes **130***a*.

FIG. **9**B is a curve diagram illustrating a relationship between wavelength and normalized light intensity of the display device with the wavelength converting enhancement layer **180** and without the wavelength enhancement converting layer **180** of FIG. **9**A. The curve T1 represents the display device not provided with the wavelength converting enhancement layer **180**; while the curve T2 represents the display device **100***i* provided with the wavelength converting enhancement layer **180**. The curve T1 and the curve T2 is a compared spectrogram which have been normalized with blue light peak (wavelength of about 430 nm to 480 nm). As shown in FIG. **9**B, the display device **100***i* with the wavelength converting enhancement layer **180** can effectively improve the light conversion efficiency of light emitted from the blue light micro light-emitting diodes **130***a* compared with the display device provided without the wavelength converting enhancement layer **180**.

It should be noted that, the wavelength converting enhancement layer **180** of the embodiment may be the filter pattern layer **190** in FIG. **7** or the patterned reflective layer **210** in FIG. **8**A and FIG. **8**B, for example. Definitely, the wavelength converting enhancement layer **180** of the embodiment may also be a microstructural layer **180***a* comprised of a plurality of high reflectivity patterns **182** and a plurality of low reflectivity patterns **184** in FIG. **9**C, wherein the light reflection path of the corresponding region can be changed by the setting density of the high reflectivity patterns **182** and the low reflectivity patterns **184**. Specifically, since the high reflectivity patterns **182** is more likely to reflect light than the low reflectivity patterns **184** in the microstructural layer **180***a*. The microstructural layer **180***a* is similar to the patterned reflective layer **210** in FIG. **8**A, which can enable light emitted from the micro light-emitting diode to have different light paths in different sub-pixel regions by the distribution density of the high reflectivity patterns **182**, thereby improving the optical display performance of the display device. Alternatively, the wavelength converting enhancement layer **180** of the embodiment may also be a microstructural layer **180***b* doped with scattering particles **186** in FIG. **9**D, wherein the light reflection path of the corresponding region can be changed by the distribution density of the scattering particles **186**. Specifically, light will be scattered when meets the scattering particles **186**, and thus the microstructural layer **180***b* enables light emitted from the micro light-emitting diode to have different light paths in different sub-pixel regions by the distribution density of the scattering particles **186**, thereby improving the optical display performance of the display device, wherein the scattering particles **186** comprise titanium dioxide, for example.

FIG. **10** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **10**, a display device **100***j* of the embodiment is similar to the display device **100***i* of FIG. **9**A, and the difference therebetween is that, the micro light-emitting diodes of the embodiment can emit light with different colors specifically, such as the blue light micro light-emitting diodes **130***a* and the green light micro light-emitting diodes **130***b*, wherein the green light micro light-emitting diodes **130***b* are located between the blue light micro light-emitting diodes **130***a*. As shown in FIG. **10**, the second accommodating regions C2 corresponding to the red color filter pattern **176** are disposed with the wavelength converting material **160**, while the first accommodating regions C1 corresponding to the blue color filter pattern **172** and corresponding to the green color filter pattern **174** are disposed with the scattering material **165**. In the embodiment, the color filter pattern **172** corresponding to blue and the color filter pattern **174** corresponding to green may be color filter patterns having color (e.g., blue and green), and may also be a transparent material.

FIG. **11** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **11**, a display device **100***k* of the embodiment is similar to the display device **100***b* of FIG. **2**, and the difference therebetween is that, the micro light-emitting diodes of the embodiment can emit light with the same color specifically, such as the blue light micro light-emitting diodes **130***a*. A first bank portion **142***b***1** disposed above the array substrate **110** of the embodiment has a first bottom surface **141***b***1** relatively far away from the opposite substrate **120**, and a second bank portion **144***b***1** disposed above the opposite substrate **120** has a second bottom surface **145***b***1** relatively far away from the array substrate **110**, wherein a width W1 of the first bottom surface **141***b* is less than a width W2 of the second bottom surface **145***b***1**, and is not limited thereto. In other embodiments not shown, the width W1 of the first bottom surface **141***b***1** may also be more than or equal to the width W2 of the second bottom surface **145***b***1**. As shown in FIG. **11**, a width of the first bank portion **142***b***1** gradually decreases from the array substrate **110** to the opposite substrate **120**, and a width of the second bank portion **144***b***1** gradually decreases from the opposite substrate **120** to the array substrate **110**. Thus, a necking portion is formed at the junction of the first bank portion **142***b***1** and the second bank portion **144***b***1**. In other embodiment, a discontinuous interface is formed at the necking portion of the first bank portion **142***b***1** and the second bank portion **144***b***1**, and is not limited thereto.

Furthermore, the display device **100***k* of the embodiment further includes a filler material **167**, the wavelength converting material **160**, the plurality of color filter patterns **172**, **174** and **176** and the wavelength converting enhancement layer **180**. The filler material **167** is disposed in at least one of the accommodating regions C around at least one of the blue light micro light-emitting diodes **130***a*, and exposing an upper surface **132** of at least one of the blue light micro light-emitting diodes **130***a* relatively far away from the array substrate **110**. The wavelength converting material **160** is disposed in at least one of the accommodating regions C, and covers at least the filler material **167** and the upper surface **132** of at least one of the blue light micro light-emitting diodes **130***a*. The color filter patterns **172**, **174** and **176** are disposed above the opposite substrate **120** and have at least two different colors, such as blue light, green light or red light. It may also be transparent. The wavelength converting enhancement layer **180** is disposed between the color filter patterns **172**, **174** and **176** and the wavelength converting material **160**. Here, the wavelength converting enhancement layer **180** is the filter pattern layer **190** in FIG. **7**, the patterned reflective layer **210** in FIG. **8**A and FIG. **8**B, the microstructural layer **180***a* in FIG. **9**C, or the microstructural layer **180***b* in FIG. **9**D. A material of the wavelength converting enhancement layer **180** comprises titanium dioxide or silicon dioxide, for example, and is not limited thereto.

Since bank structures **140***b***1** of the embodiment are composed of the first bank portion **142***b***1** and the second bank portion **144***b***1**, wherein the design of the necking is formed between the first bank portion **142***b***1** and the second bank portion **144***b***1**, re-reflection probability of light emitted from the blue light micro light-emitting diodes **130***a* can be effectively increased, thereby effectively improving the optical display performance of the overall display device **100***k*.

Additionally, the filler material **167** of the embodiment is a scattering material or a light absorbing material, for example, and the purpose thereof is to protect the surroundings of the blue light micro light-emitting diodes **130***a*. The wavelength converting material **160** is phosphors or quantum dots, for example.

FIG. **12** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **12**, a display device **100***m* of the embodiment is similar to the display device **100***k* of FIG. **11**, and the difference therebetween is that, a width of a first bank portion **142***b***2** of bank structures **140***b***2** of the embodiment gradually increases from the array substrate **110** to the opposite substrate **120**, and a width of a second bank portion **144***b***2** gradually decreases from the opposite substrate **120** to the array substrate **110**. Thus, a discontinuous interface is formed at the junction of the first bank portion **142***b***2** and the second bank portion **144***b***2**.

FIG. **13** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **13**, a display device **100***n* of the embodiment is similar to the display device **100***k* of FIG. **11**, and the difference therebetween is that, a width of a first bank portion **142***b***3** of bank structures **140***b***3** of the embodiment gradually increases from the array substrate **110** to the opposite substrate **120**, and a width of a second bank portion **144***b***3** gradually increases from the opposite substrate **120** to the array substrate **110**. Thus, a discontinuous interface is formed at the junction of the first bank portion **142***b***3** and the second bank portion **144***b***3**.

It should be mentioned that, although the optical coating layer **150** is depicted in the embodiments of FIG. **3** to FIG. **13**, the display device may not have the optical coating layer in other embodiments not shown. That is to say, the optical coating layer is a selective element layer, not an essential element layer.

FIG. **14** is a schematic cross-sectional view of a display device according to another embodiment. Referring to FIG. **14**, a display device **100***p* of the embodiment is similar to the display device **100***a* of FIG. **1**A, and the difference therebetween is that, at least one of bank structures **140***c* includes a first bank structure **140***c***1** and a second bank structure **140***c***2**. The first bank structure **140***c***1** and the second bank structure **140***c***2** are disposed above the array substrate **110**, and the first bank structure **140***c***1** and the second bank structure **140***c***2** have a first air gap G**1** therebetween. Furthermore, the bank structures **140***c* and the opposite substrate **120** have a second air gap G**2** therebetween. The opposite substrate **120** includes a plurality of light absorbing patterns **122**, and the light absorbing patterns **122** are located in the second air gap G**2**.

Specifically, the first bank structure **140***c***1** has a first flat surface **141***c* and a first inclined surface **143***c* opposite to each other. The second bank structure **140***c***2** has a second flat surface **145***c* and a second inclined surface **147***c* opposite to each other. The first inclined surface **143***c* faces the second inclined surface **147***c*. The first bank structure **140***c***1** and the second bank structure **140***c***2** have the first air gap G**1** therebetween, and at least one of the light absorbing patterns **122** is disposed corresponding to at least one the first air gap G**1**. A width of the first bank structure **140***c***1** and a width of the second bank structure **140***c***2** gradually increase from the array substrate **110** to the opposite substrate **120**. More specifically, the first inclined surface **143***c* and the array substrate **110** have a first included angle A**31** therebetween, and the second inclined surface **147***c* and the array substrate **110** have a second included angle A**32** therebetween. It should be noted that, the included angle A**31** and the included angle A**32** represent the angles outside the first bank structures **140***c***1** as shown in FIG. **14**. The first included angle A**31** is equal to the second included angle A**32**. In an embodiment, the first included angle is more than or equal to 30 degrees and less than 90 degrees. In other embodiments, the first included angle A**31** may not be equal to the second included angle A**32**, and is not limited thereto.

Additionally, the display device **100***p* of the embodiment further includes a protective layer **220** disposed above the micro light-emitting diodes **130** and a top surface **142***c* of the bank structures **140***c* relatively far away from the array substrate **110**, which can effectively protect the micro light-emitting diodes **130** from the invasion of moisture and oxygen. Here, a material of the protective layer **220** includes an organic material, an inorganic material or a combination of an organic material and an inorganic material. As shown in FIG. **14**, the protective layer **220** of the embodiment is a single-layer structural layer specifically. However, in other embodiments not shown, the protective layer **220** may also be a multi-layer structural layer, such as a stacked layer of silicon oxide or aluminum oxide and silicon nitride, or a stacked layer of an inorganic material and an organic material; however, it is not limited thereto.

Since the first bank structure **140***c***1** and the second bank structure **140***c***2** of the embodiment have the first air gap G**1** therebetween, lights emitted from side walls of the micro light-emitting diodes **130** can be totally reflected by the structure design of the first bank structure **140***c***1** and the second bank structure **140***c***2**, such as light beam L. Thus, a higher portion of lights emitted from the side walls of the micro light-emitting diodes **130** can be guided to be emitted along a normal direction by total reflection. The light-emitting efficiency can be increased, and the optical cross-talk effects can be reduced.

It should be noted that, in other embodiments not shown, the bank structures **140***a***1**, **140***a***2**, **140***a***3**, **140***a***4**, **140***b*, **140***b***1**, **140***b***2**, **140***b***3** and **140***c*, the opposite substrate **120**, the optical coating layer **150**, the wavelength converting material **160**, the scattering material **165**, the filler material **167**, the color filter patterns **172**, **174** and **176**, the filter patterns **192**, **194** and **196**, the patterned reflective layer **210**, the microstructural layers **180***a* and **180***b* and the protective layer **220** mentioned in the embodiments can also be selected. The opposite substrate **120** might comprise a plurality of black matrix between different filter patterns or different color filter patterns to decrease an optical cross-talk phenomenon, and is not limited thereto. In other embodiments, the micro light-emitting diodes can be replaced entirely or partially by organic light-emitting diodes (OLED), liquid crystal (LC), quantum dot (QD) or other display elements, and is not limited thereto. The display device might also be a flexible display, a touch display, or a curved display, and is not limited thereto. The aforesaid components could be selected and combined according to the actual requirements in order to achieve the desirable technical effects.

In summary, since the display device of the embodiment has the design of the bank structures, the optical cross-talk phenomenon generated by the micro light-emitting diodes arranged in an array on the array substrate can be effectively reduced. Thereby, the optical display performance of the display device of the embodiment can be effectively improved.

Although the embodiment has been described, the modifications may be made without departing from the spirit of the embodiment. Accordingly, the scope of the embodiment is defined by the attached claims not by the above detailed descriptions.

What is claimed is:

1. A display device, comprising:

an array substrate;

a plurality of micro light-emitting diodes arranged in an array on the array substrate;

a plurality of bank structures located on the array substrate, wherein the plurality of micro light-emitting diodes are electrically connected to the array substrate, the plurality of bank structures form a plurality of accommodating regions, one of the plurality of micro light-emitting diodes is located in one of the plurality of accommodating regions, one of the plurality of bank structures comprises a first bank portion and a second bank portion, the first bank portion has a first bottom surface and a first side surface connected to the first bottom surface, the first bottom surface is a surface of the first bank portion adjacent to the array substrate, the second bank portion has a second bottom surface and a second side surface connected to the second bottom surface, the second bottom surface is a surface of the second bank portion away from the array substrate, and a height of the one of the plurality of bank structures is more than or equal to a height of the one of the plurality of micro light-emitting diodes; and

an optical coating layer disposed on a surface of the one of the plurality of bank structures.

2. The display device according to claim 1, wherein a first included angle is formed between the first side surface and the first bottom surface, the first included angle is between 30 degrees and 150 degrees but not equal to 90 degrees.

3. The display device according to claim 2, wherein a second included angle is formed between the second side surface and the second bottom surface, and the second included angle is between 30 degrees and 150 degrees but not equal to 90 degrees, wherein the first bank portion and the second bank portion are connected to each other, the first included angle is different from the second included angle.

4. The display device according to claim 1, further comprising:

a protective layer disposed above the one of the plurality of micro light-emitting diodes.

5. The display device according to claim 1, further comprising:

a scattering material disposed in the one of the plurality of accommodating regions, and covering the one of the plurality of micro light-emitting diodes.

6. The display device according to claim 1, further comprising:

a wavelength converting material disposed in the one of the plurality of accommodating regions, and covering the one of the plurality of micro light-emitting diodes.

7. A display device, comprising:

an array substrate;

an opposite substrate disposed opposite to the array substrate;

a plurality of micro light-emitting diodes arranged in an array on the array substrate;

a plurality of bank structures located between the array substrate and the opposite substrate, wherein the plurality of micro light-emitting diodes are electrically connected to the array substrate, the plurality of bank structures form a plurality of accommodating regions, one of the plurality of micro light-emitting diodes is located in one of the plurality of accommodating regions, one of the plurality of bank structures comprises a first bank structure and a second bank structure, the first bank structure has a first flat surface and a first inclined surface opposite to each other, the second bank structure has a second flat surface and a second inclined surface opposite to each other, the first inclined surface faces the second inclined surface, a first air gap is formed between the first bank structure and the second bank structure, a width of the first bank structure and a width of the second bank structure gradually increase from the array substrate to the opposite substrate, a first included angle is formed between the first inclined surface and the array substrate, a second included angle is formed between the second inclined surface and the array substrate, and the first included angle and the second included angle are more than or equal to 30 degrees and less than 90 degrees, and a height of the one of the plurality of bank structures is more than or equal to a height of the one of the plurality of micro light-emitting diodes; and

an optical coating layer disposed on a surface of the one of the plurality of bank structures.

8. The display device according to claim 7, further comprising:

a scattering material disposed in the one of the plurality of accommodating regions, and covering the one of the plurality of micro light-emitting diodes.

9. The display device according to claim 7, further comprising:

a wavelength converting material disposed in the one of the plurality of accommodating regions, and covering the one of the plurality of micro light-emitting diodes.

10. The display device according to claim 9, further comprising:

a color filter layer disposed above the opposite substrate and having a plurality of color filter patterns.

11. The display device according to claim 7, further comprising:

a filler material disposed in the one of the plurality of accommodating regions around the one of the plurality of micro light-emitting diodes, and exposing an upper surface of the one of the plurality of micro light-emitting diodes relatively far away from the array substrate; and

a wavelength converting material disposed in the one of the plurality of accommodating regions, and covering the filler material and the upper surface of the one of the plurality of micro light-emitting diodes.

12. The display device according to claim 11, further comprising:

a color filter layer disposed above the opposite substrate and having a plurality of color filter patterns.

13. The display device according to claim 7, wherein a second air gap is formed between the plurality of bank structures and the opposite substrate, the opposite substrate comprises a plurality of light absorbing patterns, the plurality of light absorbing patterns are located in the second air gap, and one of the plurality of light absorbing patterns is disposed corresponding to one of the first air gap.

14. The display device according to claim 13, further comprising:

a protective layer disposed above the one of the plurality of micro light-emitting diodes and a top surface of the one of the plurality of bank structures relatively far away from the array substrate.

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专利名称(译)	具有多个堤结构的显示装置
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[标]申请(专利权)人(译)	群创光电股份有限公司
申请(专利权)人(译)	群创光电
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IPC分类号	H01L25/16 H01L33/58 H01L33/60 H01L33/56 H01L33/50 H01L33/48 H01L25/18 H01L25/13 H01L25/07 H01L25/075
CPC分类号	H01L25/167 H01L33/48 H01L33/502 H01L33/56 H01L33/58 H01L33/60 H01L2933/0091 H01L25/0756 H01L25/13 H01L25/16 H01L25/18 H01L2933/0083 H01L25/075 H01L25/0753 H01L33/50
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摘要(译)

本实施例提供一种显示装置，包括阵列基板，对向基板，多个微型发光二极管和多个堤结构。对向基板与阵列基板相对设置。微发光二极管阵列排列在阵列基板上，其中微发光二极管电连接到阵列基板。堤结构位于阵列基板和相对基板之间，其中堤结构形成多个容纳区域，并且一个微发光二极管位于容纳区域之一中。堤结构的高度大于或等于微发光二极管的高度。