



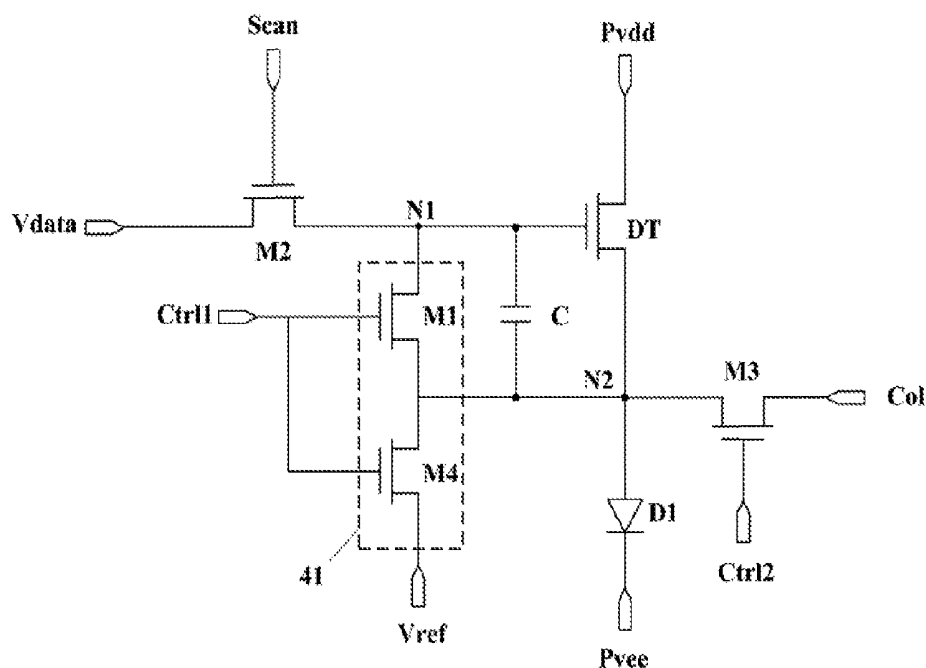
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(19) **United States**(12) **Patent Application Publication**
LI et al.(10) **Pub. No.: US 2017/0278462 A1**(43) **Pub. Date: Sep. 28, 2017**(54) **ORGANIC LIGHT-EMITTING DISPLAY
PANEL AND DRIVING METHOD THEREOF,
AND ORGANIC LIGHT-EMITTING DISPLAY
DEVICE**(71) Applicant: **SHANGHAI TIANMA AM-OLED
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2300/0819 (2013.01); **G09G 2300/0871**
(2013.01)(57) **ABSTRACT**

The present application discloses an organic light-emitting display panel, and a driving method for the display. The organic light-emitting display panel comprises a plurality of pixel driving circuits, each of the pixel driving circuits comprises a first voltage terminal, a second voltage terminal, a scanning signal terminal, a data signal terminal, a first control signal terminal, a second control signal terminal, a potential collecting terminal, a driving module, an organic light-emitting device, a luminance control module, a data write module, and a potential collecting module. The driving module is configured to drive the organic light-emitting device to emit light under control of the control terminal based on voltage provided by the first voltage terminal. The method therefore mitigates a threshold voltage drift in advanced organic light-emitting display panel technology.

400

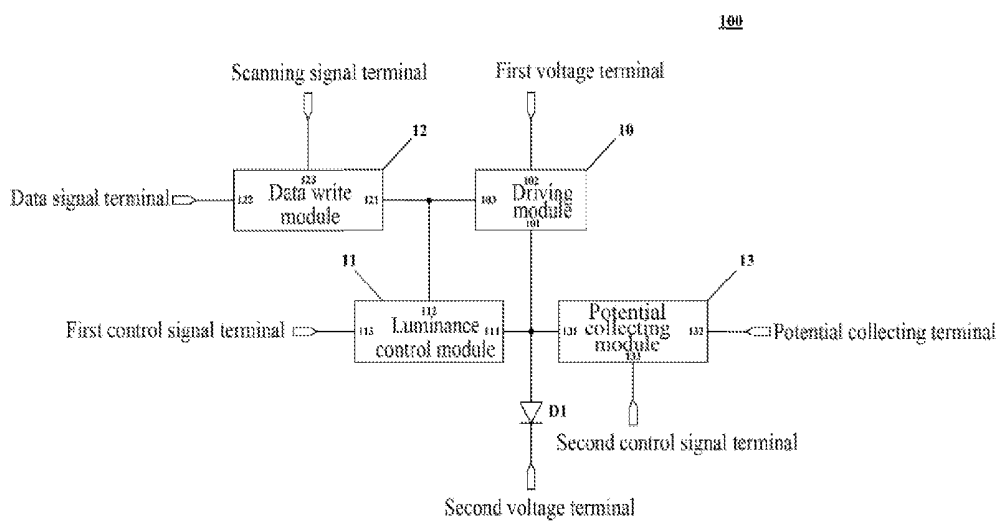


Fig. 1

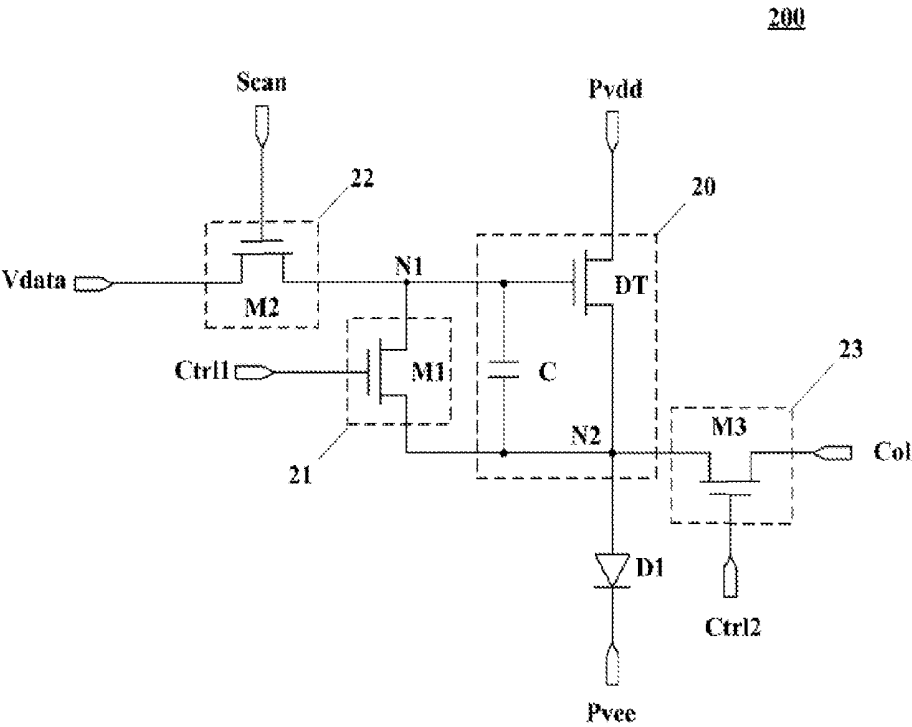


Fig. 2

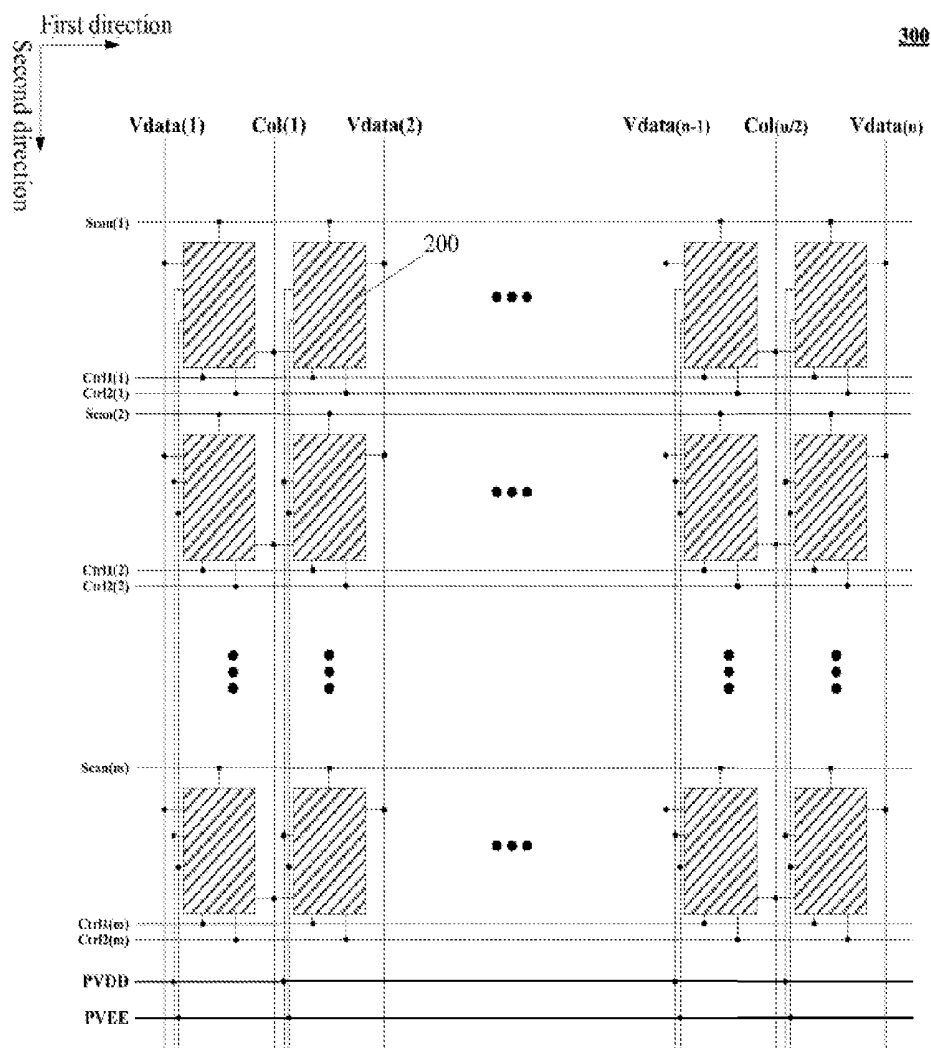


Fig. 3

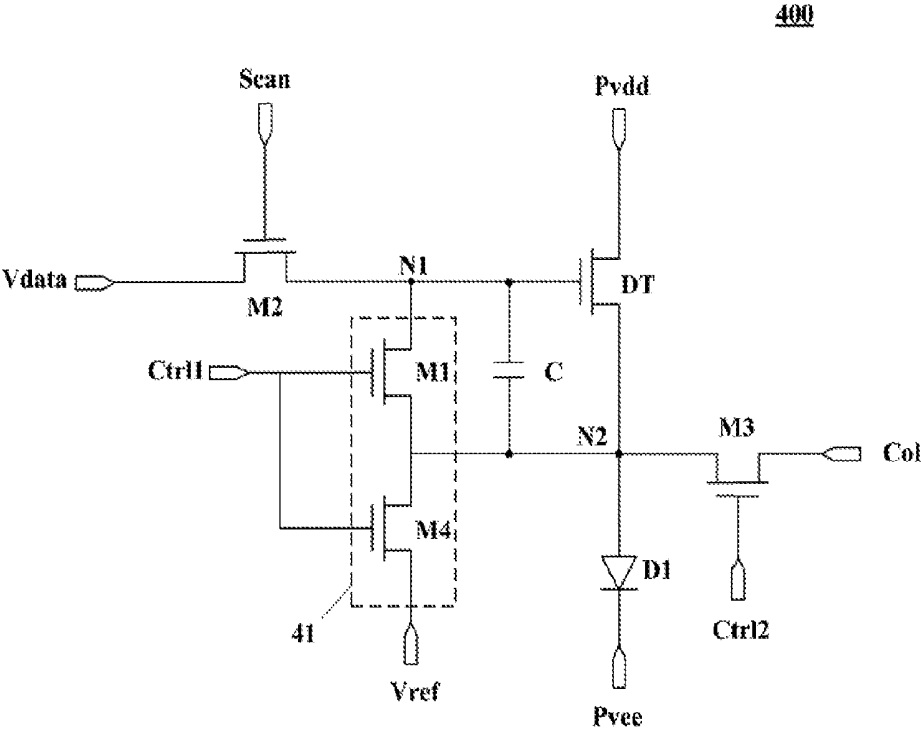


Fig. 4

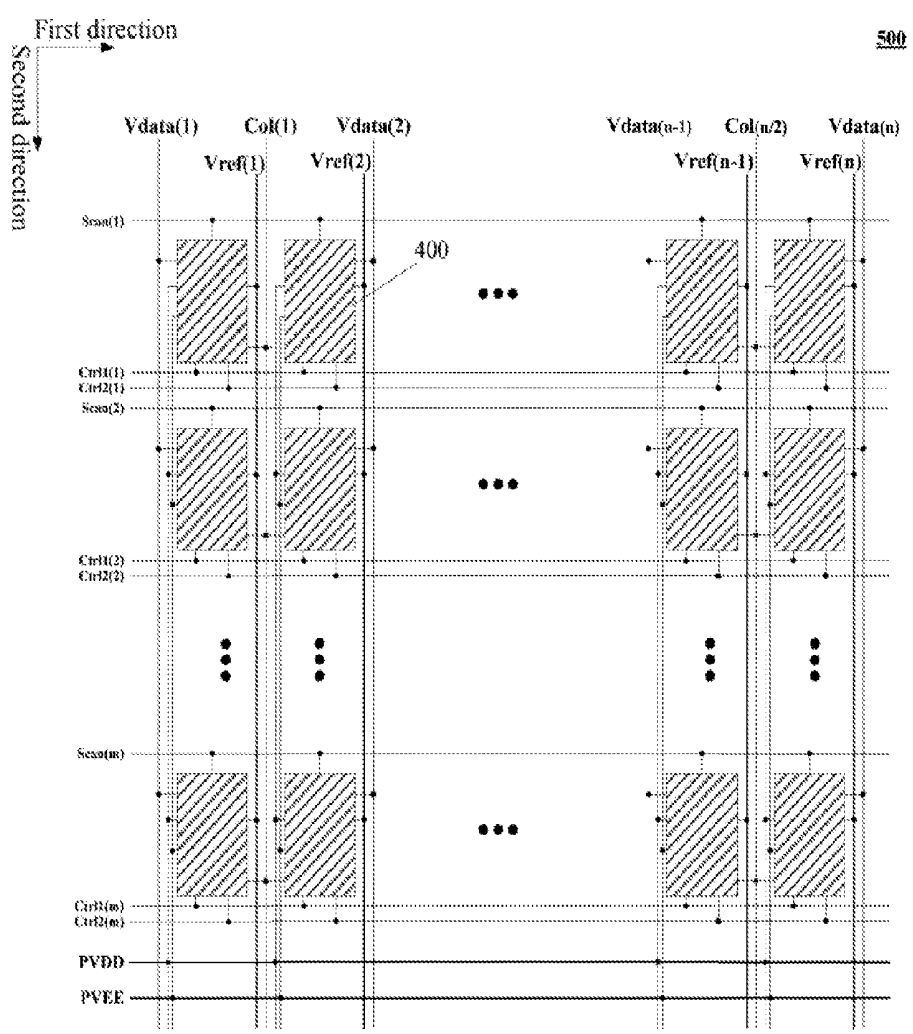


Fig. 5

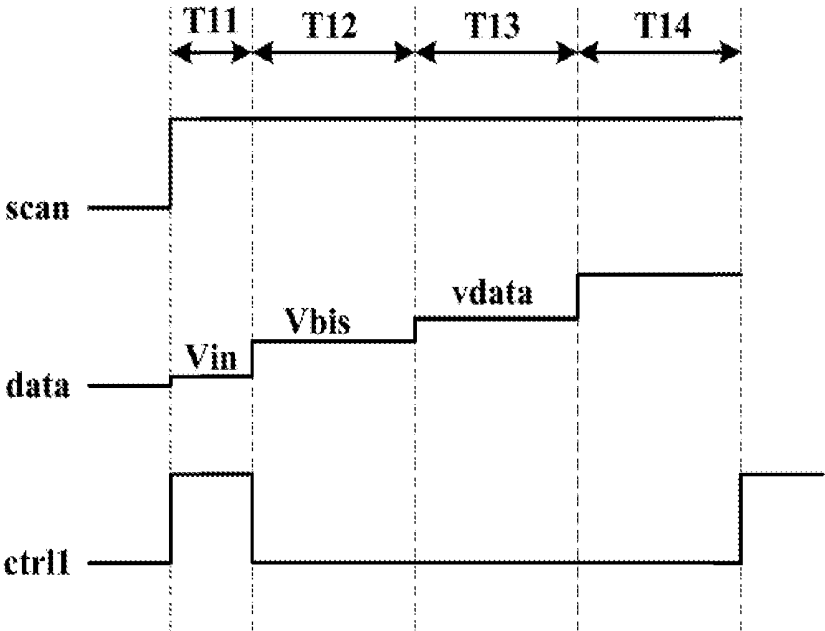


Fig. 6

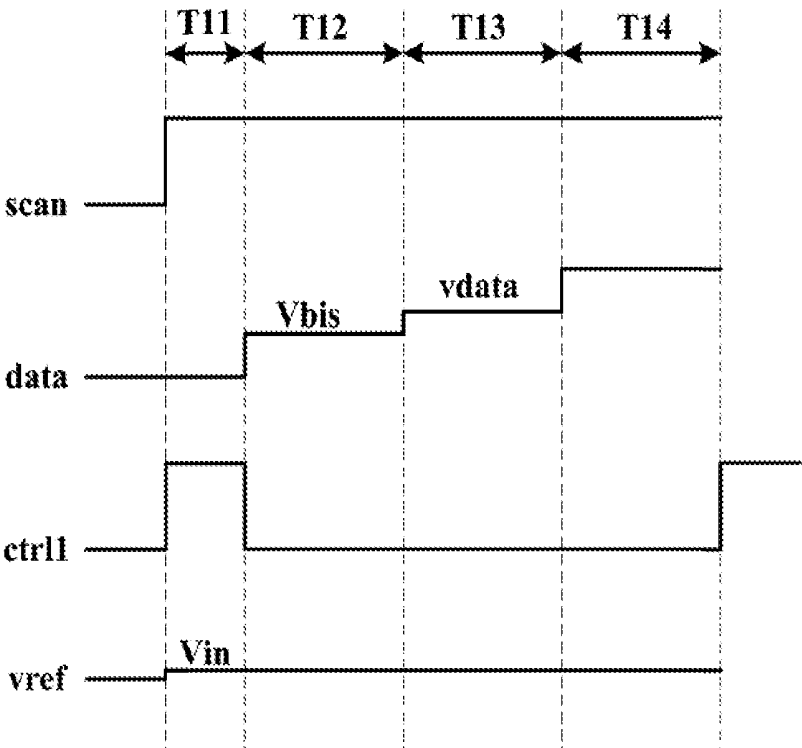


Fig. 7

800

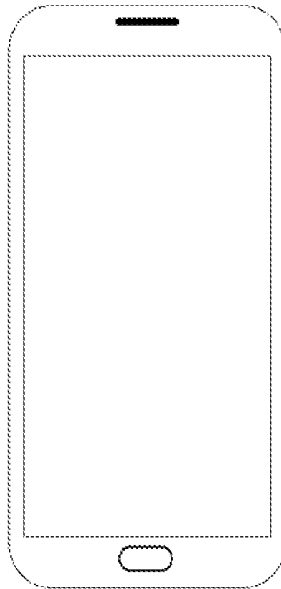


Fig. 8

**ORGANIC LIGHT-EMITTING DISPLAY
PANEL AND DRIVING METHOD THEREOF,
AND ORGANIC LIGHT-EMITTING DISPLAY
DEVICE**

**CROSS-REFERENCE TO RELATED
APPLICATION**

[0001] This application is related to and claims priority from Chinese Patent Application No. CN201710038196.7, filed on Jan. 19, 2017, entitled “Organic Light-Emitting Display Panel and Driving Method Thereof, and Organic Light-Emitting Display Device,” the entire disclosure of which is hereby incorporated by reference for all purposes.

TECHNICAL FIELD

[0002] The present application relates to the technical field of display, particularly to the technical field of organic light emission display, and more particularly to an organic light-emitting display panel and a driving method thereof, and an organic light-emitting display device.

BACKGROUND

[0003] An organic light-emitting display (OLED) performs display using a self-lighting emission property of an organic semiconductor material. As compared with a liquid crystal display, the organic light-emitting display does not need backlight and may effectively reduce a thickness of a display screen. Usually, in OLED a pixel array comprised of sub-pixels is disposed in a display region of the organic light-emitting display. Each sub-pixel comprises an organic light-emitting diode, which is driven by a pixel driving circuit to emit light.

[0004] A current type of pixel driving circuit may comprise a driving transistor, and the driving transistor provides light-emitting current to the organic light-emitting diode under control of a light-emitting control signal. Usually, the light-emitting current of the organic light-emitting diode is relevant to a threshold voltage V_{th} of the driving transistor, but the threshold voltage V_{th} of the driving transistor undergoes drift (namely, “threshold drift”) due to factors such as process or aging after long-term use, so the luminance of the organic light-emitting diode exhibits a poor accuracy. Furthermore, an amount of drift of the threshold voltage of different organic light-emitting diodes might be different from one another, and display luminance of the sub-pixels deviates apparently so that display uniformity of images is undesirable.

SUMMARY

[0005] The present application provides an organic light-emitting display panel and a driving method thereof, and an organic light-emitting display device, in order to solve the technical problem mentioned above.

[0006] To achieve the above object, in a first aspect, the present application provides an organic light-emitting display panel, comprising a plurality of pixel driving circuits arranged in a matrix. Each of the pixel driving circuits comprises a first voltage terminal, a second voltage terminal, a scanning signal terminal, a data signal terminal, a first control signal terminal, a second control signal terminal, a potential collecting terminal, a driving module, an organic light-emitting device, a luminance control module, a data write module and a potential collecting module; the driving

module comprises a first terminal, a second terminal and a control terminal, and the first terminal of the driving module is electrically connected with a first electrode of the organic light-emitting device, the second terminal of the driving module is electrically connected with the first voltage terminal, the driving module is configured to drive the organic light-emitting device to emit light under control of the control terminal and based on voltage provided by the first voltage terminal; a second electrode of the organic light-emitting device is electrically connected with the second voltage terminal; the luminance control module comprises a first terminal, a second terminal and a control terminal, the first terminal of the luminance control module is electrically connected with the first terminal of the driving module, the second terminal of the luminance control module is electrically connected with the control terminal of the driving module, the control terminal of the luminance control module is electrically connected with the first control signal terminal, the luminance control module is configured to control the luminance of the organic light-emitting device by controlling the potential of the first terminal and the control terminal of the driving module; the data write module is electrically connected with the scanning signal terminal, the control terminal of the driving module, and the data signal terminal, and the data write module is configured to write the signal of the data signal terminal into the control terminal of the driving module under the control of the scanning signal terminal; the potential collecting module is electrically connected with the second control signal terminal, the potential collecting terminal, the first terminal of the driving module, and the potential collecting module is configured to collect the potential of the first terminal of the driving module.

[0007] In a second aspect, the present application provides a driving method applied to the organic light-emitting display panel. The driving method comprises: in a first phase, providing a first level signal to the first control signal terminal, providing a second level signal to the second control signal terminal, and the luminance control module initializing the control terminal and first terminal of the driving module to have an identical potential; in a second phase, providing a first level signal to the scanning signal terminal, providing a second level signal to the first control signal terminal, providing a second level signal to the second control signal terminal, providing a first signal to the data signal terminal, the data write module writing the first signal into the control terminal of the driving module, and the first voltage terminal charging the first terminal of the driving module; in a third phase, providing a second level signal to the first control signal terminal and the second control signal terminal, providing a data signal to the data signal terminal, and the potential of the control terminal of the driving module rising or falling; in a fourth phase, providing a first level signal to the scanning signal terminal and data signal terminal, providing a luminance control signal to the first control signal terminal Ctrl1, providing a second level signal to the second control signal terminal, the organic light-emitting device emits light according to a potential difference between the first terminal of the driving module and the control terminal of the driving module, the luminance control signal is used to control the luminance of light emitted by the organic light-emitting device by controlling light-emitting time of the organic light-emitting device.

[0008] In a third aspect, the present application provides an organic light-emitting display device comprising the organic light-emitting display panel.

[0009] The organic light-emitting display panel and the driving method thereof, and the organic light-emitting display device according to the present application comprise a plurality of pixel driving circuits arranged in a matrix, each of the pixel driving circuits comprises a driving module, an organic light-emitting device, a luminance control module, a data write module and a potential collecting module, wherein the driving module drives the organic light-emitting device to emit light under control of the control terminal and based on voltage provided by the first voltage terminal, the luminance control module controls the luminance of the organic light-emitting device by controlling the potential of the first terminal and the control terminal of the driving module, the data write module writes the signal of the data signal terminal into the control terminal of the driving module under the control of the scanning signal terminal, the potential collecting module is configured to collect the potential of the first terminal of the driving module, and the luminance control module drives the gate and the first electrode of the driving transistor to the same potential according to the luminance control signal, which avoids the threshold voltage drift of the driving transistor, and extends the service life of the driving transistor. Meanwhile, it is also feasible to change the light-emitting time of the organic light-emitting device by using the luminance control signal and thereby control the luminance of light emitted by the organic light-emitting device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Other features, objects, and advantages of the present application will become more apparent upon reading of the following detailed description of the non-limiting embodiments with reference to the accompanying drawings, in which

[0011] FIG. 1 is a schematic view of a pixel driving circuit in an organic light-emitting display panel according to an embodiment of the present application.

[0012] FIG. 2 is an exemplary circuit diagram of the pixel driving circuit shown in FIG. 1;

[0013] FIG. 3 is a schematic view of an organic light-emitting display panel of the pixel driving circuit in an embodiment shown in FIG. 2;

[0014] FIG. 4 is another specific circuit diagram of the pixel driving circuit shown in FIG. 1;

[0015] FIG. 5 is a schematic view of the organic light-emitting display panel of the pixel driving circuit of an embodiment shown in FIG. 4;

[0016] FIG. 6 is a working time-sequence diagram of the pixel driving circuit shown in FIG. 2;

[0017] FIG. 7 is a working time-sequence diagram of the pixel driving circuit shown in FIG. 4;

[0018] FIG. 8 is a schematic diagram of another display device according to the present application.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] The present application will be further described below in detail in combination with the accompanying drawings and the embodiments. It should be appreciated that the specific embodiments described herein are merely used for explaining the relevant invention, rather than limiting the

invention. In addition, it should be noted that, for the ease of description, only the parts related to the relevant invention are shown in the accompanying drawings.

[0020] It should also be noted that the embodiments in the present application and the features in the embodiments may be combined with each other on a non-conflict basis. The present application will be described below in detail with reference to the accompanying drawings and in combination with the embodiments.

[0021] Referring to FIG. 1, it is a structural schematic view of an embodiment of a pixel driving circuit in an organic light-emitting display panel according to the present application. In the present embodiment, the organic light-emitting display panel comprises a plurality of pixel driving circuits 100 arranged in an array.

[0022] As shown in FIG. 1, each pixel driving circuit 100 comprises a first voltage terminal Pvd, a second voltage terminal Pvee, a scanning signal terminal Scan, a data signal terminal Vdata, a first control signal terminal Ctrl1, a second control signal terminal Ctrl2, a potential collecting terminal Col, a driving module 10, an organic light-emitting device D1, a luminance control module 11, a data write module 12 and a potential collecting module 13, wherein the organic light-emitting device D1 maybe an organic light-emitting diode, which is identified by a circuit symbol of the organic light-emitting diode in FIG. 1.

[0023] The driving module 10 comprises a first terminal 101, a second terminal 102 and a control terminal 103, and the first terminal 101 of the driving module 10 is electrically connected with a first electrode of the organic light-emitting device D1. The second terminal 102 of the driving module 10 is electrically connected with the first voltage terminal Pvd. The driving module 10 is configured to drive the organic light-emitting device D1 to emit light under control of the control terminal 103 and based on voltage provided by the first voltage terminal Pvd.

[0024] A second electrode of the organic light-emitting device D1 is electrically connected with the second voltage terminal Pvee.

[0025] The luminance control module 11 comprises a first terminal 111, a second terminal 112 and a control terminal 113, and the first terminal 111 of the luminance control module 11 is electrically connected with the first terminal 101 of the driving module 10. The second terminal 112 of the luminance control module 11 is electrically connected with the control terminal 103 of the driving module 10. The control terminal 113 of the luminance control module 11 is electrically connected with the first control signal terminal Ctrl1. The luminance control module 11 is configured to control the luminance of the organic light-emitting device D1 by controlling the potential of the first terminal 101 and the control terminal 103 of the driving module 10.

[0026] The data write module 12 is electrically connected with the scanning signal terminal Scan, the control terminal 103 of the driving module 10, and the data signal terminal Vdata. The data write module 12 is configured to write the signal of the data signal terminal Vdata into the control terminal 103 of the driving module 10 under the control of the scanning signal terminal Scan.

[0027] Referring to FIG. 1 and FIG. 2, the potential collecting module 13 is electrically connected with the second control signal terminal Ctrl2, the potential collecting terminal Col and the first terminal 101 of the driving module

10. The potential collecting module **14** is configured to collect the potential of the first terminal **101** of the driving module **10**.

[0028] In the aforesaid pixel driving circuit **100**, the luminance control module **11**, under control of the first control signal terminal **Ctrl1**, may initialize the potential of the control terminal **103** of the driving module **10** and the first terminal **101** of the driving module **10**. That is to say, the luminance control module **11** may simultaneously initialize the potential of the control terminal **103** and first terminal **101** of the driving module **10**. Optionally, the luminance control module **11** may initialize the potential of the control terminal **103** and first terminal **101** of the driving module **10** to have an identical potential.

[0029] In the present embodiment, the driving module **10** is turned on or turned off by the control of a voltage difference of the control terminal **103** and the first terminal **101** of the driving module **10**. The driving module **10** is in an ON state, the first voltage terminal **Pvdd** may charge the first terminal **101** of the driving module **10** until the voltage difference of the control terminal **103** and first terminal **101** of the driving module **10** reaches an OFF state. The potential collecting module **13** is turned on under control of the second control signal terminal **Ctrl2** so that the potential collecting terminal **Col** collects the potential of the first terminal **101** of the driving module **10**. As such, a threshold voltage of the driving module **10** may be determined by a potential difference of the control terminal **103** and first terminal **101** of the driving module **10**. Therefore, the pixel driving circuit **100** in the embodiment of the present application may grasp the threshold voltage of the driving module **10**, then adjust the data signal terminal **Vdata** according to the threshold voltage, and control electrical current passing through the organic light-emitting device **D1** to control the luminance of the organic light-emitting device **D1**.

[0030] The pixel driving circuit **100** may have many types of different circuit structures. Reference is made to FIG. **2** which shows a specific circuit structural diagram of the pixel driving circuit shown in FIG. **1**.

[0031] As shown in FIG. **2**, the pixel driving circuit **200** comprises a driving module **20**, a luminance control module **21**, a data write module **22** and a potential collecting module **23**. The driving module **20**, the luminance control module **21**, the data write module **22** and the potential collecting module **23** may respectively be the driving module **10**, luminance control module **11**, data write module **12** and potential collecting module **13** in the pixel driving circuit **100** shown in FIG. **1**.

[0032] In the present embodiment, the driving module **20** comprises a driving transistor **DT** and a capacitor **C**, wherein a gate of the driving transistor **DT** is a control terminal (namely, **N1** node shown in FIG. **2**) of the driving module **20**, and a first electrode and a second electrode of the driving transistor **DT** are a first terminal (namely, **N2** node shown in FIG. **2**) and a second terminal of the driving module **20** respectively. Both terminals of the capacitor **C** are electrically connected with the gate and the first electrode of the driving transistor **DT** respectively. The first electrode of the driving transistor **DT** is electrically connected with the first electrode of the organic light-emitting device **D1**. The second electrode of the driving transistor **DT** is electrically connected with the first voltage terminal **Pvdd**. Here, the first

electrode of the organic light-emitting device **D1** may be an anode, and the second electrode of the organic light-emitting device **D1** may be a cathode.

[0033] The luminance control module **21** comprises a first transistor **M1**. A first electrode of the first transistor **M1** is electrically connected with the first electrode of the driving transistor **DT**. A second electrode of the first transistor **M1** is electrically connected with the gate of the driving transistor **DT**. The gate of the first transistor **M1** is electrically connected with the first control signal terminal **Ctrl1**.

[0034] The data write module **22** comprises a second transistor **M2**. A first electrode of the second transistor **M2** is electrically connected with the gate of the driving transistor **DT**. A second electrode of the second transistor **M2** is electrically connected with the data signal terminal **Vdata**. A gate of the second transistor **M2** is electrically connected with the scanning signal terminal **Scan**.

[0035] The potential collecting module **23** comprises a third transistor **M3**. A first electrode of the third transistor **M3** is electrically connected with the first electrode of the driving transistor **DT**. A second electrode of the third transistor **M3** is electrically connected with the potential collecting terminal **Col**. A gate of the third transistor **M3** is electrically connected with the second control signal terminal **Ctrl2**.

[0036] In the present embodiment, the gate and first electrode of the driving transistor **DT** are electrically connected with the second electrode and the first electrode of the first transistor **M1**. When the first transistor **M1** is turned on, the gate and first electrode of the driving transistor **DT** have equal potential. The gate and first electrode of the driving transistor **DT** are further respectively connected with two electrode plates of the capacitor **C** so that when the first transistor **M1** is in an OFF state, the capacitor **C** may maintain the potential difference (namely, a voltage between the gate and first electrode of the driving transistor **DT**) between the gate and first electrode of the driving transistor **DT**. When the first voltage terminal **Pvdd** charges the first electrode of the driving transistor **DT** until the difference between the potential of the gate of the driving transistor **DT** and the potential of the first electrode of the driving transistor **DT** is equal to the threshold voltage of the driving transistor **DT**, the driving transistor **DT** changes from the ON state to the OFF state. At this time, the third transistor **M3** is turned on under control of the second control signal terminal **Ctrl2**, and the potential collecting terminal **Col** records the potential of the first electrode of the driving transistor **DT**. After other devices of the organic light-emitting display panel obtain the potential of the first electrode of the driving transistor **DT**, the threshold voltage of the driving transistor **DT** may be obtained by calculating according to the signal received by the data signal terminal **Vdata** at this time. During subsequent control of the luminance of the organic light-emitting device **D1**, the voltage of the signal received by the data signal terminal **Vdata** may be changed purposefully to control the electrical current flowing through the organic light-emitting device **D1** and thereby control the luminance of light emitted by the organic light-emitting device **D1**.

[0037] In the aforesaid pixel driving circuit **200**, the first electrode of the first transistor **M1** in the luminance control module **21** is electrically connected with the first electrode of the driving transistor **DT**. The second electrode of the first transistor **M1** is electrically connected with the gate of the

driving transistor DT. The first electrode of the second transistor M2 in the data write module 12 is electrically connected with the gate of the driving transistor DT. When the first control signal terminal Ctrl1 controls the first transistor M1 to turn on and the scanning signal terminal Scan controls the second transistor M2 to turn on, the data signal terminal Vdata achieves the initialization for the gate and first electrode of the driving transistor DT. It can be seen that the pixel driving circuit 200 does not need to employ an initialization signal line, reduces the number of signal lines of the organic light-emitting display panel, facilitates increase of an area for evaporating an organic light-emitting material, and may further improve the aperture ratio and resolution.

[0038] FIG. 3 shows a plan view of an organic light-emitting display panel of the pixel driving circuit according to the embodiment shown in FIG. 2. As shown in FIG. 3, the organic light-emitting display panel 300 comprises a plurality of pixel driving circuits 200 arranged in an array, for example, a plurality of pixel driving circuits 200 arranged in a matrix array in a first direction and a second direction as shown in FIG. 3, wherein the first direction is a row direction of the matrix array, and the second direction is a column direction of the matrix array. Each pixel driving circuit 200 may have a circuit structure shown in FIG. 2, which will not be detailed here.

[0039] Furthermore, as shown in FIG. 3, the organic light-emitting display panel 300 further comprise a plurality of first control signal lines Ctrl1(1), Ctrl1(2), . . . Ctrl1(m), a plurality of second control signal lines Ctrl2(1), Ctrl2(2), . . . Ctrl2(m), a plurality of data lines Vdata(1), Vdata(2), . . . Vdata(n-1) and Vdata(n), a plurality of scanning lines Scan(1), Scan(2), . . . Scan(m), a plurality of potential collecting lines Col(1), . . . Col(n), a first voltage signal line PVDD and a second voltage signal line PVEE, wherein m and n are positive integers and n-1 is an even number.

[0040] Each of the first control signal lines Ctrl1(1), Ctrl1(2), . . . Ctrl1(m) is electrically connected with the first control signal terminal Ctrl1 in one row of pixel driving circuits 200. Each of the second control signal lines Ctrl2(1), Ctrl2(2), . . . Ctrl2(m) is electrically connected with the second control signal terminal Ctrl2 in one row of pixel driving circuits 200. Each of the data lines Vdata(1), Vdata(2), . . . Vdata(n-1) and Vdata(n) is electrically connected with the data signal terminal Vdata in one column of pixel driving circuits 200. Each of the scanning lines Scan(1), Scan(2), . . . Scan(m) is electrically connected with the scanning signal terminal Scan in one row of pixel driving circuit 200. Each of the potential collecting lines Col(1), . . . Col(n) is electrically connected with the potential collecting terminal Col. The first voltage terminal Pvdd of each of the pixel driving circuits 200 is electrically connected with the first voltage signal line PVDD. The second voltage terminal Pvee of each of the pixel driving circuits is electrically connected with the second voltage signal line PVEE.

[0041] Reference is made to FIG. 4 which shows another specific circuit diagram of the pixel driving circuit shown in FIG. 1.

[0042] As shown in FIG. 4, on the basis of the pixel driving circuit 200 shown in FIG. 2, the pixel driving circuit 400 in the present embodiment further comprise a reference voltage signal terminal Vref. The luminance control module 41 includes, in addition to the first transistor M1, a fourth transistor M4. A gate of the fourth transistor M4 is electrically

connected with the first control signal terminal Ctrl1, a first electrode of the fourth transistor M4 is electrically connected with the reference voltage signal terminal Vref, and a second electrode of the fourth transistor M4 is electrically connected with the first electrode of the driving transistor DT.

[0043] In the present embodiment, gates of the first transistor M1 and fourth transistor M4 are both electrically connected with the first control signal terminal Ctrl1, so the first transistor M1 and fourth transistor M4 are simultaneously turned on or simultaneously turned off. The potential of the gate and first electrode of the driving transistor DT may be provided by the reference voltage signal terminal Vref. That is, when the circuit is initialized, the reference voltage signal terminal Vref controls the first transistor M1 and fourth transistor M4 to turn on, thereby transmitting the signal of the reference voltage signal terminal Vref to the gate and first electrode of the driving transistor DT.

[0044] As compared with the embodiment shown in FIG. 2, the present embodiment is added with the reference voltage signal terminal Vref, the data signal terminal Vdata does not need to provide initialization signal to the driving transistor DT, the number of times of changes of the potential of the signal of the data signal terminal Vdata is decreased, and the complexity of the signal of the data signal terminal Vdata is reduced. Since the signal of the data signal terminal Vdata is provided by an integrated circuit IC, the pixel driving circuit of the present embodiment may reduce a load of the integrated circuit.

[0045] Furthermore, the present application further provides an organic light-emitting display panel including the pixel driving circuit 400 shown in FIG. 4. On the basis of the organic light-emitting display panel shown in FIG. 3, the organic light-emitting display panel further includes at least one reference voltage signal line, and each reference voltage signal line is electrically connected with the reference voltage signal terminal Vref of at least two pixel driving circuit 400. Optionally, at least two pixel driving circuits electrically connected with the same reference voltage signal line maybe located in the same row or the same column, or located in different rows and different columns.

[0046] Referring to FIG. 5, FIG. 5 shows a structural schematic view of an embodiment of the organic light-emitting display panel of the pixel driving circuit shown in FIG. 4. As shown in FIG. 5, on the basis of the organic light-emitting display panel 300 shown in FIG. 3, the organic light-emitting display panel 500 in the present embodiment further comprises reference voltage signal lines Vref(1), Vref(2), . . . Vref(n-1) and Vref(n). Each of the reference voltage signal lines Vref(1), Vref(2), . . . Vref(n-1) and Vref(n) is electrically connected with the reference voltage signal terminal Vref in one column of pixel driving circuits 400. In other implementation modes, reference voltage signal terminals of all pixel driving circuits in the organic light-emitting display panel may be connected to the same reference voltage signal line, namely, the potential of the driving transistors DT in all pixel driving circuits on the organic light-emitting display panel is initialized through the same reference voltage signal line.

[0047] It needs to be appreciated that in FIG. 3 and FIG. 5, every two adjacent columns of pixel driving circuits on the organic light-emitting display panel in the first direction share one potential collecting line to reduce line complexity.

[0048] The organic light-emitting display panel shown in FIG. 5 uses the reference voltage signal line to initialize the potential of the driving transistor DT in the pixel driving circuit, and data lines does not have to transmit the initialization signal so that the number of times of changes of the voltage values of signals on the data lines is reduced, and stability of signals transmitted through the data lines is enhanced.

[0049] It should be appreciated that the first transistor M1, second transistor M2, third transistor M3 and fourth transistor M4 and the driving transistor DT in the above embodiments may all be a N-type transistor or P-type transistor. When the driving transistor DT is the N-type transistor, its threshold voltage $V_{th} > 0$; when the driving transistor is the P-type transistor, its threshold voltage $V_{th} < 0$.

[0050] The present application further provides a method of driving embodiments of the organic light-emitting display panel. The driving method comprises: in a first phase, providing a first level signal to the first control signal terminal Ctrl1, providing a second level signal to the second control signal terminal Ctrl2, and the luminance control module initializing the control terminal and first terminal of the driving module to have an identical potential. In a second phase, providing a first level signal to the scanning signal terminal Scan, providing a second level signal to the first control signal terminal Ctrl1, providing a second level signal to the second control signal terminal Ctrl2, providing a first signal to the data signal terminal Vdata, the data write module writing the first signal into the control terminal of the driving module, and the first voltage terminal Pvdd charging the first terminal of the driving module. In a third phase, providing a second level signal to the first control signal terminal Ctrl1 and the second control signal terminal Ctrl2, providing a data signal to the data signal terminal Vdata, and the potential of the control terminal of the driving module rising or falling. In a fourth phase, providing a first level signal to the scanning signal terminal Scan and data signal terminal Vdata, providing a luminance control signal to the first control signal terminal Ctrl1, providing a second level signal to the second control signal terminal Ctrl2, the organic light-emitting device emits light according to a potential difference between the first terminal of the driving module and the control terminal of the driving module. The luminance control signal is used to control the luminance of light emitted by the organic light-emitting device D1 by controlling light-emitting time of the organic light-emitting device.

[0051] The working principle of the driving method is further described in conjunction with FIG. 6 and FIG. 7 by way of an example in which the first transistor M1, second transistor M2, third transistor M3, fourth transistor M4 and the driving transistor DT in the above embodiments all are N-type transistors, and the first level signal in the above driving method is a high level signal and the second level signal is a low level signal. Scan, data, ctrl1, ctrl2, col and vref respectively represent signals respectively provided to the scanning signal terminal Scan, data signal terminal Vdata, first control signal terminal Ctrl1, second control signal terminal Ctrl2, the potential collecting terminal Col, and the reference voltage signal terminal Vref. The high level and low level only represent a relative relationship of levels and are not particularly defined as a certain level signal. The high level signal maybe a signal turning on the

first through fourth transistors, and the low level signal may be a signal turning off the first through fourth transistors.

[0052] Reference is made to FIG. 6 which shows a working time-sequence diagram of the pixel driving circuit 200 shown in FIG. 2.

[0053] As shown in FIG. 6, in the first phase T11, the first level signal is provided to the first control signal terminal Ctrl1 and the scanning signal terminal Scan. The initialized voltage signal Vin is provided to the data signal terminal Vdata, the data write module transmits the initialized voltage signal to the luminance control module, and the luminance control module initializes the control terminal and first terminal of the driving module to have an identical potential. Specifically, the first phase T11 is an initialization phase, the first transistor M1 and second transistor M2 in the pixel driving circuit 200 are turned on, and the initialized voltage signal Vin input by the data signal terminal Vdata is transmitted to nodes N1 and N2. The luminance control module initializes the gate and the first electrode of the driving transistor DT to have an identical potential. At this time, the potential of each of the nodes N1 and N2 is Vin, the voltage value of the initialization voltage signal Vin is smaller, a difference between it and the voltage value of the signal at the second voltage terminal Pvee is smaller than a turn-on voltage of the organic light-emitting device D1, and the organic light-emitting device D1 does not emit light.

[0054] In the second phase T12, the first level signal is provided to the scanning signal terminal Scan, the second level signal is provided to the first control signal terminal Ctrl1, the second level signal is provided to the second control signal terminal Ctrl2, the first signal Vbis is provided to the data signal terminal Vdata, the data write module writes the first signal Vbis into the gate of the driving transistor DT, and the first voltage terminal Pvdd charges the first electrode of the driving transistor DT. The capacitor C stores the voltage between the gate and first electrode of the driving transistor DT. Specifically, the second phase T12 is a voltage biasing phase. At this time, the first signal Vbis is slightly smaller than the threshold voltage Vth of the driving transistor DT, the potential at both terminals of the capacitor C is $V_{bis} - V_{in} < V_{th}$, the driving transistor DT is not ON, and the organic light-emitting device D1 does not emit light. Usually, the voltage value of the initialization voltage signal is lower than the voltage value of the first signal, and the difference between the voltage value of the initialization voltage signal and the voltage of the signal of the second voltage terminal Pvee is smaller than the ON voltage of the organic light-emitting device D1.

[0055] In the third phase T13, the second level signal is provided to the first control signal terminal Ctrl1, the first level signal is provided to the scanning signal terminal Scan, the data signal vdata is provided to the data signal terminal Vdata, and the data write module writes the data signal vdata into the gate of the driving transistor DT. The potential of the gate of the driving transistor changes, and the signal of the gate of the driving transistor changes from the first signal Vbis to the data signal vdata. Specifically speaking, the third phase T13 is a data write phase, the second transistor M2 is turned on and transmits the data signal vdata to the first node N1, furthermore $vdata - V_{in} < V_{th}$, and the driving transistor DT is not turned on. An amount of change of the potential of one terminal (the first node N1) of the capacitor C is $vdata - V_{bis}$, and the other end (the second node N2) of the capacitor C is in a suspended state. Under the coupling

action of the capacitor C and a voltage division action of the organic light-emitting device D1, the amount of change of the potential of the second node N2 is $(C01/(C01+Coled)) \times (vdata-Vbis)$, namely, the potential of the second node N2 becomes $Vin+(C01/(C01+Coled)) \times (Vdata-Vbis)$, wherein C01 and Coled respectively represent a capacitance value of the capacitor C and the organic light-emitting device D1. Optionally, $Vdata-Vbis > 0$.

[0056] In the fourth phase, the first level signal is provided to the scanning signal terminal Scan and the data signal terminal Vdata, the luminance control signal is provided to the first control signal terminal Ctrl1, the second level signal is provided to the second control signal terminal Ctrl2, and the organic light-emitting device D1 emits light according to a potential difference between the first terminal of the driving module and the control terminal of the driving module. The luminance control signal is used to control the luminance of light emitted by the original light-emitting device D1 by controlling light-emitting time of the organic light-emitting device. Specifically, the fourth phase T14 is a light-emitting phase. In the light-emitting phase, the luminance control signal is a low level, and the first transistor M1 is not ON. When the light-emitting phase ends, the luminance control signal is a high level, the first transistor M1 is ON so that the gate and first electrode of the driving transistor DT have the same potential, the driving transistor DT is not ON, and the organic light-emitting device D1 does not emit light. There is no voltage difference between the gate and the first electrode of the driving transistor DT, which avoids the threshold voltage drift of the driving transistor DT, and extends the service life of the driving transistor DT and capacitor C. It is further feasible to set the time when the luminance control signal changes from the low level to the high level. The earlier the high level of the luminance control signal arrives, the shorter the light-emitting time of the organic light-emitting device D1 is, and the lower the luminance is; the later the high level of the luminance control signal arrives, the longer the light-emitting time of the organic light-emitting device D1 is, and the higher the luminance is.

[0057] In this way, the pixel driving circuit 200 shown in FIG. 2 can avoid the threshold voltage drift of the driving transistor, the circuit structure is simple, the number of signal lines is smaller, and the design of a high-resolution display panel is facilitated.

[0058] Referring to FIG. 7, FIG. 7 shows a working time-sequence diagram of the pixel driving circuit 400 shown in FIG. 4.

[0059] As shown in FIG. 7, in a first phase T21, the first level signal is provided to the first control signal terminal Ctrl1, the first signal is provided to the data signal terminal Vdata, the second level signal is provided to the scanning signal terminal Scan, and the reference voltage signal vref is provided to the reference voltage signal terminal Vref. At this time, the first transistor M1 and fourth transistor M4 are ON, and the luminance control module transmits the reference voltage signal vref to the control terminal (the first node N1) and the first electrode (the second node N2) of the driving transistor DT. The potential of the first node N1 and the potential of the second node N1 are both vref. Specifically, the luminance control module transmits the reference voltage signal vref to the gate and first electrode of the driving transistor DT. At this time, the voltage value of the reference voltage signal vref is lower than the turn-on voltage Voled

of the organic light-emitting device D1, and the organic light-emitting device D1 does not emit light.

[0060] In a second phase T22, the first level signal is provided to the scanning signal terminal Scan, the second level signal is provided to the first control signal terminal Ctrl1, and the first signal Vbis is provided to the data signal terminal Vdata. The data write module writes the first signal Vbis into the control terminal of the driving module, and the first voltage terminal Pvdd charges the first terminal of the driving module. The first signal Vbis is slightly smaller than the threshold voltage Vth of the driving transistor DT, the potential of both terminals of the capacitor C is $Vbis-Vin < Vth$, the driving transistor DT is not ON, and the organic light-emitting device D1 does not emit light.

[0061] In a third step T23, the second level signal is provided to the first control signal terminal Ctrl1, the first level signal is provided to the scanning signal terminal Scan, the data signal vdata is provided to the data signal terminal Vdata, and the voltage value of the first signal is lower than the voltage value of the data signal.

[0062] The data write module writes the data signal vdata into the gate of the driving transistor DT, and the signal of the gate of the driving transistor changes from the first signal Vbis to the data signal vdata. The second transistor M2 is ON and transmits the data signal vdata to the first node N1, $vadata-Vin < Vth$, and the driving transistor DT is not ON.

[0063] A fourth phase T24 is a light-emitting phase, and its working principle is the same as the working principle of the fourth phase T14 shown in FIG. 6.

[0064] As can be seen from FIG. 6 and FIG. 7, the pixel driving circuit 400 shown in FIG. 4 is employed, upon driving the signal of the data signal terminal Vdata only changes once and changes from Vbis to vdata. As compared with the pixel driving circuit 200 shown in FIG. 2, the pixel driving circuit effectively reduces the number of times of changes of the potential of the signal of the data signal terminal Vdata, reduces the complexity of the driving method, and facilitates enhancement of the stability of the signal transmitted through the data signal line connected with the data signal terminal.

[0065] Prior to the fourth phase to the fourth phase, the pixel driving circuit further comprises a threshold voltage obtaining phase. Specifically, the first level signal is provided to the scanning signal terminal Ctrl1 and the second control signal terminal Ctrl2. The second level signal is provided to the first control signal terminal Ctrl1. The first signal is provided to the data signal terminal Vdata, the data write module writes the first signal into the control terminal of the driving module, the driving module is ON, and the first voltage terminal Pvdd begins to charge the first terminal of the driving module. Specifically, the data write module writes the first signal into the gate of the driving transistor DT, and the first voltage terminal Pvdd charges the first electrode of the driving transistor DT. The capacitor C stores the voltage between the gate and the first electrode of the driving transistor DT. The potential collecting terminal Col collects the potential of the first electrode of the driving transistor. When the potential collected by the potential collecting terminal Col does not change any more, this indicates that at this time the voltage between the gate and the first electrode of the driving transistor DT is the threshold voltage. The differential value between the potential of the first signal and the potential collected by the potential

collecting terminal Col is the threshold voltage. After the threshold voltage is obtained, the value of the data signal may be set purposefully.

[0066] It should be appreciated that embodiments of the driving method according to the present application further comprises: in the first phase, second phase, third phase and fourth phase, providing the first voltage signal to the first voltage terminal PVDD, and providing a second voltage signal to the second voltage terminal PVEE, wherein the voltage value of the first voltage signal is greater than the voltage value of the second voltage signal. Both the first voltage signal and second voltage signal are a signal having a constant voltage, the first voltage signal terminal of each pixel driving circuit in the organic light-emitting display panel may be connected to the same first voltage signal line, and the second voltage signal terminal of each pixel driving circuit may be connected to the same second voltage signal line.

[0067] The present application further provides an organic light-emitting display device. As shown in FIG. 8, the organic light-emitting display device 800 includes the organic light-emitting display panel of the above embodiments, and may be a mobile phone, a tablet computer, a wearable device or the like. It may be appreciated that the organic light-emitting display device 800 may further include known structures such as an packaging film and protective glass, which will not be described in detail here.

[0068] What have been described above are only a few preferred embodiments of the present application and illustrations of the employed technical principles. Those skilled in the art should understand that the invention scope related to in the present application is not limited to technical solutions formed by specific combinations of the technical features above, which should also cover other technical solutions formed by any arbitrary combination of the technical features above or their equivalent features without departing from the inventive concept. For example, technical features formed by mutual substitution of the features above with technical features with similar functions disclosed in the present application (but not limited thereto).

What is claimed is:

1. An organic light-emitting display panel, comprising: a plurality of pixel driving circuits arranged in a matrix, each of the pixel driving circuits comprising a first voltage terminal, a second voltage terminal, a scanning signal terminal, a data signal terminal, a first control signal terminal, a second control signal terminal, a potential collecting terminal, a driving module, an organic light-emitting device, a luminance control module, a data write module and a potential collecting module;

wherein the driving module comprises a first terminal, a second terminal and a control terminal, wherein the first terminal of the driving module is electrically connected with a first electrode of the organic light-emitting device, the second terminal of the driving module is electrically connected with the first voltage terminal, wherein the driving module is configured to drive the organic light-emitting device to emit light under control of the control terminal, based on a voltage provided by the first voltage terminal;

wherein a second electrode of the organic light-emitting device is electrically connected with the second voltage terminal;

wherein the luminance control module comprises a first terminal, a second terminal and a control terminal, the first terminal of the luminance control module is electrically connected with the first terminal of the driving module, the second terminal of the luminance control module is electrically connected with the control terminal of the driving module, the control terminal of the luminance control module is electrically connected with the first control signal terminal, and the luminance control module is configured to control luminance of the organic light-emitting device by controlling potentials of the first terminal and the control terminal of the driving module;

wherein the data write module is electrically connected with the scanning signal terminal, the control terminal of the driving module and the data signal terminal, and the data write module is configured to write a signal from the data signal terminal into the control terminal of the driving module under control of the scanning signal terminal; and

wherein the potential collecting module is electrically connected with the second control signal terminal, the potential collecting terminal, and the first terminal of the driving module, and the potential collecting module is configured to collect the potential of the first terminal of the driving module.

2. The organic light-emitting display panel according to claim 1,

wherein the driving module comprises a driving transistor and a capacitor, both terminals of the capacitor are electrically connected with a gate and a first electrode of the driving transistor, respectively, the first electrode of the driving transistor is electrically connected with the first electrode of the organic light-emitting device, and a second electrode of the driving transistor is electrically connected with the first voltage terminal;

Wherein the luminance control module comprises a first transistor, a first electrode of the first transistor is electrically connected with the first electrode of the driving transistor, a second electrode of the first transistor is electrically connected with the gate of the driving transistor, and a gate of the first transistor is electrically connected with the first control signal terminal;

Wherein the data write module comprises a second transistor, a first electrode of the second transistor is electrically connected with the gate of the driving transistor, a second electrode of the second transistor is electrically connected with the data signal terminal, and a gate of the second transistor is electrically connected with the scanning signal terminal; and

Wherein the potential collecting module comprises a third transistor, a first electrode of the third transistor is electrically connected with the first electrode of the driving transistor, a second electrode of the third transistor is electrically connected with the potential collecting terminal, and a gate of the third transistor is electrically connected with the second control signal terminal.

3. The organic light-emitting display panel according to claim 1, wherein the organic light-emitting display panel further comprises: a plurality of first control signal lines, a plurality of second control signal lines, a plurality of data

lines, a plurality of scanning lines, a plurality of potential collecting lines, a first voltage signal line and a second voltage signal line;

wherein each of the first control signal lines is electrically connected with the first control signal terminals of one of the rows of the pixel driving circuits, wherein each of the second control signal lines is electrically connected with the second control signal terminals of one of the rows of the pixel driving circuits, wherein each of the data lines is electrically connected with the data signal terminals of one of the rows of the pixel driving circuits, wherein each of the scanning lines is electrically connected with the scanning signal terminals of one of the rows of the pixel driving circuits, and wherein each of the potential collecting lines is electrically connected with the potential collecting terminal; and

wherein the first voltage terminal of each of the pixel driving circuits is electrically connected with the first voltage signal line, and the second voltage terminal of each of the pixel driving circuit is electrically connected with the second voltage signal line.

4. The organic light-emitting display panel according to claim 3, wherein the pixel driving circuit further comprises a reference voltage signal terminal, the luminance control module further includes a fourth transistor, a gate of the fourth transistor is electrically connected with the first control signal terminal, a first electrode of the fourth transistor is electrically connected with the reference voltage signal terminal, and a second electrode of the fourth transistor is electrically connected with the first electrode of the driving transistor.

5. The organic light-emitting display panel according to claim 4, further comprising at least one reference voltage signal line, wherein the at least one reference voltage signal line is electrically connected with the reference voltage signal terminals of at least two of the pixel driving circuits.

6. The organic light-emitting display panel according to claim 3, wherein the matrix of pixel driving circuits form a plurality of pairs of adjacent columns, each pair sharing one of the potential collecting lines.

7. A driving method applied to the organic light-emitting display panel according to claim 1, wherein the driving method comprises:

in a first phase,

providing a first level signal to the first control signal terminal, providing a second level signal to the second control signal terminal, and initializing the control terminal and first terminal of the driving module by the luminance control module to have an identical potential;

in a second phase,

providing the first level signal to the scanning signal terminal, providing the second level signal to the first control signal terminal, providing the second level signal to the second control signal terminal, providing a first signal to the data signal terminal, writing the first signal into the control terminal of the driving module by the data write module, and charging the first terminal of the driving module by the first voltage terminal;

in a third phase,

providing the second level signal to the first control signal terminal and the second control signal terminal, pro-

viding a data signal to the data signal terminal, and raising or lowering a potential of the control terminal of the driving module; and

in a fourth phase,

providing the first level signal to the scanning signal terminal and data signal terminal, providing a luminance control signal to the first control signal terminal, providing the second level signal to the second control signal terminal, emitting light by the organic light-emitting device according to a potential difference between the first terminal of the driving module and the control terminal of the driving module, controlling a light-emitting luminance of the organic light-emitting device with the luminance control signal by controlling light-emitting time of the organic light-emitting device.

8. The driving method according to claim 7, wherein the driving module further comprises a driving transistor and a capacitor, both terminals of the capacitor are electrically connected with a gate and a first electrode of the driving transistor, respectively, the first electrode of the driving transistor is electrically connected with the first electrode of the organic light-emitting device, a second electrode of the driving transistor is electrically connected with the first voltage terminal, the luminance control module comprises a first transistor, a first electrode of the first transistor is electrically connected with the first electrode of the driving transistor, a second electrode of the first transistor is electrically connected with the gate of the driving transistor, the gate of the first transistor is electrically connected with the first control signal terminal, the data write module comprises a second transistor, a first electrode of the second transistor is electrically connected with the gate of the driving transistor, a second electrode of the second transistor is electrically connected with the data signal terminal, a gate of the second transistor is electrically connected with the scanning signal terminal, the potential collecting module comprises a third transistor, a first electrode of the third transistor is electrically connected with the first electrode of the driving transistor, a second electrode of the third transistor is electrically connected with the potential collecting terminal, and a gate of the third transistor is electrically connected with the second control signal terminal;

wherein the driving method further comprises:

in the first phase,

initializing the gate and the first electrode of the driving transistor by the luminance control module to have an identical potential;

in the second phase,

writing the first signal into the gate of the driving transistor by the data write module, charging the first electrode of the driving transistor at the first voltage terminal, and storing a voltage between the gate and first electrode of the driving transistor at the capacitor;

in the third phase,

changing a potential of the gate of the driving transistor; and

in the fourth phase,

emitting light at the organic light-emitting device according to a potential difference between the potential of the gate and the potential of the first electrode of the driving transistor.

9. The driving method according to claim 8, further comprising:

in the first phase,

providing the first level signal to the scanning signal terminal, providing an initialization voltage signal to the data signal terminal, and transmitting the initialization voltage signal to the luminance control module by the data write module; and

in the third phase,

providing the first level signal to the scanning signal terminal, writing the data signal into the gate of the driving transistor by the data write module, and changing a signal of the gate of the driving transistor from the first signal to the data signal.

10. The driving method according to claim 9, wherein a voltage value of the initialization voltage signal is lower than a voltage value of the first signal; and

Wherein a difference between the voltage value of the initialization voltage signal and the voltage value of a signal of the second voltage terminal is smaller than an ON voltage of the organic light-emitting device.

11. The driving method according to claim 8, wherein the pixel driving circuit further comprises a reference voltage signal terminal, the luminance control module further includes a fourth transistor, a gate of the fourth transistor is electrically connected with the first control signal terminal, a first electrode of the fourth transistor is electrically connected with the reference voltage signal terminal, and a second electrode of the fourth transistor is electrically connected with the first electrode of the driving transistor; and wherein the driving method further comprises:

in the first phase, providing the second level signal to the scanning signal terminal, providing the first signal to the data signal terminal, providing a reference voltage signal to the reference voltage signal terminal, and transmitting the reference voltage signal to the gate and first electrode of the driving transistor by the luminance control module; and

in the third phase, providing the first level signal to the scanning signal terminal, and writing the data signal into the gate of the driving transistor by the data write module; and

wherein a voltage value of the reference voltage signal is lower than an ON voltage of the organic light-emitting device.

12. The driving method according to claim 8, further comprising a threshold voltage obtaining phase prior to the first phase,

wherein in the threshold voltage obtaining phase comprises providing the first level signal to the scanning signal terminal and the second control signal terminal, providing the second level signal to the first control signal terminal, providing a first signal to the data signal terminal, writing the first signal into the control terminal of the driving module by the data write module, and charging the first terminal of the driving module by the first voltage terminal.

13. The driving method according to claim 12, wherein the threshold voltage obtaining phase further comprises:

writing the first signal into the gate of the driving transistor by the data write module, charging the first electrode of the driving transistor by the first voltage terminal, storing a voltage between the gate and the first electrode of the driving transistor by the capacitor, and collecting a potential of the first electrode of the driving transistor by the potential collecting terminal.

14. The driving method according to claim 8, wherein a voltage value of the first signal is lower than a voltage value of the data signal.

15. The driving method according to claim 8, further comprising:

in the first phase, the second phase, the third phase and the fourth phase, providing the first voltage signal to the first voltage terminal, and providing the second voltage signal to the second voltage terminal, wherein a voltage value of the first voltage signal is larger than a voltage value of the second voltage signal.

16. An organic light-emitting display device, comprising the organic light-emitting display panel according to claim 1.

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专利名称(译)	有机发光显示面板及其驱动方法和有机发光显示装置		
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摘要(译)

本申请公开了一种有机发光显示面板，以及该显示器的驱动方法。有机发光显示面板包括多个像素驱动电路，每个像素驱动电路包括第一电压端，第二电压端，扫描信号端，数据信号端，第一控制信号端，第二控制信号端子，电位收集端子，驱动模块，有机发光装置，亮度控制模块，数据写入模块和电位收集模块。驱动模块被配置为基于由第一电压端子提供的电压在控制端子的控制下驱动有机发光装置发光。因此，该方法减轻了先进的有机发光显示板技术中的阈值电压漂移。

