



US007218295B2

(12) **United States Patent**
Sung

(10) **Patent No.:** **US 7,218,295 B2**
(45) **Date of Patent:** **May 15, 2007**

(54) **DRIVING METHOD FOR ACTIVE MATRIX
OLED DISPLAY**

(75) Inventor: **Chao-Chin Sung**, Pingtung (TW)
(73) Assignee: **AU Optronics Corp.**, Hsinchu (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 472 days.

(21) Appl. No.: **10/791,158**

(22) Filed: **Mar. 1, 2004**

(65) **Prior Publication Data**

US 2004/0227706 A1 Nov. 18, 2004

(30) **Foreign Application Priority Data**

May 14, 2003 (TW) 92113027 A

(51) **Int. Cl.**
G09G 3/32 (2006.01)

(52) **U.S. Cl.** **345/82**; 345/76; 345/79;
345/96; 315/169.1; 315/169.3

(58) **Field of Classification Search** 345/76,
345/79-83, 90, 92, 46, 34, 45, 95, 96, 77;
315/169.1-169, 169.03, 169.04

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,583,581 B2 *	6/2003	Kaneko et al.	315/169.3
6,809,481 B2 *	10/2004	Seo et al.	315/169.1
6,870,192 B2 *	3/2005	Yamazaki et al.	257/79
2002/0180671 A1 *	12/2002	Inukai	345/76
2003/0160745 A1 *	8/2003	Osame et al.	345/82

* cited by examiner

Primary Examiner—Richard Hjerpe

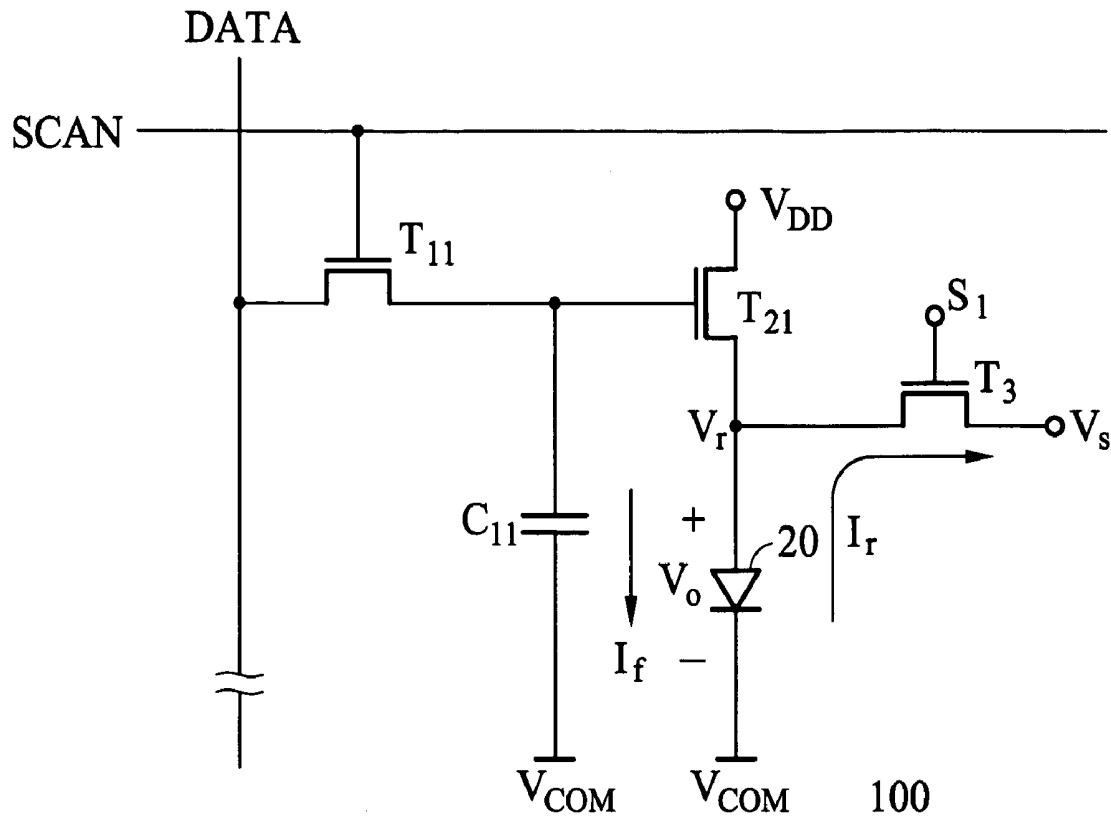
Assistant Examiner—Jennifer T. Nguyen

(74) *Attorney, Agent, or Firm*—Thomas, Kayden,
Horstemeyer & Risley

(57) **ABSTRACT**

A driving method for an active matrix OLED display. In the driving method, a first current is provided to flow through an OLED of a pixel in a first period of one display period, according to a video signal on the data electrode and a scan signal on the scan electrode. Next, a second current is provided to flow through the OLED in a second period of the display period to neutralize carrier accumulation inside the OLED, wherein the first current and the second current flow in opposite directions.

6 Claims, 5 Drawing Sheets



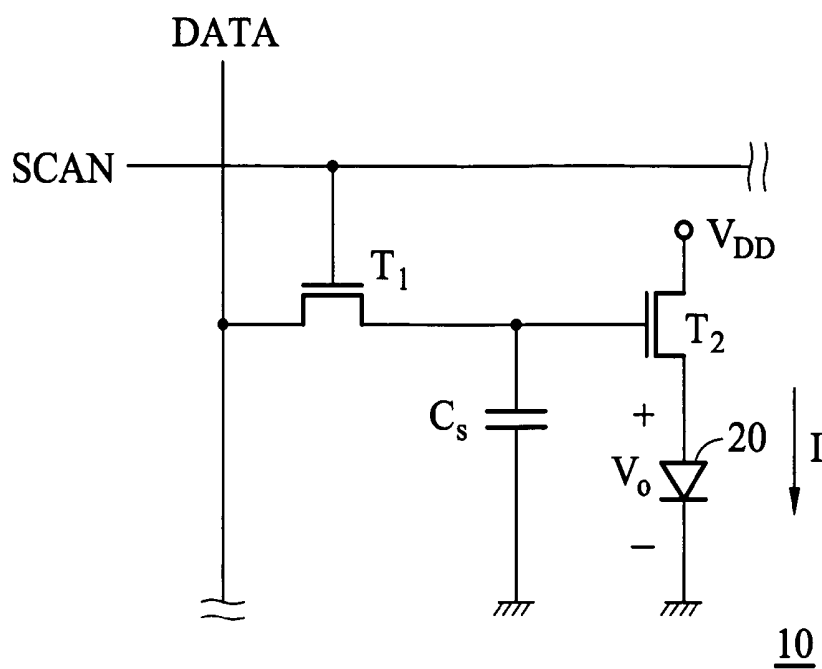


FIG. 1 (RELATED ART)

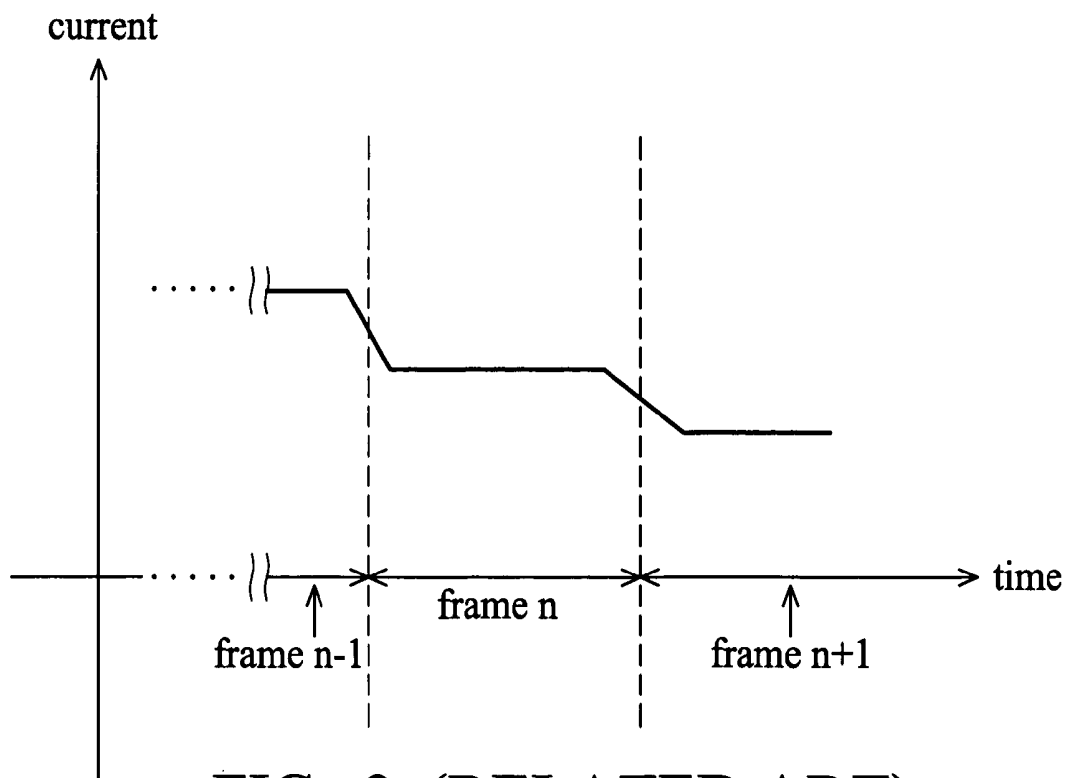


FIG. 2 (RELATED ART)

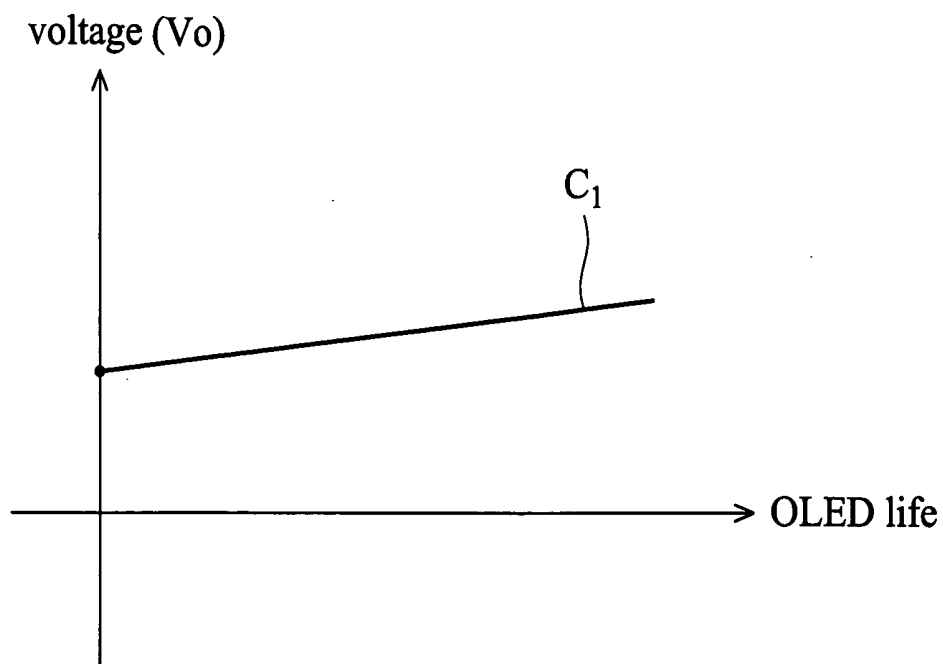


FIG. 3 (RELATED ART)

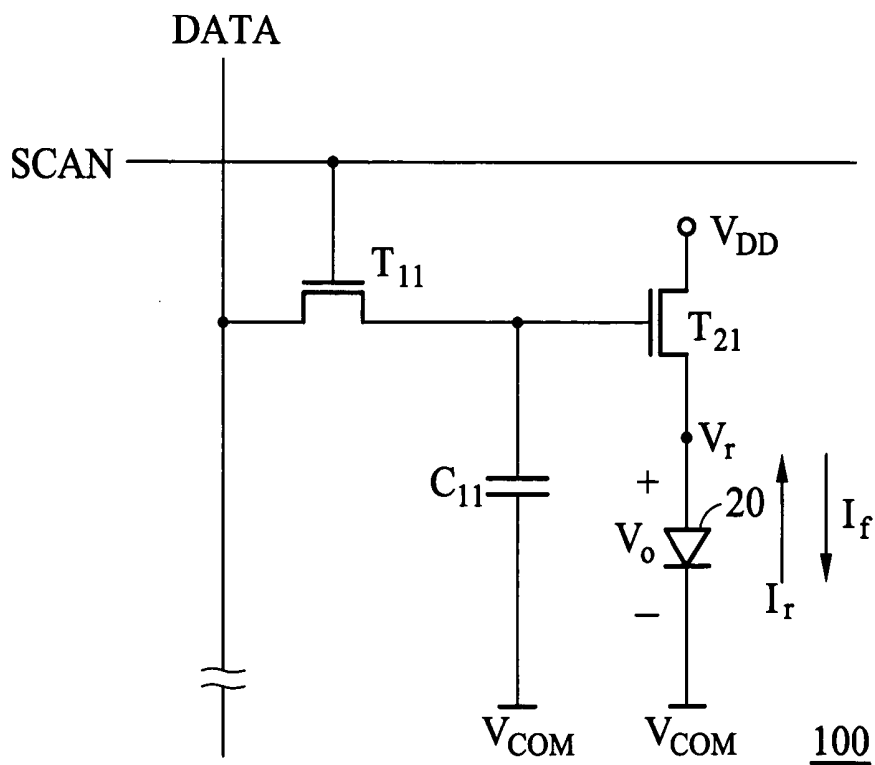


FIG. 4

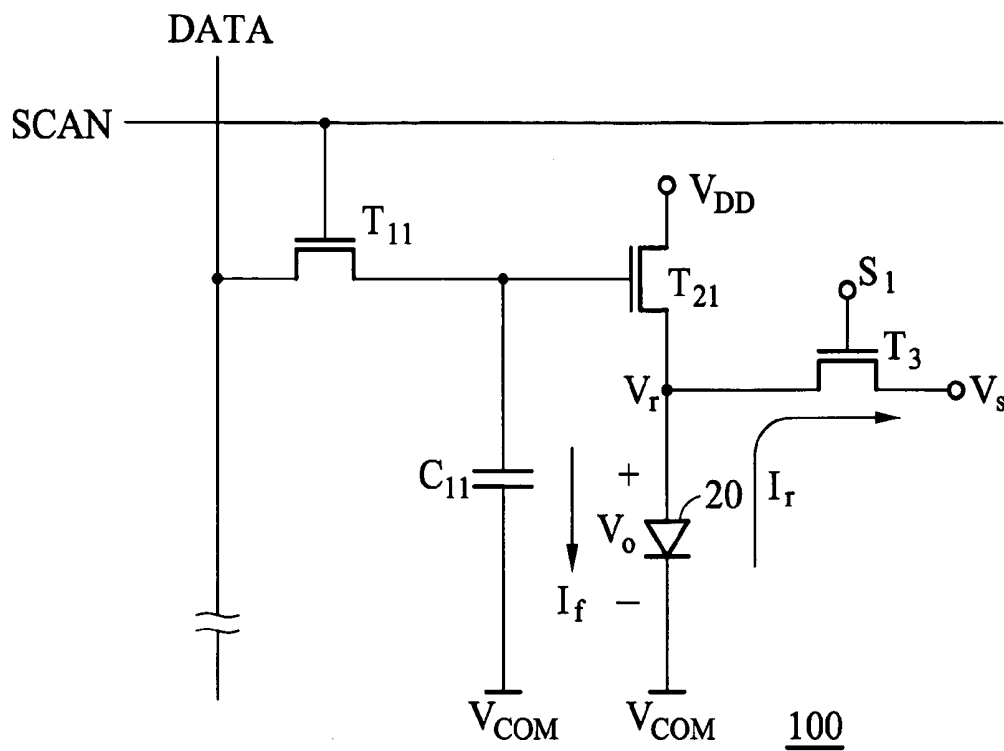


FIG. 5

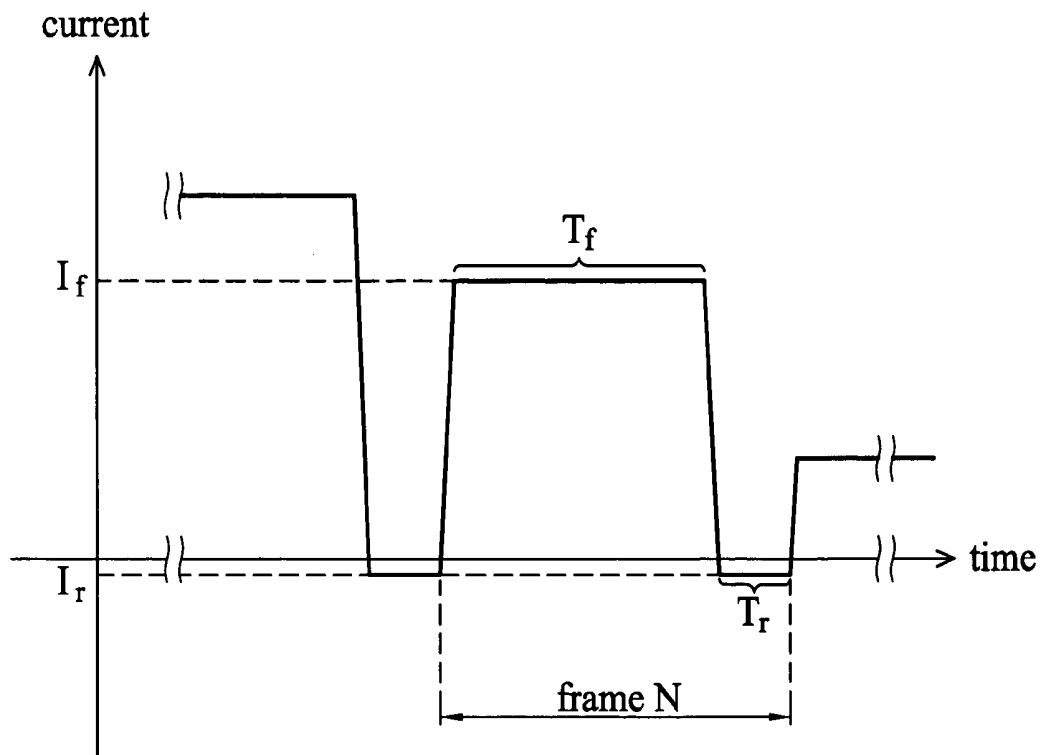


FIG. 6

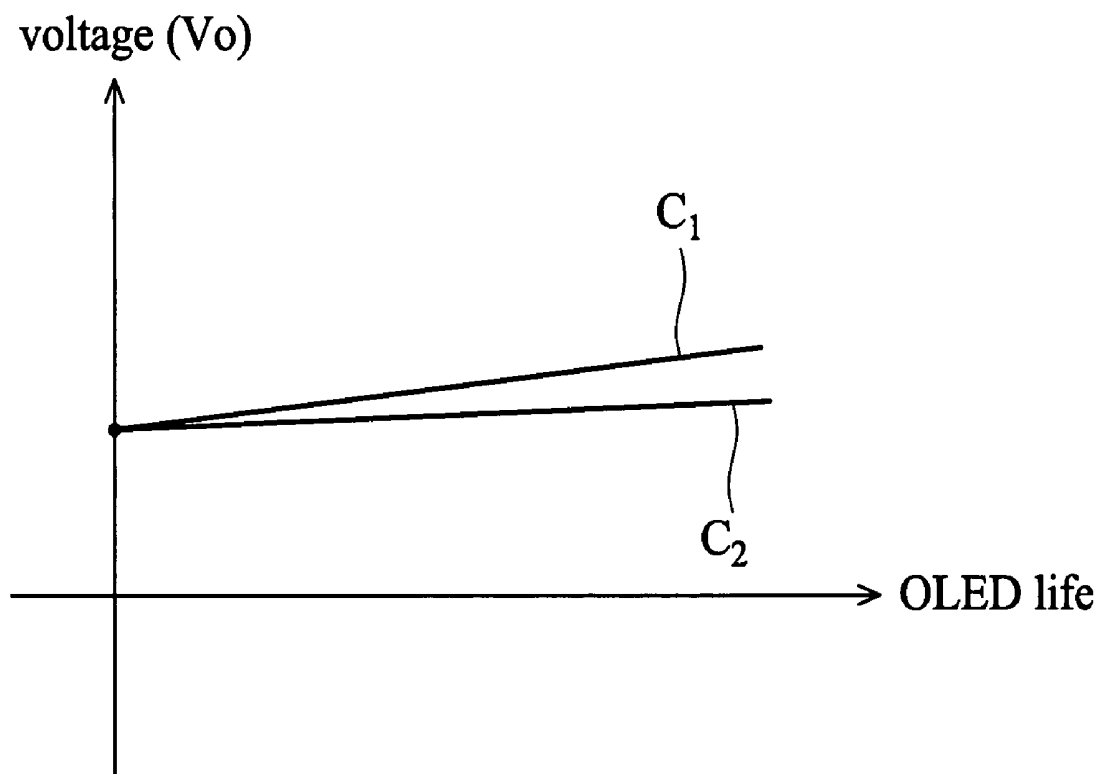


FIG. 7

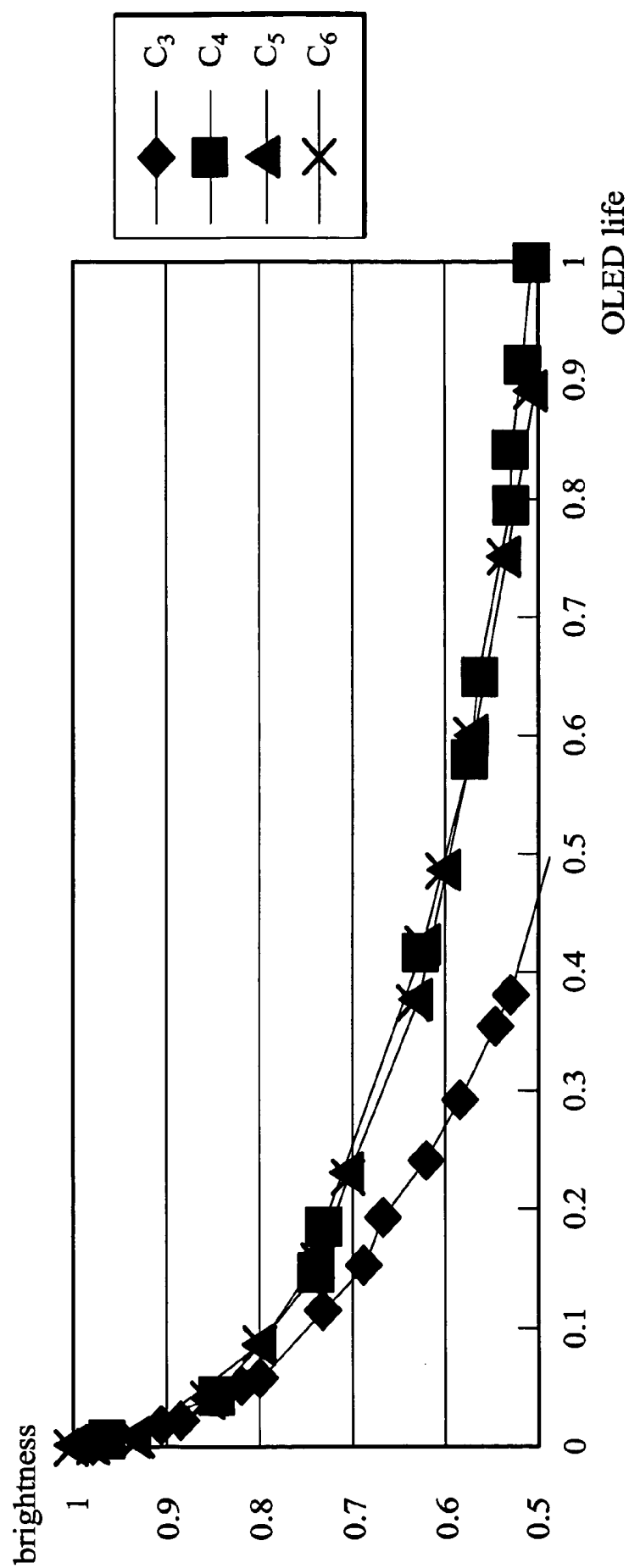


FIG. 8

1

DRIVING METHOD FOR ACTIVE MATRIX OLED DISPLAY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a driving method, and more particularly, to a driving method for an active matrix OLED display, as well as a pixel structure using the same.

2. Description of the Related Art

Typically, an active matrix OLED display employs a large number of pixels to present an image, and controls the brightness of each pixel according to a brightness data.

FIG. 1 shows a pixel structure **10** of an active matrix organic light emitting diode (AMOLED). The switching transistor T_1 is turned on and a data voltage indicated brightness is applied to a data electrode DATA when the scan electrode SCAN is activated. Thus, the storage capacitor C_s is charged or discharged, and the potential at the gate of the driving transistor T_2 may coincide with that of the data voltage. The switching transistor T_1 is turned off and the driving transistor T_2 is electrically isolated from the data electrode DATA when the scan electrode SCAN is not activated. The data voltage is stored in the storage capacitor C_s , and the potential at the gate of the driving transistor T_2 is maintained. The produced driving current I flows to the OLED **20** through the driving transistor T_2 according to the voltage (V_{gs}) between the gate and source of the driving transistor T_2 . The OLED **20** then continuously illuminates according to the driving current I .

That is, in one display frame, the current received by the OLED is fixed. However, this driving method accumulates carriers inside the OLED **20** which reduce the life of the OLEDs. Moreover, the voltage V_o across the OLED gradually increases over time as shown in FIG. 3. Further, as shown by the formula $P=I \times V$, as the voltage V_o increases over time, the power P also increases. In FIG. 3, curve C_1 shows the effect of the voltage V_o of the OLED over time.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to neutralize carrier accumulation in the OLED of an LCD, thereby reducing the increase in voltage and minimizing the increase in power consumption across both ends of the OLED over time, further increasing the life of the OLED.

According to the above mentioned objects, the present invention provides a driving method for an active matrix OLED display. The driving method provides a first current to flow through an OLED of a pixel in a first period of one display period, according to a video signal on the data electrode and a scan signal on the scan electrode. Next, a second current is provided to flow through the OLED in a second period of the display period to neutralize carrier accumulation inside the OLED. Wherein the first current and the second current flow in opposite directions.

According to the above mentioned objects, the present invention provides a pixel structure of an active matrix OLED display, which is capable of neutralizing carrier accumulation in an OLED. In the pixel structure of the present invention, a switching transistor has a control terminal coupled to a scan electrode and a first terminal coupled to a data electrode. A driving transistor has a control terminal coupled to a second electrode of the switching transistor and a first terminal coupled to a power voltage. An OLED has an anode coupled to the second terminal of the driving transistor, and a cathode coupled to a common

2

electrode. A storage capacitor has one terminal coupled to the control terminal of the driving transistor. A neutralization control circuit is coupled between the OLED and a first voltage, according to a control signal, to pull down the potential at the anode of the OLED thereby inducing a reverse current to neutralize the carrier accumulation in the OLED. The potential of the first voltage is lower than that at the cathode of the OLED.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be more fully understood by reading the subsequent detailed description and examples with reference made to the accompanying drawings, wherein:

FIG. 1 shows a pixel structure of a conventional active matrix OLED display;

FIG. 2 is a schematic diagram illustrating a conventional driving method for active matrix OLED display;

FIG. 3 shows the relationship between the voltage across both ends of the OLED and its life in the conventional pixel structure;

FIG. 4 is a diagram illustrating a driving method of the present invention;

FIG. 5 shows the pixel structure of an active matrix OLED display according to the present invention;

FIG. 6 is another diagram illustrating the driving method of the present invention;

FIG. 7 shows the relationship between the voltage across both ends of the OLED and its life using the conventional driving method and that of the present invention; and

FIG. 8 shows the relationship between the brightness and OLED life according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 4 shows a pixel structure **100** of an active matrix OLED display. In the pixel structure **100**, the switching transistor T_{11} has a control terminal coupled to a scan electrode SCAN, and a first terminal coupled to a data electrode DATA. A driving transistor T_{21} has a control terminal coupled to a second terminal of the switching transistor T_{11} , and a first terminal coupled to a power voltage V_{DD} . An OLED **20** has an anode coupled to the second terminal of the driving transistor T_{21} , and a cathode coupled to a common electrode (not shown), wherein the common electrode has a potential of V_{COM} . A storage capacitor C_{11} has one terminal coupled to the control terminal of the driving transistor T_{21} .

The driving method of the present invention is described below with reference to FIG. 4 and FIG. 6. First, in a first period T_f of one display frame N , a first current is provided and flows through the OLED **20** according to a data signal on the electrode DATA and a scan signal on the scan electrode SCAN. That is, the switching transistor T_{11} is turned on and the storage capacitor C_{11} is charged or discharged by the data signal on the data electrode DATA according to the scan signal on the scan electrode SCAN. At this time, the gate voltage of the driving transistor T_{21} can be adjusted and stored in the storage capacitor C_{11} . The driving transistor T_{21} provides the first current I_f to flow through the OLED **20** according to the gate voltage of the transistor T_{21} , and the OLED illuminates accordingly. The switching transistor T_{11} is then turned off, but driving transistor T_{21} is still turned on according to the voltage stored in the storage capacitor C_{11} , and the OLED **20** illuminates with the same

brightness. Because of the above mentioned step, carrier accumulation in the OLED 20, and further, the voltage across both ends of the OLED 20 increases as over time. Thus, the effective life of the OLED 20 may be reduced.

In view of this, the present invention provides a step of providing a second current I_r , opposite to the first current I_f to flow through the OLED in a second period T_r of the display frame N. For example, the current I_f flows from anode to cathode and the current I_r flows from cathode to anode, and vice versa. In the present invention neutralizes carrier accumulation in the OLED 20 by the second current I_r . The time ratio of the first period T_f to the second period T_r can be between 1:1~10⁵:1, for example 10:1.

In this embodiment, the second current I_r is obtained by pulling up the potential V_{COM} at the cathode of the OLED higher than the power voltage V_{DD} . As the potential V_{COM} at the cathode of the OLED 20 is higher than the power voltage V_{DD} , the potential V_{COM} is higher than the voltage V_r at the anode of the OLED 20. Thus, the voltage V_o across the OLED 20 becomes negative, and the second current I_r , opposite to the first current I_f is produced to neutralize the carrier accumulation in the OLED 20. In addition, the second current I_r , opposite to the first current I_f can also be obtained by providing a negative voltage across the anode and cathode of the OLED. Alternately, the second current I_r can be provided to flow through the OLED 20 before each first period T_f (first current I_f) of the display frame N.

Additionally, the present invention provides a pixel structure capable of neutralizing carrier accumulation in OLED, as shown in FIG. 5. In FIG. 5, a switching transistor T_{11} has a control terminal coupled to a scan electrode SCAN and a first terminal coupled to a data electrode DATA. A driving transistor T_{21} has a control terminal coupled to a second electrode of the switching transistor T_{11} and a first terminal coupled to a power voltage V_{DD} . The OLED 20 has an anode coupled to the second terminal of the driving transistor T_{21} , and a cathode coupled to a common electrode (not shown). A storage capacitor C_{11} has one terminal coupled to the control terminal of the driving transistor T_{21} .

The present invention utilizes a transistor T_3 as a neutralization control circuit coupled between the OLED and a first voltage V_s , wherein the potential of the first voltage V_s is lower than the potential V_{COM} at the cathode of the OLED 20. In the second period T_r of the display frame N, the transistor T_3 pulls the potential V_r at the anode of the OLED 20 lower than the potential V_{COM} , according to a control signal S_1 . At this time, the voltage V_o across the OLED 20 becomes negative, and thus a reverse current I_r , opposite to the current I_f is induced to neutralize carrier accumulation in the OLED 20. For example, the current I_f flows from anode to cathode and the current I_r flows from cathode to anode, and vice versa. The time ratio of the first period T_f (current I_f) between and the second period T_r (current I_r) can be 1:1~10⁵:1, for example 10:1. The embodiment of the present invention for producing a reverse current to flow through an OLED is provided as an example, and is not intended to constrain the application of this invention.

FIG. 7 shows the relationship between the voltage V_o across both ends of the OLED 20 and its life using the conventional driving method and the method of the present invention. Curve C_1 shows the relationship between the voltage V_o across both ends of the OLED 20 and its life in the present invention. Curve C_2 show the relationship between the voltage V_o across both ends of the OLED and its life using the conventional driving method. Obviously, the present invention can reduce increased voltage across both ends of the OLED over time. Additionally, the present

invention can also reduce increased power consumption of to OLED over time, as shown by the formula $P=I \times V$.

FIG. 8 shows the relationship between the brightness and the life of an OLED according to the present invention. In FIG. 8, curve C_3 shows the relationship between the brightness and the life of an OLED without using a reverse current to neutralize carrier accumulation in the OLED. Curve C_4 shows the relationship between the brightness and the life of an OLED with a reverse current I_r to neutralize carrier accumulation in the OLED, wherein the time ratio of the first period T_f (current I_f) to the second period T_r (current I_r) is 10:1. Curve C_5 shows the relationship between the brightness and the life of an OLED using the reverse current, wherein the time ratio of the first period T_f (current I_f) to the second period T_r (current I_r) is 100:1. Curve C_5 shows the relationship between the brightness and the life of an OLED with the reverse current, wherein time ratio of the first period T_f (current I_f) to the second period T_r (current I_r) is 500:1. As shown in FIG. 8, the life of OLED using a reverse current to neutralize carrier accumulation therein is about double of the conventional OLED and driving method not employing reverse current. Therefore, the present invention reduces the increase in voltage and minimizes the increase in power consumption across both ends of the OLED over time, further increasing the life of the OLED.

Furthermore, in the present invention, a period for producing a reverse current to neutralize carrier accumulation in the OLED is not limited to one display frame but extend to two or more display frames. For example, the first, fourth and seventh display frames each have a period for producing a reverse current to neutralize carrier accumulation in the OLED. The second, third, fifth and sixth display frames have no period for producing a reverse current to neutralize carrier accumulation in an OLED.

While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A pixel structure for active matrix OLED display, comprising:

- a switching transistor having a control terminal coupled to a scan electrode and a first terminal coupled to a data electrode;
- a driving transistor having a control terminal coupled to a second electrode of the switching transistor and a first terminal coupled to a power voltage;
- a OLED having an anode coupled to the second terminal of the driving transistor, and a cathode coupled to a common electrode;
- a storage capacitor coupled between the control terminal of the driving transistor and the common electrode, controlling turning on/off of the driving transistor according to data stored therein when the switch transistor is turned off; and
- a first transistor comprising a first terminal coupled to the anode of the OLED and a second terminal coupled to a first voltage and a control terminal coupled to a control signal, pulling down the potential at the anode of the OLED according to the control signal thereby inducing a reverse current to neutralize carrier accumulation inside the OLED, wherein the first voltage is

5

variable and is determined by the data stored in the storage capacitor and the control signal is applied to turn on the first transistor during an N^{th} frame and an $N+M^{th}$ frame, N and M are both positive integrals and $M>1$.

2. The pixel structure as claimed in claim 1, wherein the potential of the first voltage is lower than that at the cathode of OLED.

3. An active matrix OLED display, comprising:

at least one pixel, comprising:

a switching transistor having a control terminal coupled to a scan electrode and a first terminal coupled to a data electrode;

a driving transistor having a control terminal coupled to a second electrode of the switching transistor and a first terminal coupled to a power voltage;

a OLED having an anode coupled to the second terminal of the driving transistor, and a cathode coupled to a common electrode;

a storage capacitor to coupled between the control terminal of the driving transistor and the common electrode, controlling turning on/off of the driving transistor according to data stored therein when the switch transistor is turned off; and

a first transistor comprising a first terminal coupled to the anode of the OLED and a second terminal coupled to a first voltage and a control terminal coupled to a control signal, pulling down the potential at the anode of the OLED according to the control signal thereby inducing a reverse current to neutralize carrier accumulation inside the OLED, wherein the first voltage is variable and is determined by the data stored in the storage capacitor and the control signal is applied to

6

turn on the first transistor during a N^{th} frame and a $N+M^{th}$ frame, N and M are both positive integrals and $M>1$.

4. The active matrix OLED display as claimed in claim 3, wherein the potential of the first voltage is lower than that at the cathode of OLED.

5. A driving method for an active matrix OLED display, wherein the display has at least one pixel, each having a switch transistor, a driving transistor, an OLED and a storage capacitor, the driving method comprising:

providing a first transistor coupled between an anode of the OLED and a first voltage;

turning on the switching transistor to provide a display data on a data electrode to the storage capacitor and the driving transistor according to a scan signal, wherein the first voltage is variable and is determined by the display data stored in the storage capacitor;

turning on the driving transistor to providing a first current to flow through the OLED of the pixel according to the display data stored the storage capacitor; and

turning on the first transistor to provide a second current to flow through the OLED to neutralize carrier accumulation inside the OLED according to a control signal during an N^{th} frame and an $N+M^{th}$ frame, wherein N and M are both positive integrals, $M>1$, and the first current and the second current flow in opposite directions.

6. The driving method as claimed in claim 5, wherein the potential of the first voltage is lower than that at the cathode of OLED.

* * * * *

专利名称(译)	有源矩阵OLED显示器的驱动方法		
公开(公告)号	US7218295	公开(公告)日	2007-05-15
申请号	US10/791158	申请日	2004-03-01
[标]申请(专利权)人(译)	SUNG赵琴		
申请(专利权)人(译)	SUNG超CHIN		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	SUNG CHAO CHIN		
发明人	SUNG, CHAO-CHIN		
IPC分类号	G09G3/32 G09G3/30		
CPC分类号	G09G3/3233 G09G2300/0842 G09G2320/043 G09G2300/0866 G09G2310/0256 G09G2300/0861		
助理审查员(译)	NGUYEN , JENNIFER T.		
优先权	092113027 2003-05-14 TW		
其他公开文献	US20040227706A1		
外部链接	Espacenet USPTO		

摘要(译)

一种有源矩阵OLED显示器的驱动方法。在该驱动方法中，根据数据电极上的视频信号和扫描电极上的扫描信号，提供第一电流以在一个显示周期的第一周期中流过像素的OLED。接下来，提供第二电流以在显示时段的第二时段中流过OLED以中和OLED内部的载流子累积，其中第一电流和第二电流以相反的方向流动。

