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(54) ACTIVE MATRIX ORGANIC LIGHT EMITTING DIODE DISPLAY PIXEL STRUCTURE

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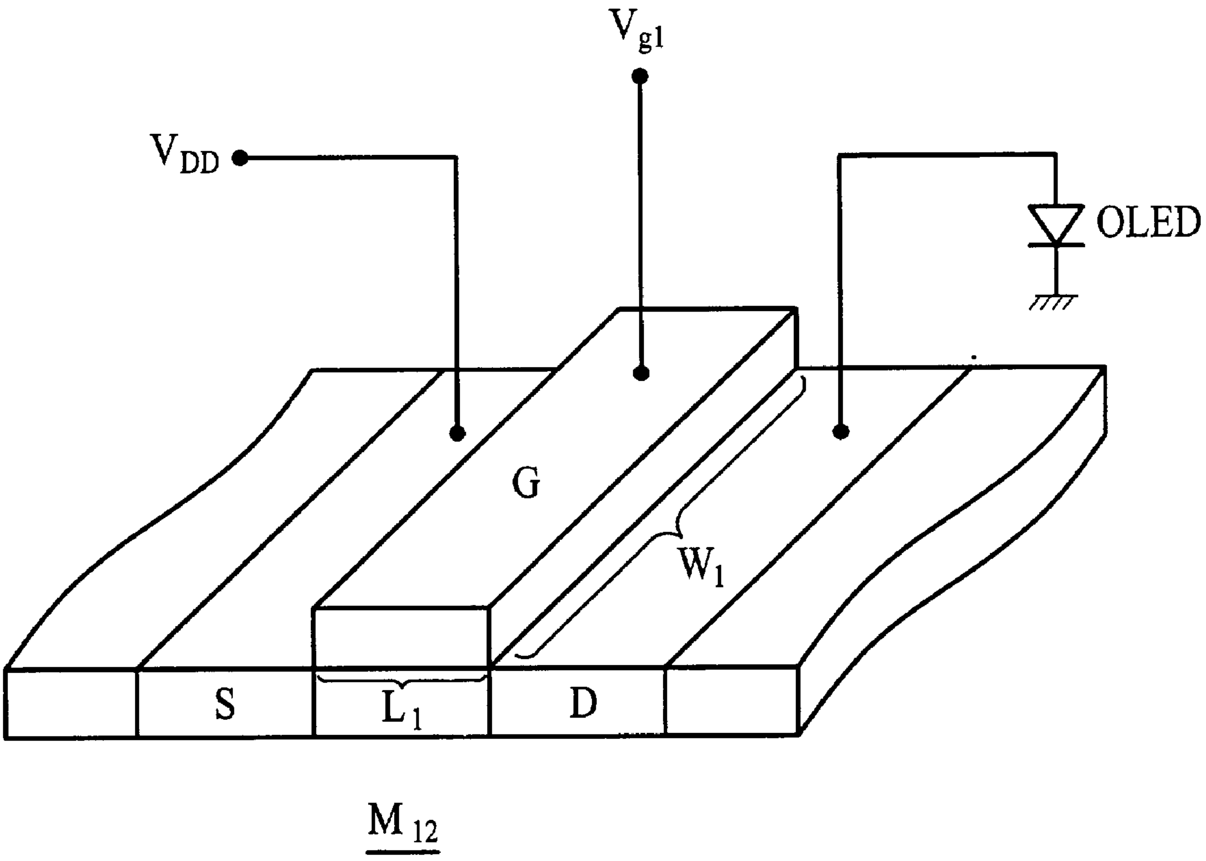
(52) **U.S. Cl.** **257/13**

(57) **ABSTRACT**

An active matrix organic light emitting diode display pixel structure. In the pixel structure of the present invention, a switching transistor has a gate terminal coupled to a scan signal and a source terminal coupled to a data signal. A storage capacitor has two terminals coupled to a drain terminal of the first transistor and a reference voltage respectively. An OLED has an anode coupled to a drain terminal of the second transistor and a cathode coupled to a first voltage. A plurality of driving transistors is coupled in cascode, wherein the first terminal of the first diving transistor of the driving transistors is coupled to a second voltage, and a second terminal of the final diving transistor of the driving transistors is coupled to the anode of the OLED, and an equivalent channel width/length (W/L) ratio of the driving transistors does not exceed 0.2.



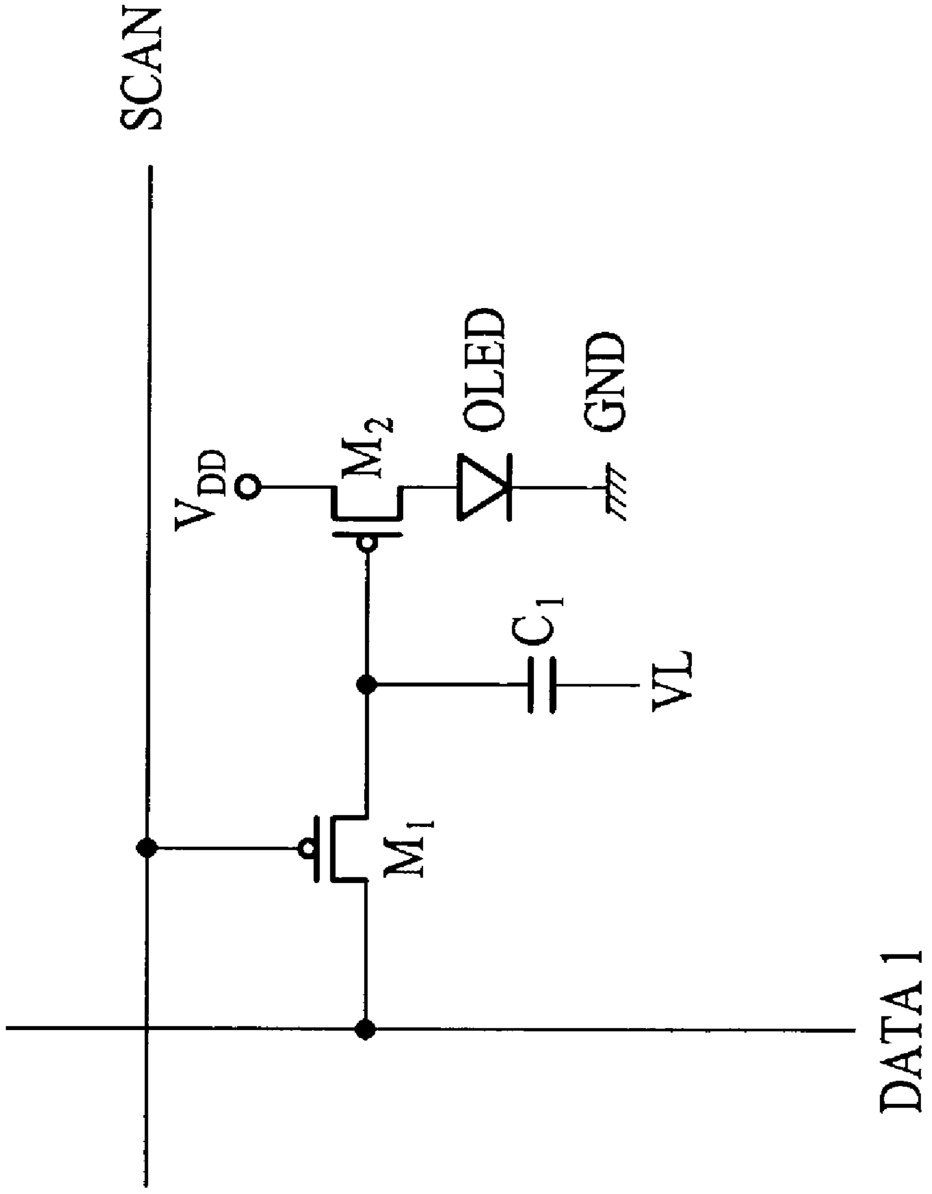


FIG. 1 (PRIOR ART)

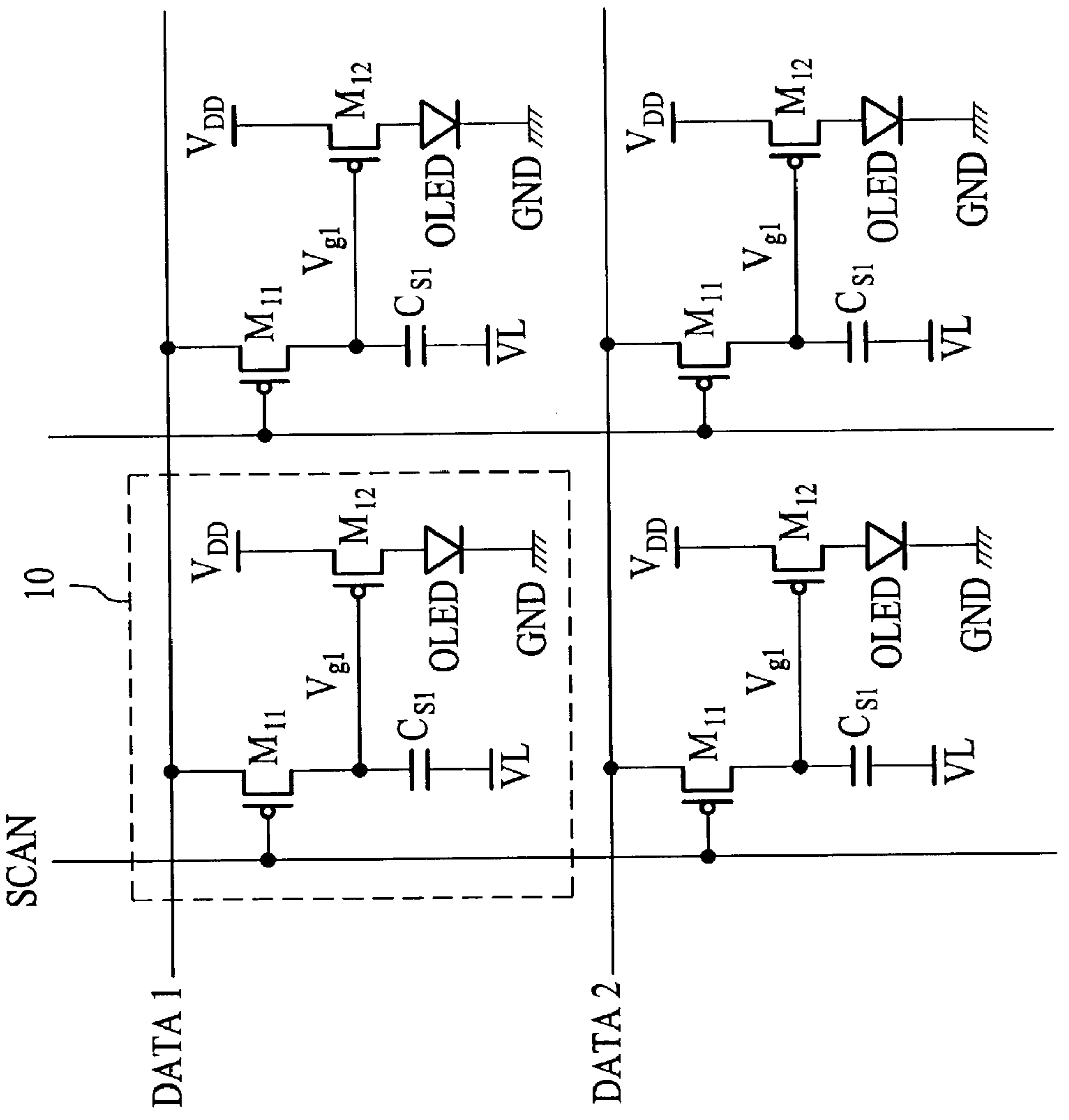

SCAN
DATA 1
DATA 2
10
V_DD
M_11
M_12
V_g1
C_S1
OLED
GND
VL
V_DD
M_11
M_12
V_g1
C_S1
OLED
GND
VL
V_DD
M_11
M_12
V_g1
C_S1
OLED
GND
VL
V_DD
M_11
M_12
V_g1
C_S1
OLED
GND
VL

FIG. 2

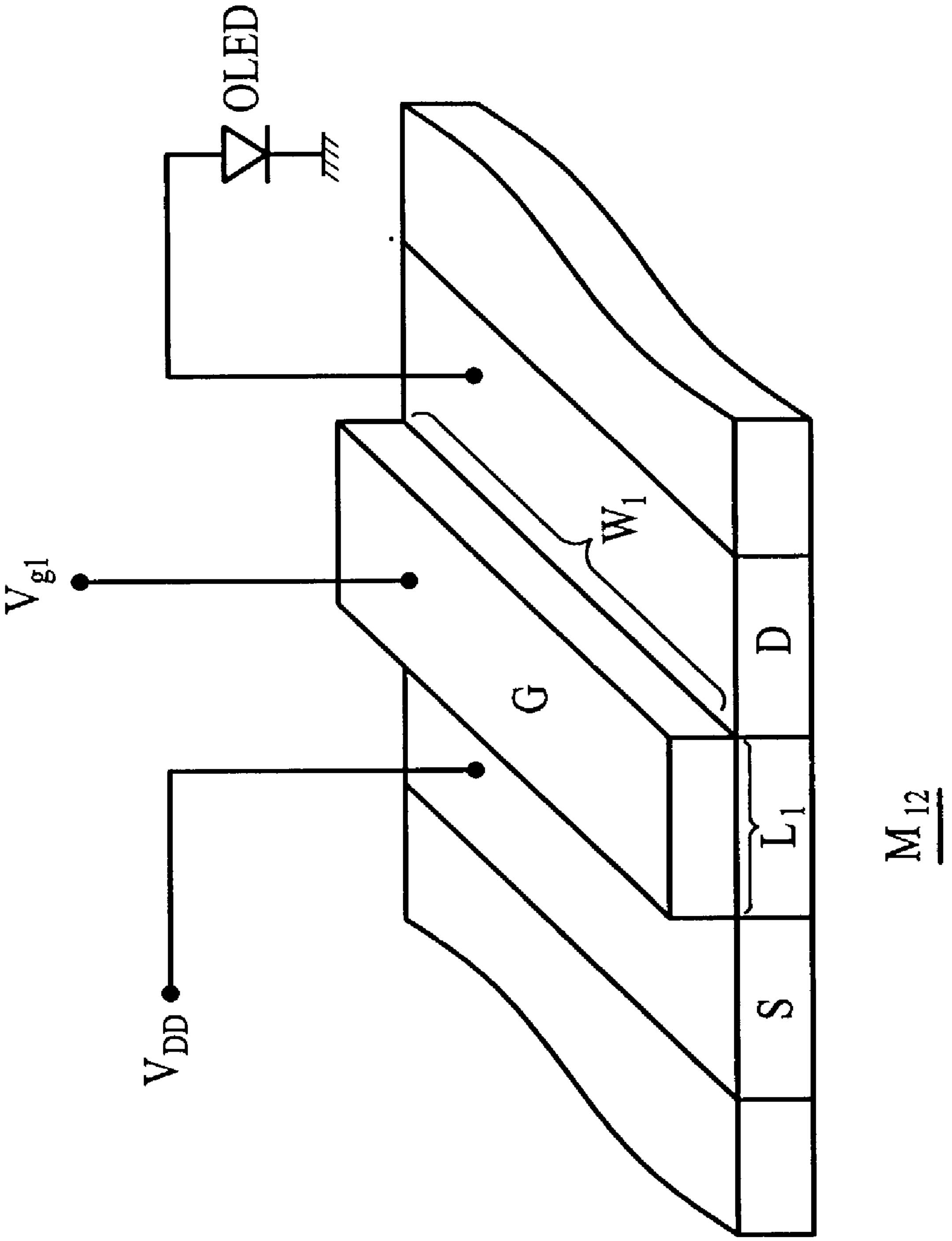


FIG. 3

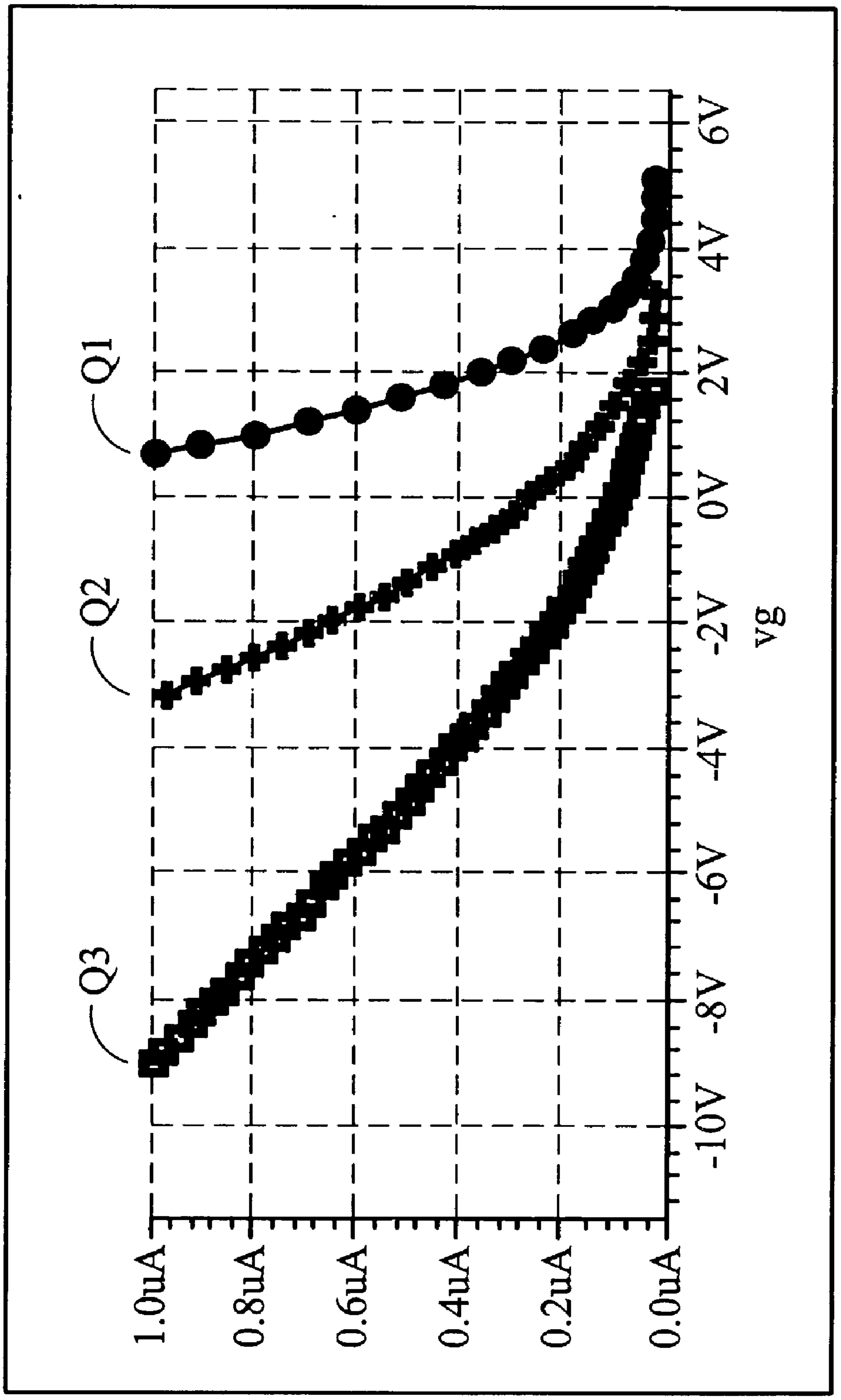

Q1
Q2
Q3
1.0uA
0.8uA
0.6uA
0.4uA
0.2uA
0.0uA
-10V
-8V
-6V
-4V
-2V
0V
2V
4V
6V
vg

FIG. 4

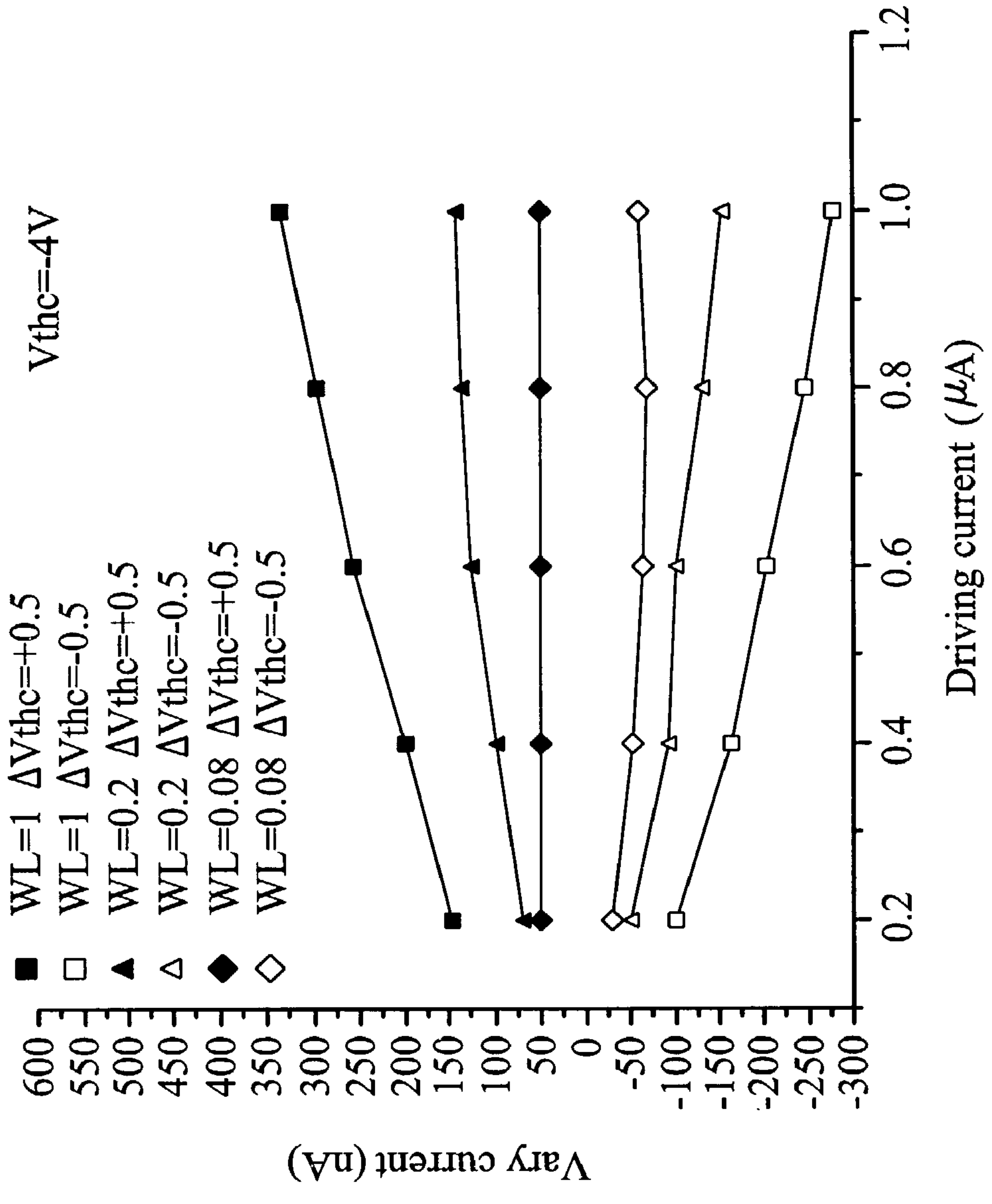

Vthc=-4V
■ WL=1 ΔVthc=+0.5
□ WL=1 ΔVthc=-0.5
▲ WL=0.2 ΔVthc=+0.5
△ WL=0.2 ΔVthc=-0.5
◆ WL=0.08 ΔVthc=+0.5
◇ WL=0.08 ΔVthc=-0.5
Vary current (nA)
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
Driving current (μA)
0.2
0.4
0.6
0.8
1.0
1.2

FIG. 5

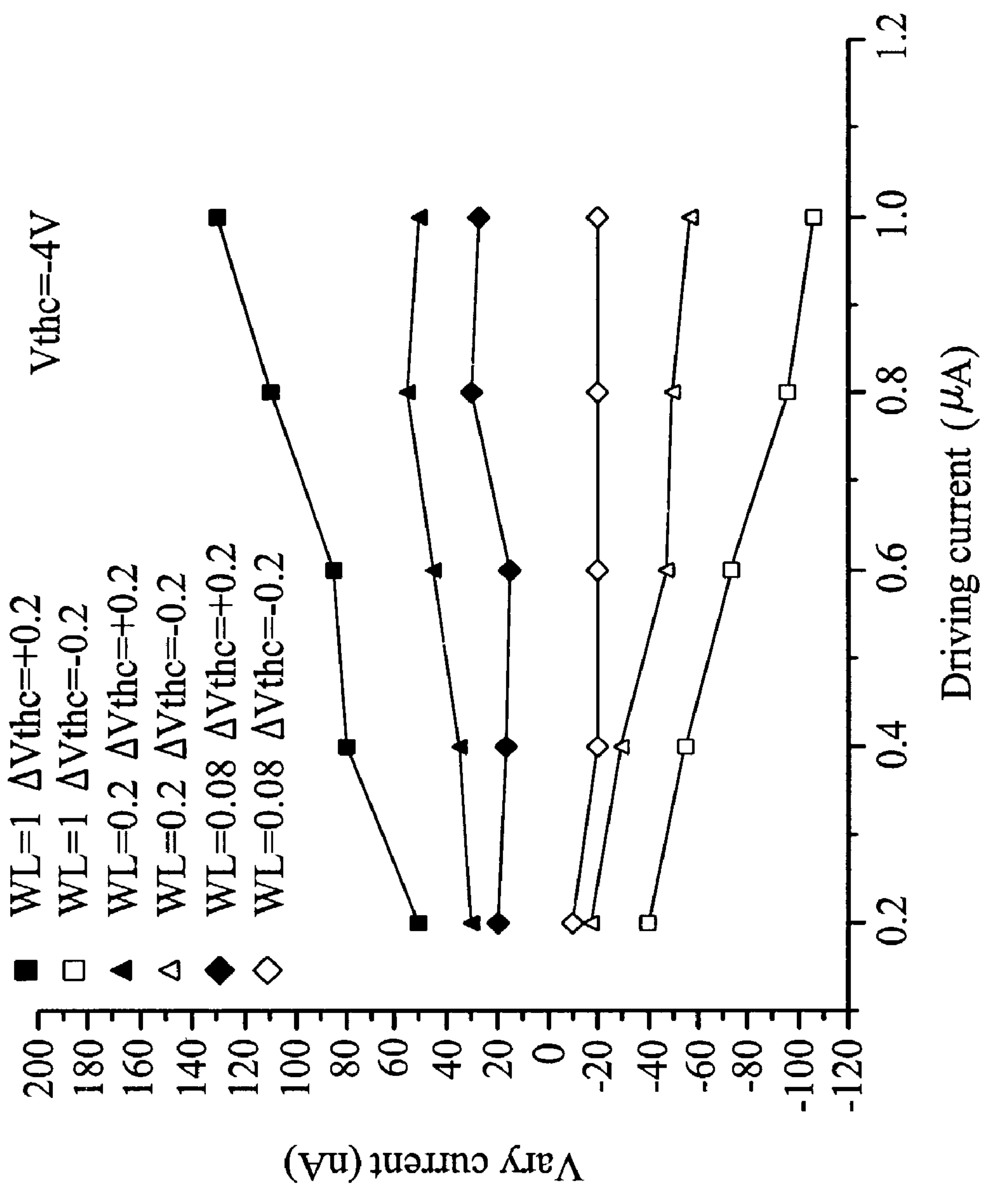

Vthc=-4V
■ WL=1 ΔVthc=+0.2
□ WL=1 ΔVthc=-0.2
▲ WL=0.2 ΔVthc=+0.2
△ WL=0.2 ΔVthc=-0.2
◆ WL=0.08 ΔVthc=+0.2
◇ WL=0.08 ΔVthc=-0.2
Vary current (nA)
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
Driving current (μA)
0.2
0.4
0.6
0.8
1.0
1.2

FIG. 6

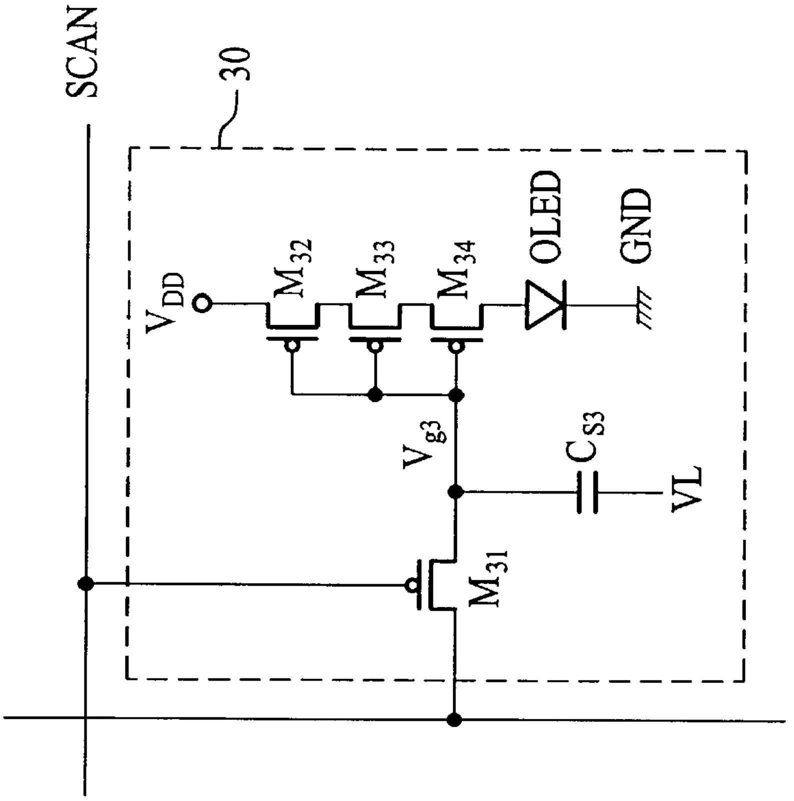

SCAN
30
V_{DD}
M_{32}
M_{33}
M_{34}
OLED
GND
V_{g3}
C_{S3}
VL
M_{31}
DATA 1

FIG. 8

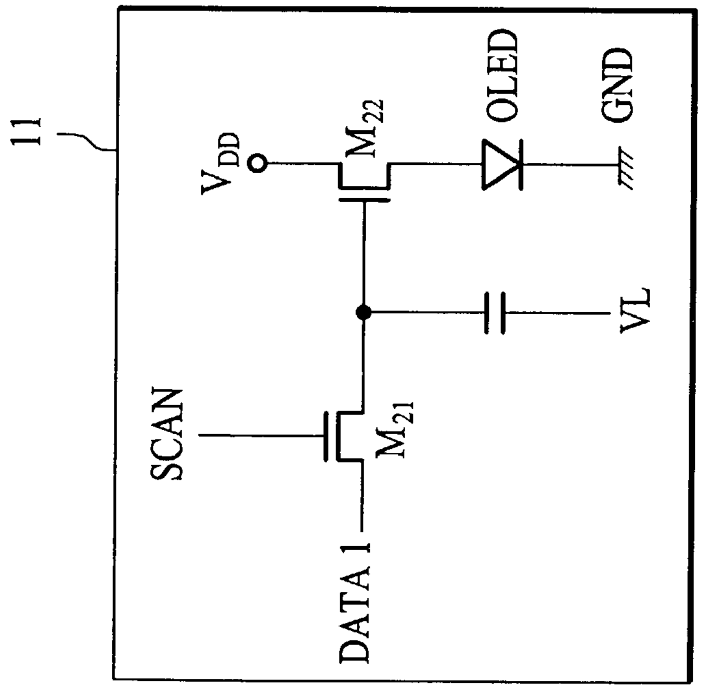

11
V_{DD}
M_{22}
OLED
GND
VL
SCAN
M_{21}
DATA 1

FIG. 7

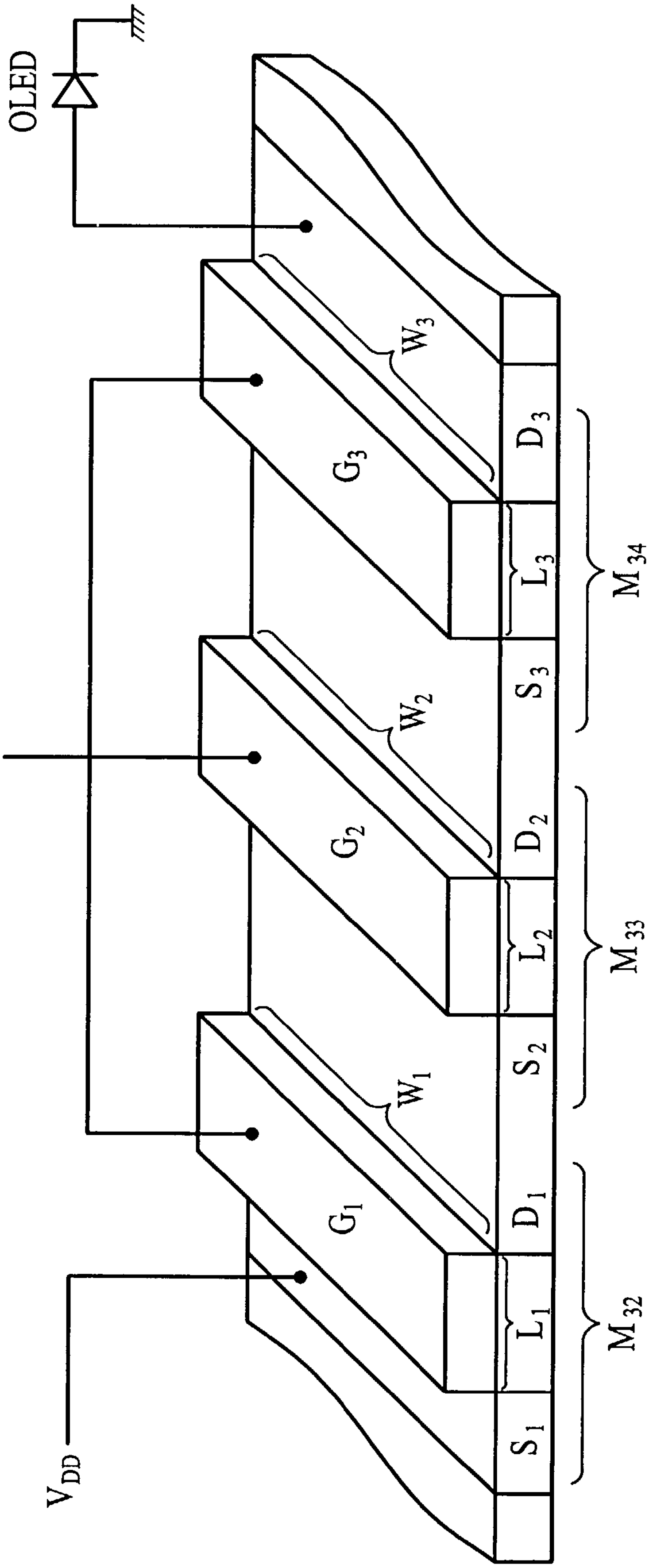


FIG. 9

ACTIVE MATRIX ORGANIC LIGHT EMITTING DIODE DISPLAY PIXEL STRUCTURE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates in general to a pixel structure. In particular, the present invention relates to an active matrix organic light emitting diode (OLED) display pixel structure that achieves high-gray scale and improved reliability of the elements by modifying the dimensions of the driving transistor.

[0003] 2. Description of the Related Art

[0004] A common feature in LCD panels is the use of thin-film transistors (TFT) in an active address scheme, which relaxes the limitation in direct addressing. The success of LCD technology is in large part due to the rapid progress in the fabrication of large-area TFTs. The almost ideal match between TFT switching characteristics and electrooptic LCD display elements also plays a key role.

[0005] A major drawback of TFT-LCD panels is the requirement for backlighting. This is because the transmission factor of the TFT-LCD, particularly of colored panels is poor, typically about 2-3 percent. Power consumption for backlit TFT-LCD panels is considerable and adversely affects portable display applications requiring battery operatios.

[0006] The need for backlighting also impairs miniaturization of the flat panel. For example, panel depth must be increased to accommodate the backlight unit. Using a typical tubular cold-cathode lamp, the added depth is ¾ to 1 inch. Backlighting also adds extra weight to the FED.

[0007] An ideal solution is a low power emitting display that eliminates the need for backlighting. A particularly attractive candidate is the thin-film-transistor-electroluminescent (TFT-EL) display. In TFT-EL displays, the individual pixels can be addressed to emit light and auxiliary backlighting is not required.

[0008] However, since the ZnS-EL requires a high drive voltage of more than a hundred volts, the switching CdSe TFT element must be designed to handle such a high voltage swing. The reliability of the high-voltage TFT is then compromised.

[0009] Recently, organic EL materials have been devised. These materials suggest themselves as candidates for display media in TFT-EL devices. Organic EL media has two important advantages: it is highly efficient and has low voltage requirements. The latter characteristic distinguishes it over other thin-film emissive devices.

[0010] The particular properties of organic EL material that make it ideal for TFT are summarized herein.

[0011] Typically, the organic EL cell requires a voltage in the range of 4 to 10 volts depending on the light output level and the cell impedance. The voltage required to produce a brightness of about 20 FL (Foot-Lamberts), is about 5V. This low voltage is highly attractive for a TFT-EL panel, as the need for the high-voltage TFT is eliminated. Furthermore, the organic EL cell can be driven by DC or AC current. As a result the driver circuit is less complicated and less expensive.

[0012] The luminous efficiency of the organic EL cell is as high as 4 lumens per watt. The current density to drive the EL cell to produce a brightness of 20 FL is about 1 mA/cm^2. Assuming a 100% duty excitation, the power needed to drive a 400 cm^2 full-page panel is only about 2.0 watts. The low power need certainly meets the portability criteria of the flat panel display.

[0013] Organic EL device can be fabricated at about room temperature. This is a significant advantage compared with inorganic emissive devices, which require high-temperature (>300° C.) processing. The high-temperature processes required to make inorganic EL devices can be incompatible with the TFT.

[0014] **FIG. 1** shows a conventional pixel structure of an active matrix OLED display. In **FIG. 1**, switching transistor M1 turns on such that data signal DATA charges storage capacitor C1 when the switching transistor receives a scan signal SCAN. Further, driving transistor M2 turns on such that organic emissive device OLED illuminates when the voltage stored at the storage capacitor C1 exceeds threshold voltage of the driving transistor M2. However, in the conventional pixel structure, threshold voltage of the driving transistor M2 will vary with process variations. Consequently, the convention pixel structure shown in **FIG. 1** shows poor reliability, poor lightness unity and cannot achieve high-gray scale.

SUMMARY OF THE INVENTION

[0015] It is an object of the present invention to provide a pixel structure for active matrix OLED display that can achieve the high-gray scale by modifying the dimensions of the driving transistor to modify the I-V curve of the driving transistor.

[0016] It is also an object of the present invention to provide a pixel structure of an active matrix OLED display that can achieve the high-gray scale and improve the reliability of the driving transistor.

[0017] According to the first embodiment of the active matrix OLED display pixel structure of the present invention, a first transistor has a gate terminal coupled to a scan signal and a source terminal coupled to a data signal. A storage capacitor has two terminals coupled to a drain terminal of the first transistor and a reference voltage respectively. A second transistor has a gate terminal coupled to the drain of the first transistor and a source terminal coupled to a second voltage. Further, an OLED has an anode and a cathode coupled to a drain terminal of the second transistor and a second voltage respectively, wherein the channel width/length ratios of the second transistor is below 0.2.

[0018] According to the first embodiment of the active matrix OLED display pixel structure of the present invention, a first transistor has a gate terminal coupled to a scan signal and a source terminal coupled to a data signal. A storage capacitor has two terminals coupled to a drain terminal of the first transistor and a reference voltage respectively. An OLED has a cathode coupled to a first voltage and an anode. Furthermore, a plurality of driving transistors coupled in cascode, wherein the first terminal of the first diving transistor deposited at the first stage of the driving transistors is coupled to a second voltage, and a second terminal of the final diving transistor deposited at the final stage of the driving transistors is coupled to an anode of the OLED, and an equivalent channel width/length (W/L) ratios of the driving transistors is below 0.2.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0019**] **FIG. 1** shows a conventional pixel structure of the active matrix OLED display.

[**0020**] **FIG. 2** shows a pixel structure of the active matrix OLED display according to the first embodiment of the present invention.

[**0021**] **FIG. 3** is a sectional drawing of the driving transistor in the first embodiment.

[**0022**] **FIG. 4** shows a current-voltage curve illustrating the relationship between current and voltage of driving transistors with different W/L ratios.

[**0023**] **FIG. 5** shows the relationship between driving current and current variation of driving transistors with different W/L ratios.

[**0024**] **FIG. 6** shows another relationship between driving current and current variation of driving transistors with different W/L ratios.

[**0025**] **FIG. 7** is another aspect of the first embodiment of the present invention.

[**0026**] **FIG. 8** shows a pixel structure of the active matrix OLED display according to the second embodiment of the present invention.

[**0027**] **FIG. 9** shows a pixel structure of the active matrix OLED display according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The First Embodiment

[**0028**] **FIG. 2** shows a pixel structure of the active matrix OLED display according to the first embodiment of the present invention, wherein the pixel structure **10** is composed of a first transistor **M11**, a storage capacitor CS**1**, a second transistor M_{12} and a organic light emitting diode OLED.

[**0029**] The first transistor **M11** has a gate terminal coupled to a scan signal SCAN, a source terminal coupled to a data signal DATA**1**. The storage capacitor CS**1** has two terminals coupled to a drain terminal of the first transistor and a reference voltage VL respectively. The reference voltage VL for example is ground.

[**0030**] The second transistor **M12** has a gate terminal coupled to the drain terminal of the first transistor **M11**, and a source terminal coupled to a first voltage VDD. Further, the organic light emitting diode OLED has an anode coupled to a drain terminal of the second transistor, and a cathode coupled to a second voltage GND. **FIG. 3** is a sectional drawing of the driving transistor in **FIG. 2**, wherein the channel width/length (W**1**/L**1**) of the second transistor **M12** is below 0.2, for example 1.5 or 1.0.

[**0031**] The first transistor M_{11} turns on and off according to the scan signal SCAN, and the second transistor turns on to produce current such that the organic light emitting diode OLED illuminates according to the data signal DATA**1**.

[**0032**] Operation of the active matrix organic light emitting diode display pixel structure according to the present invention follows.

[**0033**] First, the first transistor **M11** turns on such that the data signal DATA**1** charges the storage capacitor CS**1** when the scan signal SCAN coupled to the gate terminal of the first transistor **M11** is high potential, that is, exceeds the threshold voltage of the first transistor **M11**.

[**0034**] The second transistor **M12** turns on and produces a corresponding driving current to the organic light emitting diode OLED according to a voltage Vg stored at the storage capacitor CS**1**, when the voltage Vg exceeds the threshold voltage of the second transistor **M12**. Consequently, the organic light emitting diode OLED illuminates according to the driving current.

[**0035**] To achieve high-gray scale, the present invention modifies the channel width/length ratios (W**1**/L**1**) of the second transistor **M12** to below 0.2.

[**0036**] **FIG. 4** shows a current-voltage curve to present the relationship between current and voltage of driving transistors with different W/L ratios. In the first embodiment of the present invention, the first and second transistors **M11** and **M12** are P-type transistors. As shown in **FIG. 4**, curves **Q1**, **Q2** and **Q3** correspond to channel width/length ratios of 1.0, 0.2 and 0.08. As shown in **FIG. 4**, the ratios of driving current and driving voltage decrease as those of channel width/length decrease. In other words, the linear region of the driving transistor is increased such that the driving current of the driving transistor does not enter saturation region quickly as the channel width/length ratios decrease. Consequently, the high-gray scale of the pixel structure is achieved.

[**0037**] **FIG. 5** shows the relationship between driving current and current variation of driving transistors with different W/L ratios, wherein the driving transistor has a threshold voltage variation of ±0.5 volts caused by process variation. **FIG. 6** shows another relationship between driving current and current variation of driving transistors with different W/L ratios, wherein the driving transistor has a threshold voltage variation of ±0.2 volts caused by process variation. In view of **FIG. 5** and **FIG. 6**, as the channel width/length ratio of the driving transistor reduces and the driving current variation of the driving transistor caused by threshold voltage variation is smaller. Consequently, the present invention modifies the channel width/length ratio of the driving transistor to below 0.2, and the reliability of the driving transistor of the pixel structure is thus improved.

[**0038**] **FIG. 7** shows another aspect of the first embodiment of the present invention, wherein the first and second transistors **M21** and **M22** are N-type thin-film transistors. Furthermore, the channel width/length ratios of the second transistor **M22** is also below 0.2 such that the object of achieving high-gray scale and improving reliability of the driving transistor is obtained as well.

The Second Embodiment

[**0039**] **FIG. 8** shows a pixel structure of an active matrix OLED display according to the first embodiment of the present invention, wherein the pixel structure **30** is composed of a switching transistor **M31**, a storage capacitor **CS1**, a organic light emitting diode OLED and first to third driving transistors **M32**-**M34**.

[**0040**] The switching transistor **M31** has a gate terminal coupled to a scan signal SCAN, a source terminal coupled to a data signal DATA1. The storage capacitor **CS3** has two terminals coupled to a drain terminal of the switching transistor **M31** and a reference voltage VL respectively. The reference voltage VL for example is ground or voltage source VDD.

[**0041**] The first driving transistor **M32** has a gate terminal coupled to the drain terminal of the switching transistor **M11**, and a source terminal coupled to a first voltage VDD. A source terminal of the second driving transistor **M32** is coupled to the drain terminal of the first driving transistor **M32**, and a source terminal of the third driving transistor **M34** is coupled to the drain terminal of the second driving transistor **M33**. The drain terminal of the third driving transistor **M34** is coupled to an anode of the organic light emitting diode OLED and the cathode of the OLED is coupled to ground. The gate terminals of the first to third driving transistors are coupled to switching transistor **M31**. **FIG. 9** is a sectional drawing of the driving transistor in **FIG. 8**, the channel width/length ratios of the first to third driving transistors **M32**, **M33** and **M34** are W1/L1, W2/L2, W3/L3 respectively, and the equivalent channel width/length ratios (Ws/Ls) of three driving transistor **M32** to **M34** is below 0.2, for example 0.8 or 1.0.

[**0042**] The switching transistor **M31** turns on and off according to the scan signal SCAN, and the three driving transistors **M32**-**M34** turn on to produce current such that the organic light emitting diode OLDE illuminates according to the data signal DATA1.

[**0043**] Operation of the active matrix organic light emitting diode display pixel structure **30** according to the second embodiment of the present invention follows.

[**0044**] First, the switching transistor **M31** turns on such that the data signal **DATA1** charges the storage capacitor **CS3** when the scan signal SCAN coupled to the gate terminal of the switching transistor **M31** is high potential, that is, exceeds the threshold voltage of the switching transistor **M31**.

[**0045**] The first to third driving transistors **M32**-**M34** all turn on and produce a corresponding driving current to the organic light emitting diode OLED according to a voltage Vg stored at the storage capacitor **CS3**, when the voltage Vg exceeds the threshold voltages of the three driving transistors **M32**-**M34**. Consequently, the organic light emitting diode OLED illuminates according to the driving current.

[**0046**] To achieve high-gray scale, the present invention modifies the equivalent channel width/length ratios (Ws/Ls) of the three driving transistors **M32**-**M34** also to below 0.2. In other words, the linear region of the driving transistors **M32**-**M34** is increased such that the driving current of the driving transistors **M32**-**M34** does not enter saturation region quickly if channel width/length ratios decrease. Consequently, the high-gray scale of the pixel structure is achieved.

[**0047**] Furthermore, the driving current output to OLED from the three driving transistors **M32**-**M34** is smaller than a single driving transistor based on the same driving voltage Vg because three driving transistors **M32**-**M34** are coupled in cascode. Namely, the ratios of driving current increment and driving voltage increment of three driving transistors is decreased, and the linear region of the equivalent driving transistor composed of transistors **M32**-**M34** is increased and the effect of high-gray scale of the pixel structure is improved. Further, the present invention can share the luminescence variation caused by the threshold voltage variation of the driving transistors when the threshold voltage is varied by process variation because the three driving transistors are coupled in cascode. Consequently, the second embodiment also can improve the reliability of the driving transistor and achieve high-gray scale of the pixel structure.

[**0048**] The switching transistor **M31**, the first driving transistor **M32**, the second driving transistor **M33** and third driving transistor **M34** are not only implemented by P-type thin-film transistors, but also implemented by N-type thin-film transistors. The most important point is that the equivalent channel width/length ratios must not exceed 0.2, and then the object of achieving high-gray scale and improving reliability of the driving transistor is obtained as the first embodiment.

[**0049**] Finally, 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. On 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 of the active matrix organic light emitting diode display, comprising:

a first transistor having a gate terminal coupled to a scan signal and a source terminal coupled to a data signal;

a storage capacitor having two terminals coupled to a drain terminal of the first transistor and a reference voltage respectively;

a second transistor having a gate terminal coupled to the drain terminal of the first transistor and a source terminal coupled to a first voltage, wherein a channel width/length (W/L) ratio is below 0.2; and

an organic light emitting diode (OLED) having an anode coupled to a drain terminal of the second transistor and a cathode coupled to a second voltage.

2. The pixel structure as claimed in claim 1, wherein the first and second transistors are Thin-film transistors.

3. The pixel structure as claimed in claim 2, wherein the thin-film transistors are N-type thin-film transistors.

4. The pixel structure as claimed in claim 2, wherein the thin-film transistors are P-type transistors.

5. The pixel structure as claimed in claim 1, wherein the second voltage is ground.

6. The pixel structure as claimed in claim 1, wherein the first voltage is a voltage source.

7. The pixel structure as claimed in claim 1, wherein the reference voltage is ground.

8. A pixel structure of the active matrix organic light emitting diode display, comprising:

a switching transistor having a gate terminal coupled to a scan signal and a source terminal coupled to a data signal;

a storage capacitor having two terminals coupled to a drain terminal of the first transistor and a reference voltage respectively;

an organic light emitting diode (OLED) having a cathode coupled to a first voltage; and

a plurality of driving transistors coupled in cascode, wherein the first terminal of the first diving transistor is deposited at the first stage of the driving transistors coupled to a second voltage, and a second terminal of the final diving transistor is deposited at the final stage of the driving transistors coupled to an anode of the OLED, and an equivalent channel width/length (W/L) ratio of the driving transistors is below 0.2.

9. The pixel structure as claimed in claim 8, wherein the switching transistor is a thin-film transistor.

10. The pixel structure as claimed in claim 9, wherein the switching transistor is an N-type thin-film transistor.

11. The pixel structure as claimed in claim 9, wherein the switching transistor is a P-type thin-film transistor.

12. The pixel structure as claimed in claim 10, wherein the plurality of driving transistors comprises P-type thin-film transistors.

13. The pixel structure as claimed in claim 10, wherein the plurality of driving transistors comprises N-type thin-film transistors.

14. The pixel structure as claimed in claim 10, wherein the plurality of driving transistors comprises N-type thin-film transistors.

15. The pixel structure as claimed in claim 8, wherein the second voltage is a voltage source.

16. The pixel structure as claimed in claim 15, wherein the first voltage is ground.

17. The pixel structure as claimed in claim 1, wherein the reference voltage is ground.

* * * * *

patsnap

专利名称(译)	有源矩阵有机发光二极管显示像素结构		
公开(公告)号	US20030234392A1	公开(公告)日	2003-12-25
申请号	US10/265266	申请日	2002-10-07
[标]申请(专利权)人(译)	KUNG NEIN HUI YEH许容		
申请(专利权)人(译)	KUNG NEIN-HUI YEH YUNG-HUI		
当前申请(专利权)人(译)	KUNG NEIN-HUI YEH YUNG-HUI		
[标]发明人	KUNG NEIN HUI YEH YUNG HUI		
发明人	KUNG, NEIN-HUI YEH, YUNG-HUI		
IPC分类号	G09G3/32 H01L27/32 H01L29/06 H01L31/0328 H01L31/0336 H01L31/072 H01L31/109		
CPC分类号	G09G3/3233 H01L27/3262 G09G2320/0271 G09G2300/0842		
优先权	091113889 2002-06-25 TW		
外部链接	Espacenet USPTO		

摘要(译)

有源矩阵有机发光二极管显示像素结构。在本发明的像素结构中，开关晶体管具有耦合到扫描信号的栅极端子和耦合到数据信号的源极端子。存储电容器具有分别耦合到第一晶体管的漏极端子和参考电压的两个端子。 OLED具有耦合到第二晶体管的漏极端子的阳极和耦合到第一电压的阴极。多个驱动晶体管以级联方式耦合，其中驱动晶体管的第一潜水晶体管的第一端子耦合到第二电压，并且驱动晶体管的最终潜水晶体管的第二端子耦合到第二潜在晶体管的阳极。 OLED和驱动晶体管的等效沟道宽度/长度（W / L）比不超过0.2。