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(54) **VOLTAGE-DRIVING PIXEL UNIT HAVING BLOCKING TRANSISTOR, DRIVING METHOD AND OLED DISPLAY**

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G09G 3/10 (2006.01)

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USPC **345/76**; 315/169.3

(58) **Field of Classification Search**
USPC 345/76; 315/169.3
See application file for complete search history.

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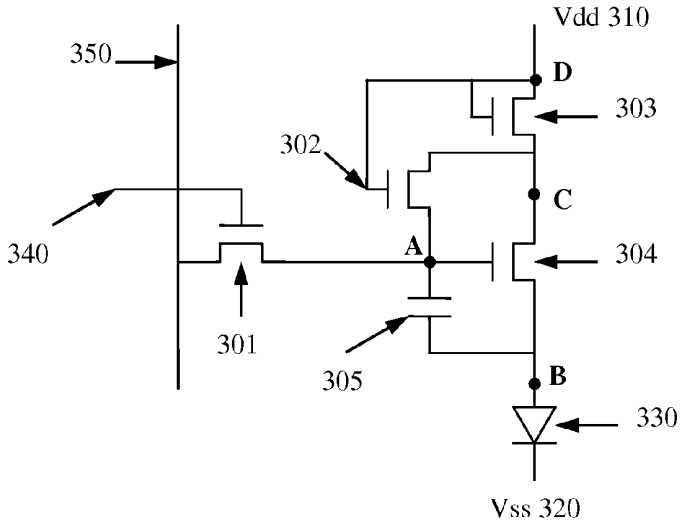
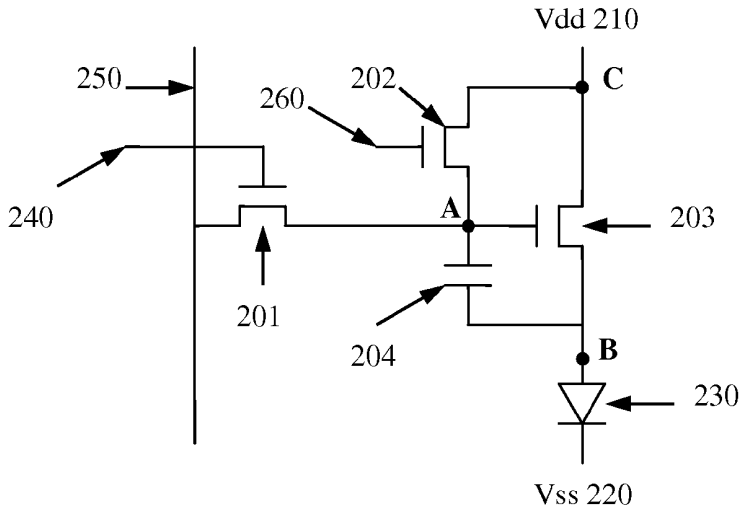
(57) **ABSTRACT**

A voltage-driving pixel unit comprises a voltage-driving pixel circuit and an organic light emitting diode (OLED) driven by the voltage-driving pixel circuit is provided. The voltage-driving pixel circuit comprises a gate line, a data line, a power source line, a ground terminal, a switching transistor, a driving transistor, a compensating transistor, a blocking transistor and a storage capacitor.

11 Claims, 4 Drawing Sheets





(PRIOR ART)

FIG.1

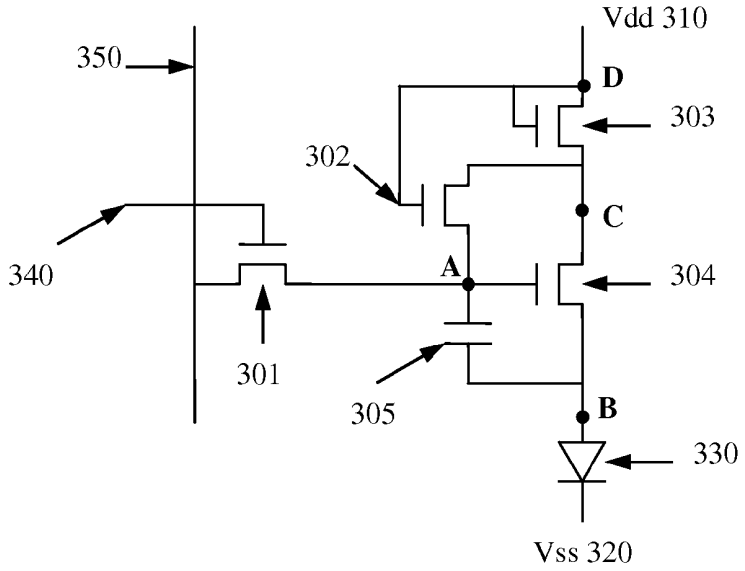


FIG.2

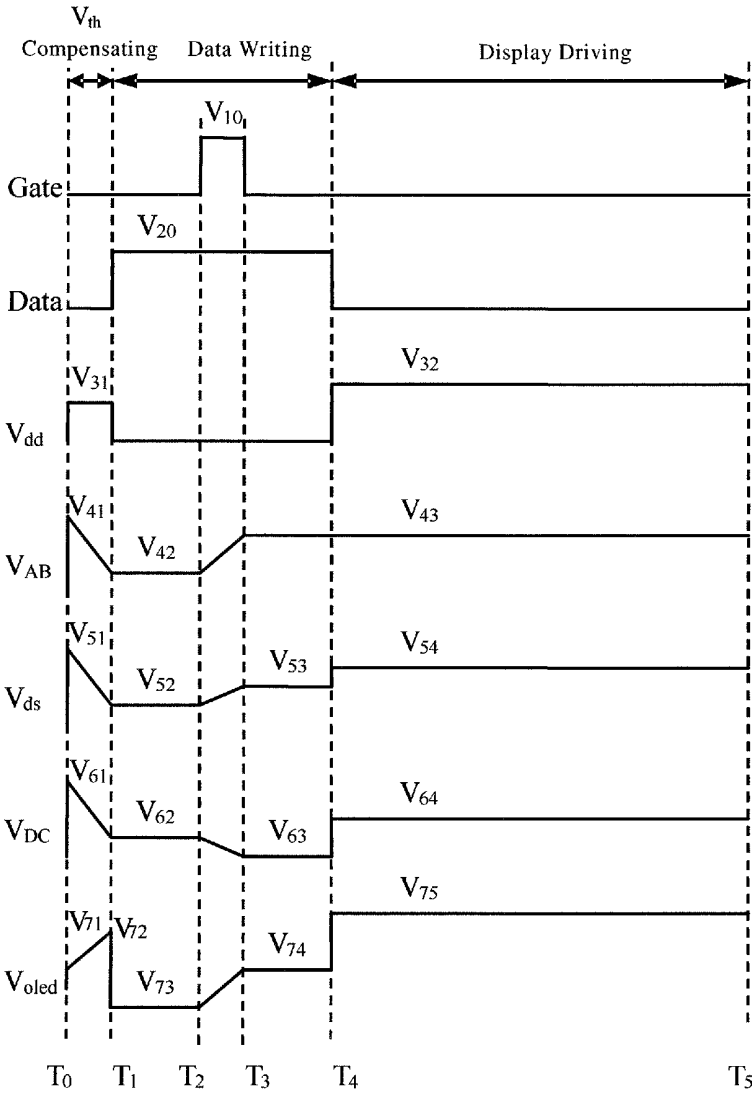

Vth
Compensating
Data Writing
Display Driving
V10
Gate
V20
Data
V32
V31
Vdd
V41
V43
V42
VAB
V51
V54
V53
V52
Vds
V61
V64
V62
V63
VDC
V75
V71
V72
V74
Voled
V73
T0
T1
T2
T3
T4
T5

FIG.3

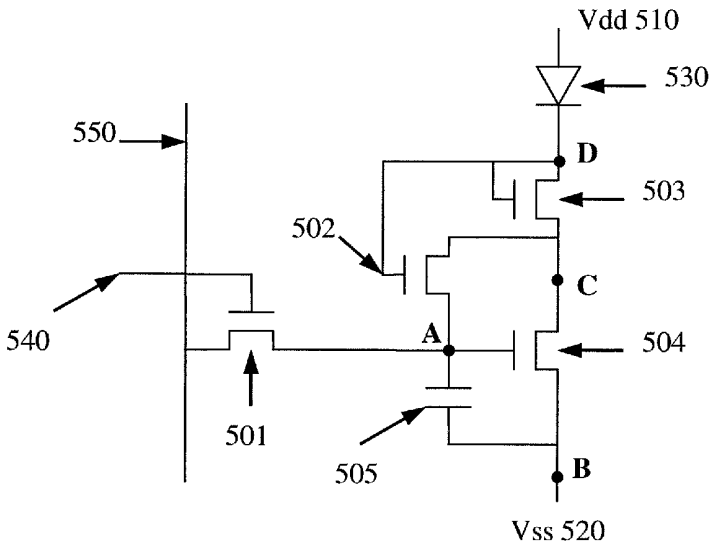


FIG.4

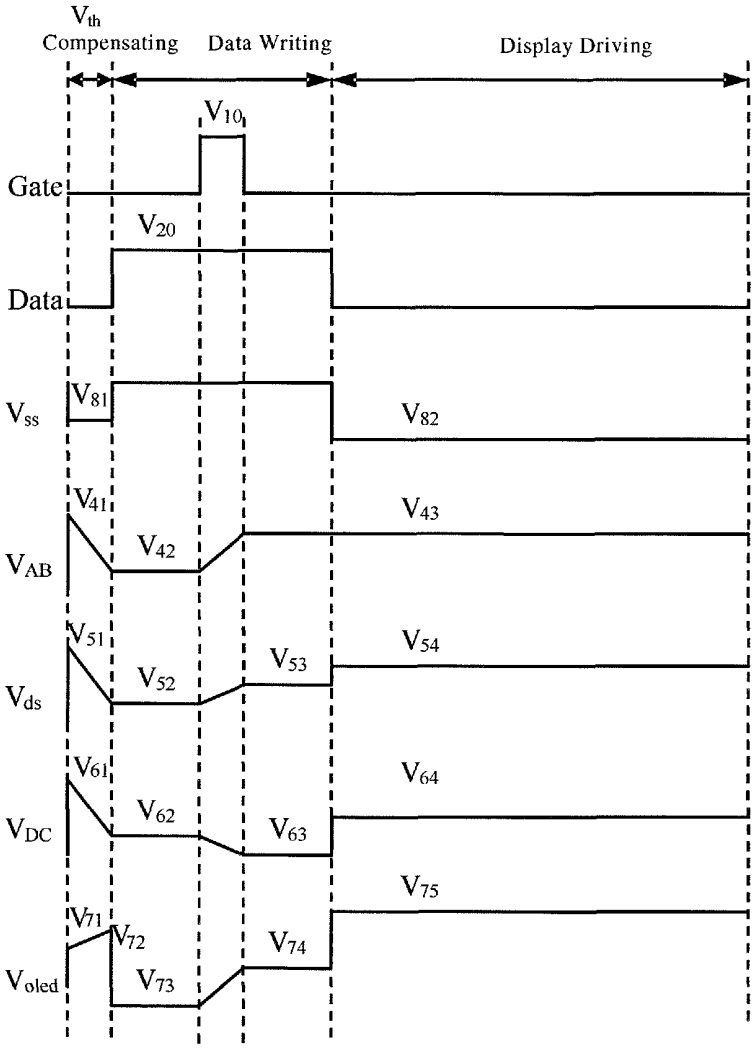

Vth
Compensating
Data Writing
Display Driving
Gate
Data
Vss
VAB
Vds
VDC
Voled
V10
V20
V81
V82
V41
V42
V43
V51
V52
V53
V54
V61
V62
V63
V64
V71
V72
V73
V74
V75

FIG.5

VOLTAGE-DRIVING PIXEL UNIT HAVING BLOCKING TRANSISTOR, DRIVING METHOD AND OLED DISPLAY

BACKGROUND

Embodiments of the present invention relate to a voltage-driving pixel unit, a driving method and an organic light emitting diode (OLED) display.

One way to achieve an OLED display of a large size is to form an active matrix substrate using thin film transistors. Such substrate comprises a pixel array defined by intersecting of gate lines and data lines. For each pixel of the pixel array, a switch transistor is provided; the gate line supplies a selecting signal to turn on the switch transistor; the data line supplies a voltage signal to a driving transistor in the pixel though the turned-on switch transistor; and the driving transistor drives the OLED in the pixel to emit light. Where the driving transistor is voltage-driven for a long time, stress effect may occur in the driving transistor, and, as a result, the threshold voltage of the driving transistor may drift and the current passing through the driving transistor may correspondingly vary. Since the brightness of the OLED is in proportion to the current, the above variation of the current passing through the driving transistor may result in an uncontrollable variation of the brightness of the OLED and further results in a deterioration of the display quality.

A circuit is designed to compensate the threshold voltage drift of the driving transistor, as shown in FIG. **1**. FIG. **1** is a structural view showing a conventional voltage-driving pixel circuit. The voltage-driving pixel circuit in FIG. **1** comprises a switching transistor **201**, a compensating transistor **202**, a driving transistor **203** and a storage capacitor **204** which constitute a three-transistor-and-one-capacitor (3T1C) structure. In addition, the voltage-driving pixel circuit further comprises a signal line **260** for controlling the compensating transistor **202**, a gate line **240**, a data line **250**, a power source V_{dd} **210** and a ground terminal V_{ss} **220**. The voltage-driving pixel circuit is used to drive an organic light emitting diode (OLED) **230** and the operation mechanism is described as follows. Before data is written into the pixel, the cathode voltage V_{ss} is set to a low level, the data line **260** is set to a high level, the driving transistor **203** is turned on, and in this way, a voltage substantially equal to the threshold voltage of the driving transistor **203** is established and temporarily stored in the storage capacitor **204**. During the data is written, the data line **260** is set to a low level, the data signal voltage is written (transferred) to the node A, and in this way, the voltage across the storage capacitor **204** becomes $V_{data}+V_{th}$. Next, during sequence for display driving, the cathode voltage V_{ss} of the OLED **230** is set to a low level so that the driving transistor **203** operates in the current saturation region. Because the driving transistor for the OLED **230** operates in the current saturation region, the current passing through the driving transistor is proportional to $(V_{gs}-V_{th})^2$, i.e., $I\propto(V_{gs}-V_{th})^2$, where V_{gs} is the voltage drop between the gate electrode and the source electrode of the driving transistor and V_{th} is the threshold voltage of the driving transistor. In addition, when V_{gs} is equal to the sum of the written data signal voltage (V_{data}) and the threshold voltage (V_{th}), $I\propto(V_{gs}-V_{th})^2=(V_{data}+V_{th}-V_{th})^2=V_{data}^2$, that is, the current for driving the OLED becomes independent of the threshold voltage. Thus, the drift of the threshold voltage can be compensated.

However, the above-described voltage-driving pixel circuit has the following disadvantage. During the data is written, the driving transistor **203** is in the turned-on state so that the node B is charged and reaches a high level, and thus the voltage across the storage capacitor **204** is decreased; that is, the voltage that is previously equal to the threshold voltage and stored in the storage capacitor before the data is written is decreased. Thus, the effect of compensating the drift of the driving transistor threshold voltage is degraded. Therefore, the current for driving the OLED **230** may still vary, and correspondingly, the brightness of the OLED may vary and the display quality may be deteriorated.

SUMMARY

In an aspect, a voltage-driving pixel unit is provided. The voltage-driving pixel unit comprises a voltage-driving pixel circuit and an organic light emitting diode (OLED) driven by the voltage-driving pixel circuit. The voltage-driving pixel circuit comprises a gate line, a data line, a power source line, a ground terminal, a switching transistor, a driving transistor, a compensating transistor, a blocking transistor and a storage capacitor. The switching transistor is used to control inputting of a data signal voltage from the data line, a gate electrode thereof is connected with the gate line, a drain electrode thereof is connected with the data line and a source electrode thereof is connected with a gate electrode of the driving transistor. The compensating transistor is used to pre-store an instant threshold voltage of the driving transistor to the storage capacitor, a gate electrode thereof is connected with the power source line, a drain electrode thereof is connected with a source electrode of the blocking transistor and a source electrode thereof is connected with source electrode of the switching transistor. The driving transistor is used to provide a driving current to the OLED, a gate electrode thereof is connected with one side of the storage capacitor and a source electrode thereof is connected with the other side of the storage capacitor. The blocking transistor is used to block a connection between the driving transistor and the power source line, both a gate electrode and a drain electrode thereof are connected with the power source line and a source electrode thereof is connected with a drain electrode of the driving transistor.

In another aspect, a driving method for a voltage-driving pixel unit is further provided. The voltage-driving pixel unit comprises a voltage-driving pixel circuit and an organic light emitting diode (OLED) driven by the voltage-driving pixel circuit. The voltage-driving pixel circuit comprises a gate line, a data line, a power source line, a ground terminal, a switching transistor, a driving transistor, a compensating transistor, a blocking transistor and a storage capacitor. The method comprises: step 1 of applying a low level signal to the gate line, respectively applying a voltage signal to the power source line and the ground terminal, thus turning on the compensating transistor and the blocking transistor and charging the storage capacitor to a threshold voltage of the driving transistor; step 2 of applying a high level signal to the gate line and respectively applying a voltage signal to the power source line and the ground terminal, thus rendering the compensating transistor and the blocking transistor in an OFF state, turning on the switching transistor, and writing a data signal voltage from the data line to the storage capacitor; and step 3 of applying a low level signal to the gate line, respectively applying a voltage signal to the power source line and the ground terminal, thus turning on the blocking transistor and driving the OLED to emit light with the voltage stored in the storage capacitor.

In still another aspect, an organic light emitting diode display comprising the above-described voltage-driving pixel unit is further provided, wherein the voltage-driving pixel unit is provided on an array substrate.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention and wherein:

FIG. **1** is a structural view showing a conventional voltage-driving pixel circuit;

FIG. **2** is a structural view showing a voltage-driving pixel unit according to a first embodiment of the invention;

FIG. **3** is a diagram showing a driving sequence of a driving method performing by the voltage-driving pixel unit in FIG. **2**;

FIG. **4** is a structural view showing a voltage-driving pixel unit according to a second embodiment of the invention; and

FIG. **5** is a diagram showing a driving sequence of a driving method performing by the voltage-driving pixel unit in FIG. **4**.

DETAILED DESCRIPTION

In an embodiment of the invention, a blocking transistor is added to the conventional voltage-driving pixel circuit. The blocking transistor may be connected with the power source line so that the voltage across the storage capacitor is not decreased during the data is written, and thus the compensation to the threshold voltage of the driving transistor can be precisely controlled. Hereinafter, the embodiments of the invention will be described in detail with reference to the accompanying drawings.

FIG. **2** is a structural view showing a voltage-driving pixel unit according to a first embodiment of the invention. In this embodiment, a pixel unit in an active matrix organic light emitting diode (AMOLED) display with common cathode is shown as an example.

As shown in FIG. **2**, the voltage-driving pixel unit in this embodiment comprises a voltage-driving pixel circuit and an organic light emitting diode (OLED) **330** driven by the voltage-driving pixel circuit. The voltage-driving pixel circuit comprises four N-type transistors, i.e., a switching transistor **301**, a compensating transistor **302**, a blocking transistor **303** and a driving transistor **304**. In addition, the voltage-driving pixel circuit further comprises a storage capacitor **305**, a power source line **310**, a ground terminal **320**, a gate line **340** and a data line **350**. The cathode of the OLED **330** is grounded, and the anode of the OLED **330** is connected with a source electrode of the driving transistor **304**. A gate electrode of the switching transistor **301** is connected with the gate line **340**, a drain electrode of the transistor **301** is connected with the data line **350**, and a source electrode of the transistor **301** is commonly connected with one electrode of the storage capacitor **305**, a source electrode of the compensating transistor **302** and a gate electrode of the driving transistor **304**. The switching transistor **301** is used to supply a data signal voltage from the data line **350** to the storage capacitor **305** and the driving transistor **304** under the control of a selecting signal from the gate line **340**. A gate electrode of the compensating transistor **302** and both a gate electrode and a drain electrode of the blocking transistor **303** are connected with the power source line V_{dd} **310**. A drain electrode of the compensating transistor **302** is connected with a source electrode of the blocking transistor **303**. The compensating transistor **302** is used to compensate the threshold voltage through pre-storing the instant threshold voltage of the driving transistor **304** in the storage capacitor **305** by charging the storage capacitor **305** under the control of the power source signal V_{dd}. The blocking transistor **303** is used to prevent the driving transistor **304** from being turned on to charge the node B when the switching transistor **301** is turned on to write the data signal voltage from the data line **350** to the pixel circuit, thus the threshold voltage pre-stored by the compensating transistor **302** will not be deviated. The driving transistor **304** is turned on or off under the control of the voltage across the storage capacitor **305**. The source electrode of the driving transistor **304** is connected with the anode of the OLED **330**, and the drain electrode of the transistor **304** is connected with the source electrode of the blocking transistor **303**. The driving transistor **304** is used to supply a precise driving current to the OLED **330**, and the current passing through the driving transistor **304** is controlled by the data signal voltage stored in the storage capacitor **305**. The cathode of the OLED **330** is connected with the ground terminal V_{ss} **320**. The ground terminal V_{ss} **320** is used as the common cathode in this embodiment and supplies a reference voltage.

The voltage-driving pixel circuit in this embodiment is compatible with a voltage amplitude modulation data-driving chip and/or a pulse width modulation data-driving chip. In addition, the voltage-driving pixel circuit in this embodiment can be produced by using the low-cost, high-reliable and simple amorphous silicon manufacturing process, which facilitates the optimization of the product yield. In addition, in this embodiment, the additional signal line is omitted by employing the modulated power source signal as the control signal of the compensating transistor and the blocking transistor, and thus the layout of the array substrate can be simplified, which facilitates the improvement of the yield of the voltage-driving pixel circuit. In addition, the voltage-driving pixel circuit in this embodiment can employ only same type transistors such as N type amorphous silicon transistors, and thus the manufacture process can be further simplified and the product yield can be further improved.

In addition, a driving method with the above-described voltage-driving pixel circuit in the embodiment is further provided. FIG. **3** is a diagram showing a driving sequence of the driving method with the voltage-driving pixel unit shown in FIG. **2**. In the sequence diagram shown in FIG. **3**, the following signals during one frame is displayed are illustrated: the selecting signal V_{10} of the gate line **340**; the data signal voltage V_{20} of the data line **350**, the voltage V_{dd} of the power source line **310** (comprising the control voltage V_{31} for voltage presetting and the control voltage V_{32} for display driving); the voltage V_{41}, V_{42} and V_{43} of the voltage V_{AB} across the storage capacitor **305** in three respective sequences (the voltage V_{AB} between the node A on one side of the storage capacitor **305** and the node B on the other side of the storage capacitor, and also the V_{gs} of the driving transistor **304**); the voltage V_{51}, V_{52}, V_{53} and V_{54} of the source-drain voltage of the driving transistor **304** respectively at the initial point and in three sequences, i.e., V_{ds}; the voltage V_{61}, V_{62}, V_{63} and V_{64} of the source-drain voltage of the blocking transistor **303** respectively at the initial point and in three sequences, i.e., V_{DC}; the voltage V_{71}, V_{72}, V_{73}, V_{74} and V_{75} of the voltage V_{oled} across the OLED **330** respectively at the

initial point and in three sequences. The first discharging prior to the data writing can be performed to eliminate the influence of the previous frame, and the second discharging can be performed after the data writing to eliminate the influence on the next frame. The driving method mainly comprises a compensating sequence (i.e., voltage-presetting sequence), a data-writing sequence and a display driving sequence. The compensating transistor and the blocking transistor are controlled by multi-level voltage signals from the power source line so that the threshold voltage of the driving transistor is pre-stored in the storage capacitor and such pre-stored threshold voltage is kept invariable within the data-writing sequence. Hereinafter, the compensating sequence, the data-writing sequence and the display driving sequence of the driving method are described in detail with reference to FIG. **2** and FIG. **3**.

The Compensating Sequence

This sequence is the voltage-presetting stage. In this sequence, when the OLED **330** is in the OFF state (i.e., turned off), an initial voltage substantially equal to the threshold voltage of the driving transistor **304** is preset in the storage capacitor **305**. Specifically, as shown in FIG. **3**, in the period from the initial point T**0** to T**1** of the frame, the selecting signal of the gate line **340** is set at a low level so that the switching transistor **301** is in an OFF state. The operation voltage of the power source line **310** is V_{dd}, and the power source line **310** supplies a first voltage signal V_{31} to the gate electrode of the compensating transistor **302** and the gate and drain electrodes of the blocking transistor **303**. The voltage signal V_{31} is the range of 2~5 V. In this way, the compensating transistor **302** and the blocking transistor **303** are turned on so that the storage capacitor **305** can be temporarily charged to a high level V_{41} larger than the threshold voltage of the driving transistor **304**. In addition, the gate electrode and the drain electrode of the blocking transistor **303** are kept to be at the same potential, thus the blocking transistor **303** and the compensating transistor **302** operate in the current saturation region, and thus stable charge current can be provided. In addition, the voltage V_{AB} between the node A on one side of the storage capacitor **305** and the node B on the other side of the storage capacitor equals to the V_{gs} of the driving transistor **304**, that is, $V_{AB}=V_{41}=V_{gs}$ (**304**), and in this way, the driving transistor **304** is turned on. The node B of the storage capacitor **305** is charged by the current passing through the driving transistor **304** so that the potential of the node B is increased and in turn the voltage V_{AB} is decreased. Since the current passing through the driving transistor **304** is proportional to $(V_{gs}-V_{yh})^2$, a current passes through the driving transistor **304** to charge the node B till the voltage V_{AB} is decreased to V_{th}. Then, the V_{AB} of the storage capacitor **305** is stably maintained to V_{th}. V_{th} substantially equals to the threshold voltage of the driving transistor **304**.

It should be noted that, the voltage sequence shown in FIG. **3** is merely a schematic view and may not fully reflect the variation of the voltage V_{AB} stored by the storage capacitor during the period from T**0** to T**1**. For example, depending on the sizes of the transistors and the storage capacitor and the value of the voltage signal, the voltage V_{AB} may reach the V_{th} prior to T**1** or at T**1**; these two cases are within the spirit and scope of the invention. In addition, it should be noted that, the initial threshold voltage is about 1.5V~2.5 V for the N-type amorphous silicon transistor, and the threshold voltage of such transistor may drift to even 10 V due to the stress effect resulted from long-time operation. The pixel circuit in this embodiment can compensate such drift of the threshold voltage. In FIG. **3**, the variation of the source-drain voltag e V_{ds} of the driving transistor **304**, the variation of the source-drain voltage V_{DC} of the blocking transistor **303** and the variation of the voltage V_{oled} of the organic light emitting diode are shown as well. The blocking transistor **303** and the compensating transistor **302** are in the current saturation region, and their source-drain voltages V_{ds} are larger or equal to $V_{gs}-V_{th}$. Similar to the above variation process of the voltage V_{AB}, the voltage V_{ds} transits from the transient voltage V_{51} at the time when the voltage signal V_{31} is supplied to the stable voltage V_{52}, and the voltage V_{DC} transits from the transient voltage V_{61} at the time when the voltage signal V_{31} is supplied to the stable voltage V_{62}. In addition, since the voltage V_{oled} satisfies the relationship: $V_{oled}+V_{ds}+V_{DC}=V_{dd}$, the voltage V_{oled} is increased from V_{71} to V_{72}. At the time of T**1**, the supply of the high level voltage signal V_{31} from the power source line **310** is stopped, and the pre-charging of the pixel circuit and the compensation of the threshold voltage are completed.

In addition, before the compensating voltage is preset into the storage capacitor **305**, that is, at the initial stage of writing the threshold voltage into the storage capacitor **305**, a reverse bias may be supplied to the OLED **330**. Specifically, the power source line **310** temporarily supplies a high level signal, and the voltage larger than the threshold voltage of the driving transistor **304** is established and stored in the storage capacitor **305**; then the cathode voltage Vss of the OLED **330** is set to a high level, and the voltage Vdd of the power source line **330** is set to a low level. The OLED **330** is reversely biased, and the driving transistor **304** is turned on so that any residual charges or voltage from the previous frame can be eliminated. Since the OLED **330** is a thin film device, charges are easily accumulated under a forward bias; when the reverse bias is applied to the OLED **330**, the accumulated charges can be eliminated and the OLED **330** can operate under a low voltage.

The Data-Writing Sequence

When the voltage V_{dd} of the power source line **310** is set to a low level (or no voltage signal is transmitted over the power source line **310**), the blocking voltage **303** is in an OFF state, preventing current from passing through the driving transistor **304** to charge the node B of the storage capacitor, and accordingly, it is prevented that the pre-stored threshold voltage drifts. At this time, the pixel circuit is set into the operation state, that is, the data signal voltage from the data line **350** is supplied to the pixel. Specifically, in the sequence when the data signal voltage is written, the data signal voltage V_{20} is supplied to the data line **350** during the period from T**1** to T**4**, and the high level voltage V_{10} is supplied to the gate line **340** during the period from T**2** to T**3**. In this case, the switching transistor **301** is turned on by the high level voltage V_{10} of the gate line **340**, and the date signal voltage from a driving chip is written into the pixel circuit in the form of the current passing through the data line **350**. Since the impedance of the switching transistor **301** is low after it is turned on, the resultant current loss can be kept low, and thus the potential at the node A is substantially consistent with the data signal voltage V_{data} from the data line **340**. At this time, the voltage V_{dd} of the power source line **310** is at a low level and smaller than $V_{ss}+2V$ (i.e., $V_{dd}<V_{ss}+2V$), and the OLED **330** is in an OFF state. When the voltage across the OLED **330** is smaller than 2V, the OLED **330** generally is in an OFF state and not turned on. When the voltage V_{dd} of the power source line **310** is set to a low level, the OLED **330** is not or substantially not turned on, and at this time, the voltage across the OLED **330** may be in a forward-biased or reverse-biased state depending on the value of the voltage V_{dd}, the size of the devices in the pixel circuit, and the size and material of the OLED **330**. At this time, the OLED **330** can be regarded as a capacitor; the current passing through the OLED **330** is very low and thus

has little influence on the process of writing the signal into the pixel circuit. In addition, since the voltage V_{dd} from the power source line **310** is at a low level, both the compensating transistor **302** and the blocking transistor **303** are in an OFF state, and thus substantially no leakage current passes through the driving transistor **304** and the node B is substantially not charged. In the data-writing sequence, since the OLED **330** is regarded as a capacitor and the blocking transistor **303** is in an OFF state as described above, the node B can be kept at the stable preset potential, and thus the voltage V_{AB} across the storage capacitor **305** can be equal to the sum of the data signal voltage and the preset threshold voltage. As shown in FIG. **3**, the stored voltage $V_{AB}=V_{43}=V_{42}+V_{data}=V_{th}+V_{data}$, that is, the data signal voltage is added to the preset voltage in the storage capacitor.

It should be noted that, the voltage sequence shown in FIG. **3** is merely a schematic view and may not fully reflect the variation of the voltage V_{AB} of the storage capacitor during the period from T**2** to T**3**. For example, depending on the sizes of the transistors and the storage capacitor and the value of the voltage signal, the voltage V_{AB} may reach the stable $V_{th}+V_{data}$ prior to T**3** or at T**3**. In addition, in the data-writing sequence, the voltage across the OLED **330** is smaller than 2V, and the OLED **300** is in an OFF state. Although the capacitive impedance of the OLED **330** is almost ten times larger than that of the storage capacitor **305**, a small potion of the voltage across the storage capacitor **305** is applied across the OLED **330**, and thus the data signal voltage on the storage capacitor is generally decreased by about 5%. In FIG. **3**, the variation of the source-drain voltage V_{ds} of the driving transistor **304**, the variation of the source-drain voltage V_{DC} of the blocking transistor **303**, the variation of the voltage V_{oled} of the OLED **330** during the period from T**1** to T**4** are shown as well. The variations of V_{ds} and V_{DC} are incurred by the parasitic capacitances of the driving transistor **304** and the blocking transistor **303**, respectively. The voltage of the OLED **330** varies according to the relationship: $V_{oled}=V_{dd}-V_{DC}-V_{ds}$. In addition, it also should be noted that, the parasitic capacitances of the driving transistor **304** and the blocking transistor **303** have no influences on the process of writing the data signal voltage into the pixel circuit because both the blocking transistor **303** and the driving transistor **304** are not directly connected with the node B.

The Display Driving Sequence

In the display driving sequence, the driving current provided through the driving transistor only depends on the data signal voltage stored in the storage capacitor and is not related to the threshold voltage of the driving transistor. In the display driving sequence, the power source line **310** supplies a high-level signal V_{dd}, and thus the OLED **330** is driven to emit light. Specifically, at the initial point T**4** of the display-written sequence, the voltage V_{dd} of the power source line **310** is set to a high-level voltage V_{32}. At this time, the voltage V_{dd} is required to supply the driving current and operation voltage to the blocking transistor **303**, the driving transistor **304** and the OLED **330**, and thus the voltage V_{dd} is generally set in the range of 20~30 V. The blocking transistor **303** is turned on so that a current path for the driving current is formed. The driving current I flows into the OLED **330** through the driving transistor **304**. The potential at the node C in the pixel circuit is slightly smaller than the power source voltage V_{32} because of a small voltage drop on the blocking transistor **303**. The voltage V_{gs} of the driving transistor **304** is provided by the voltage V_{AB} stored in the storage capacitor, that is, $V_{gs}=V_{data}+V_{th}$. The voltage V_{ds} of the driving transistor **304** satisfies the relationship: $Vds\approx V_{32}-V_{AB}>V_{gs}-V_{th}=V_{data}$, and thus the driving transistor **304** operates in the current saturation region. In addition, the driving current I provided to the OLED **330** satisfy the relationship: $I\propto (V_{gs}-V_{th})^2=(V_{data}+V_{th}-V_{th})^2=V_{data}^2$. That is, the driving current for the OLED **330** is merely associated with V_{data}^2. Therefore, since the brightness of the OLED **330** is proportional to the driving current passing through it, the brightness of the OLED **330** is merely associated with the data signal voltage V_{data}.

According to the above-described driving method, a relationship between the voltage signal and the driving current is established regardless of the threshold voltage of the driving transistor **304**, that is, the driving current provided to the OLED **330** through the driving transistor **304** is not associated with the threshold voltage. As shown in FIG. **3**, in the display driving sequence, the source-drain voltage of the blocking transistor **303** is V_{64}, the source-drain voltage of the driving transistor **304** is V_{54}, and the voltage V_{oled} applied across the OLED **330** satisfies the relationship: $V_{75}=V_{32}-V_{64}-V_{54}$, which is larger than or equal to the turned-on voltage (~2V) of the OLED **330** and depends on the driving current of the driving transistor **304**. The brightness of the OLED **330** is proportional to the driving current of the driving transistor **304**.

According to the above-described driving method, the influence of the data signal voltage on the threshold voltage that is pre-stored in the storage capacitor can be alleviated to a most degree by blocking the connection between the driving transistor and the power source line with the blocking transistor in the data-writing sequence, and thus the threshold voltage preset in the storage capacitor can be stably maintained and the data signal voltage can be precisely written. In addition, since the influence of the data signal voltage on the threshold voltage preset in the storage capacitor is alleviated during the data-writing sequence, the accuracy of the threshold voltage preset in the storage capacitance can be maintained, and the accuracy of the data signal voltage for controlling the brightness of the OLED can be maintained as well. In addition, since the driving current of the driving transistor is not associated with the threshold of the driving transistor, the brightness of the OLED merely depends on the data signal voltage, and the influence of the threshold voltage variation on the driving current and the brightness of the OLED can be reduced, especially the influence of the drift of the threshold voltage by the stress effect resulting from long-time operation of the driving transistor can be greatly reduced.

FIG. **4** is a structural view showing a voltage-driving pixel unit according to a second embodiment of the invention. In this embodiment, a pixel unit in an AMOLED display with common anode is shown as an example.

As shown in FIG. **4**, the voltage-driving pixel unit in this embodiment comprises a voltage-driving pixel circuit and an OLED **530** driven by the voltage-driving pixel circuit. The voltage-driving pixel circuit comprises four N-type transistors, i.e., a switching transistor **501**, a compensating transistor **502**, a blocking transistor **503** and a driving transistor **504**. In addition, the voltage-driving pixel circuit further comprises a storage capacitor **505**, a power source line **510**, a ground terminal **520**, a gate line **540** and a data line **550**. The anode of the OLED **530** is connected with the power source line **510**, and the cathode of the OLED **530** is connected with a drain electrode of the blocking transistor **503**.

A gate electrode of the switching transistor **501** is connected with the gate line **540**, a drain electrode of the transistor **501** is connected with the data line **550**, and a source electrode of the transistor **501** is connected with one side of the storage capacitor **505**, a source electrode of the compensating transistor **502** and a gate electrode of the driving tran-

sistor **504**. A gate electrode of the compensating transistor **502** and both a gate electrode and a drain electrode of the blocking transistor **503** are connected with the cathode of the OLED **530**. A drain electrode of the compensating transistor **502** is connected with a source electrode of the blocking transistor **503**. The blocking transistor **503** is used to prevent the driving transistor **504** from being turned on to charge the node B when the switching transistor is **501** is turned on to write the data signal voltage from the data line **550** to the pixel circuit, so that the threshold voltage pre-compensated by the compensating transistor **502** will not be deviated. The driving transistor **504** is turned on or off under the control of the voltage across the storage capacitor **505**. The source electrode of the driving transistor **504** is connected with the other side of the storage capacitor **505**, and the drain electrode of the transistor **504** is connected with the source electrode of the blocking transistor **503** and the drain electrode of the compensating transistor **502**. The functions of the transistors **501** to **504** are similar to those in the first embodiment.

In addition, the effects and advantages of the voltage-driving pixel circuit in this embodiment are similar to those of the first embodiment. The additional signal line is omitted by employing the modulated power source signal as the control signal of the compensating transistor and the blocking transistor, and thus the layout of the array substrate can be simplified, which facilitates the improvement of the yield of the voltage-driving pixel circuit. In addition, the voltage-driving pixel circuit in this embodiment can employ only same type transistors such as N type amorphous silicon transistors, and thus the manufacture process can be further simplified and the product yield can be further improved.

In addition, a driving method with the voltage-driving pixel circuit according to this embodiment is further provided. FIG. **5** is a diagram showing the driving sequence of a driving method with the voltage-driving pixel unit in FIG. **4**. As shown in FIG. **5**, the driving method mainly comprises three sequences, i.e., the compensating sequence, the data-writing sequence and the display driving sequence. In the sequence diagram shown in FIG. **5**, the following signals during one frame is displayed are illustrated: the selecting signal V_{10} of the gate line **540**; the data signal voltage V_{20} of the data line **550**, the voltage V_{ss} of the ground terminal **520** (comprising the control voltage V_{81} for voltage presetting and the control voltage V_{82} for display driving); the voltage V_{41}, V_{42} and V_{43} of the voltage V_{AB} of the storage capacitor **505** in the three respective sequences (the voltage V_{AB} between the node A on one side of the storage capacitor **505** and the node B on the other side of the storage capacitor **505**, and also the V_{gs} of the driving transistor **504**); the voltage V_{51}, V_{52}, V_{53} and V_{54} of the source-drain voltage of the driving transistor **504** respectively at the initial point and in the three sequences, i.e., V_{ds}; the voltage V_{61}, V_{62}, V_{63} and V_{64} of the source-drain voltage of the blocking transistor **503** respectively at the initial point and in three sequences, i.e., V_{DC}; the voltage V_{71}, V_{72}, V_{73}, V_{74} and V_{75} of the voltage V_{oled} across the OLED **530** respectively at the initial point and in the three sequences.

The driving method in this embodiment is similar to that in the first embodiment. The process and mechanism of the threshold voltage-presetting sequence, the data-writing sequence and the display driving sequence, and the variation of V_{gs} and V_{ds} of the driving transistor **504**, the variation of the voltage V_{AB} of the storage capacitor **505**, the variation of the source-drain voltage V_{DC} of the blocking transistor **503** and the variation of the voltage V_{oled} across the OLED **530** are similar to those in the first embodiment, and the details thereof are omitted here for simplicity. The second embodiment is different from the first embodiment in that, the voltage V_{dd} supplied from the power source line **510** to the common anode of the OLED **530** is maintained to be stable in the driving process, while multi-level voltage signals are provided by the voltage Vss of the ground terminal **520** according to the different sequences of threshold voltage-presetting, data-writing and display driving. The voltage provided by the ground terminal **520** is a negative voltage.

According to the above-described driving method, the influence of the data signal voltage on the threshold voltage preset in the storage capacitor can be alleviated to a most degree by blocking the connection between the driving transistor and the power source line with the blocking transistor during the data-writing sequence, and thus the threshold voltage preset in the storage capacitor can be stably maintained and the data signal voltage can be precisely written. In addition, since the influence of the data signal voltage on the threshold voltage preset in the storage capacitor is alleviated during the data-writing sequence, the accuracy of the threshold voltage preset in the storage capacitor can be maintained, and the accuracy of the data signal voltage for controlling the brightness of the OLED can be maintained as well. In addition, since the driving current of the driving transistor is not associated with the threshold of the driving transistor, the brightness of the OLED merely depends on the data signal voltage, and thus the influence of the threshold voltage variation on the driving current and the brightness of the OLED can be reduced, especially the influence of the drift of the threshold voltage resulting from a long-time operation of the driving transistor can be greatly reduced.

In addition, an OLED display comprising the voltage-driving pixel unit according anyone of the above embodiments is also provided. In the OLED display, the voltage-driving pixel unit is provided on an array substrate.

The array substrate comprises a plurality of gate lines and a plurality of data lines. The gate lines and the data lines are intersected with each other to define a plurality of pixel regions for forming the voltage-driving pixel units. The array substrate may further comprise a row driving chip for providing voltage signals to the voltage-driving pixel units and a column driving chip for providing column signals. The OLED display may further comprise a circuit board and a structure for packaging the OLED display. The circuit board may be provided with a chip group, a voltage source and a voltage source for proving sequence-control signal to the row driving chip and the column driving chip.

The OLED display may be a common anode type or a common cathode type. In the OLED of the common cathode type, the cathode of the OLED in each pixel circuit is connected to a ground terminal, the ground terminals for the pixel circuits within the same row are connected together and then connected to the driving chip, and the control signals are provided by the driving chip. In addition, in the OLED display of the common anode type, the anode of the OLED in each pixel circuit is connected to a power source line, the power source lines for the pixel circuits within the same row are connected together and then connected to the driving chip, and the control signals are provided by the driving chip.

In the OLED display, the blocking transistor and the switching transistor in a pixel within the N-th row can be controlled by a common gate line, thus the design of the pixel circuit and the array substrate can be further simplified, the load on the power source can be reduced and the power consumption can be decreased.

It should be appreciated that the embodiments described above are intended to illustrate but not limit the present invention. Although the present invention has been described in detail herein with reference to the preferred embodiments, it

should be understood by those skilled in the art that the present invention can be modified and some of the technical features can be equivalently substituted without departing from the spirit and scope of the present invention.

What is claimed is:

1. A voltage-driving pixel unit, comprising a voltage-driving pixel circuit and an organic light emitting diode (OLED) driven by the voltage-driving pixel circuit,

wherein the voltage-driving pixel circuit comprises a gate line, a data line, a power source line, a ground terminal, a switching transistor, a driving transistor, a compensating transistor, a blocking transistor and a storage capacitor,

wherein the switching transistor is used to control inputting of a data signal voltage from the data line, a gate electrode of the switching transistor is connected with the gate line, a drain electrode of the switching transistor is connected with the data line, and a source electrode of the switching transistor is connected with a gate electrode of the driving transistor;

the compensating transistor is used to pre-store an instant threshold voltage of the driving transistor to the storage capacitor, a gate electrode of the compensating transistor is directly connected with the power source line or a cathode of the OLED, a drain electrode of the compensating transistor is connected with a source electrode of the blocking transistor, and a source electrode of the compensating transistor is connected with source electrode of the switching transistor;

the driving transistor is used to provide a driving current to the OLED, a gate electrode of the driving transistor is connected with one side of the storage capacitor, and a source electrode of the driving transistor is connected with the other side of the storage capacitor; and

the blocking transistor is used to block a connection between the driving transistor and the power source line, both a gate electrode and a drain electrode of the blocking transistor are directly connected with the power source line or the cathode of the OLED, and a source electrode of the blocking transistor is connected with a drain electrode of the driving transistor.

2. The voltage-driving pixel unit according to claim **1**, wherein a cathode of the OLED is connected with the ground terminal, and an anode of the OLED is connected with the source electrode of the driving transistor.

3. The voltage-driving pixel unit according to claim **1**, wherein an anode of the OLED is connected with the power source line, and the cathode of the OLED is directly connected with the gate and drain electrodes of the blocking transistor and the gate electrode of the compensating transistor.

4. An organic light emitting diode (OLED) display comprising the voltage-driving pixel unit according to claim **1**, wherein the voltage-driving pixel unit is provided on an array substrate.

5. The OLED display according to claim **4**, wherein a cathode of the OLED of the pixel unit on the array substrate is connected with the ground terminal.

6. The OLED display according to claim **4**, wherein an anode of the OLED of the pixel unit on the array substrate is connected with the power source line.

7. The OLED display according to claim **4**, wherein the array substrate is further provided with a row driving chip for providing voltage signal to the voltage-driving pixel unit and a column driving chip for providing current signal.

8. The OLED display according to claim **4**, further comprising a circuit board and a structure for packaging the OLED display.

9. A driving method for a voltage-driving pixel unit, the voltage-driving pixel unit comprising a voltage-driving pixel circuit and an organic light emitting diode (OLED) driven by the voltage-driving pixel circuit, the voltage-driving pixel circuit comprising a gate line, a data line, a power source line, a ground terminal, a switching transistor, a driving transistor, a compensating transistor, a blocking transistor and a storage capacitor, the method comprising:

after supplying a high level signal via the power source line, thus storing a voltage larger than the threshold voltage of the driving transistor into the storage capacitor, and setting a cathode of the OLED to a high level, setting the power source to a low level, thus reversely biasing the OLED and turning on the driving transistor,

step 1 of applying a low level signal to the gate line, applying a signal voltage to the power source line and the ground terminal respectively, thus directly turning on the compensating transistor and the blocking transistor and charging the storage capacitor to a threshold voltage of the driving transistor;

step 2 of applying a high level signal to the gate line and applying a signal voltage to the power source line and the ground terminal respectively, thus directly rendering the compensating transistor and the blocking transistor in an OFF state, turning on the switching transistor, and writing a data signal voltage from the data line to the storage capacitor; and

step 3 of applying a low level signal to the gate line, applying a signal voltage to the power source line and the ground terminal respectively, thus directly turning on the blocking transistor and driving the OLED to emit light with the voltage stored in the storage capacitor.

10. The method according to claim **9**, wherein applying a signal voltage to the power source line and the ground terminal respectively in the step 1 comprises applying a first high level signal to the power source line, and applying a low level signal to the ground terminal;

applying a signal voltage to the power source line and the ground terminal respectively in the step 2 comprises applying a low level signal to the power source line, and applying a high level signal to the ground terminal; and

applying a signal voltage to the power source line and the ground terminal respectively in the step 3 comprises applying a second high level signal to the power source line, and applying a low level signal to the ground terminal.

11. The method according to claim **10**, wherein the first high level signal is in the range of 2~5 V, and the second high level signal is in the range of 20~30 V.

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专利名称(译)	具有阻挡晶体管的电压驱动像素单元，驱动方法和OLED显示器		
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摘要(译)

电压驱动像素单元包括电压驱动像素电路，并且提供由电压驱动像素电路驱动的有机发光二极管（OLED）。电压驱动像素电路包括栅极线，数据线，电源线，接地端子，开关晶体管，驱动晶体管，补偿晶体管，阻塞晶体管和存储电容器。