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Miyagawa

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(54) **DISPLAY DEVICE**

(75) Inventor: **Keisuke Miyagawa**, Atsugi (JP)

(73) Assignee: **Semiconductor Energy Laboratory Co., Ltd.**, Kanagawa-ken (JP)

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G09G 3/32 (2006.01)
G09G 3/20 (2006.01)

(52) **U.S. Cl.** **345/82**; 345/55; 345/76

(58) **Field of Classification Search** 345/55, 345/76, 77, 80, 82, 83
See application file for complete search history.

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Primary Examiner—My-Chau T. Tran
(74) *Attorney, Agent, or Firm*—Eric J. Robinson; Robinson Intellectual Property Law Office, P.C.

(57) **ABSTRACT**

By operating a driving TFT in a saturation region, luminance is not easily reduced when an EL element is degraded. However, such problems occur as a high voltage, high power consumption, and heat generation. In the case of operating a driving TFT in a saturation region, luminance varies due to a variation of driving TFTs. In view of the aforementioned problems, a high current capacity TFT is used in the high gray-scale and a low current capacity TFT is used in the low gray-scale. The high current capacity TFT can supply a large current with a lower Vgs, therefore, it does not easily operate in a linear region even when Vds is lowered. Thus, a luminance is not reduced easily even when an EL element is degraded, and an operation at a low voltage is realized. The low current capacity TFT supplies current when high Vgs is applied. With high Vgs, an effect of variation in characteristics of TFTs, especially in Vth can be ameliorated.

28 Claims, 15 Drawing Sheets

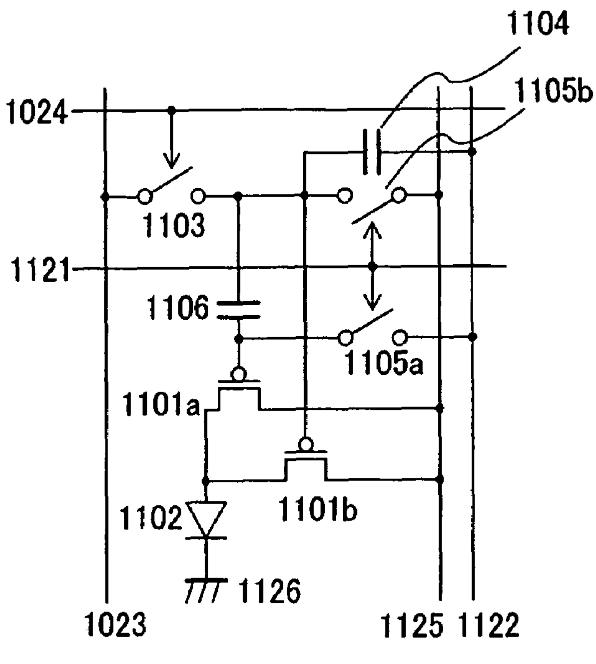

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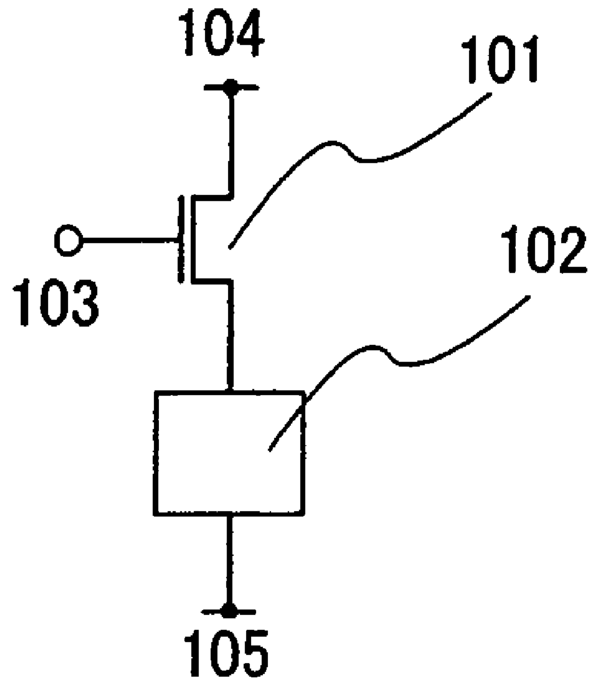
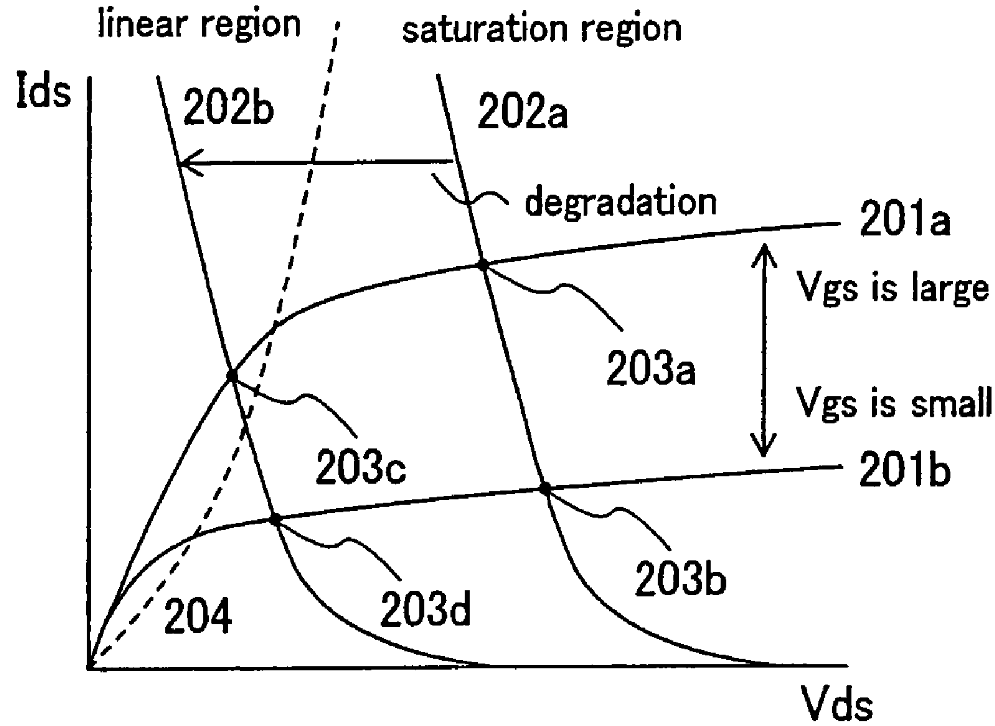
FIG.1



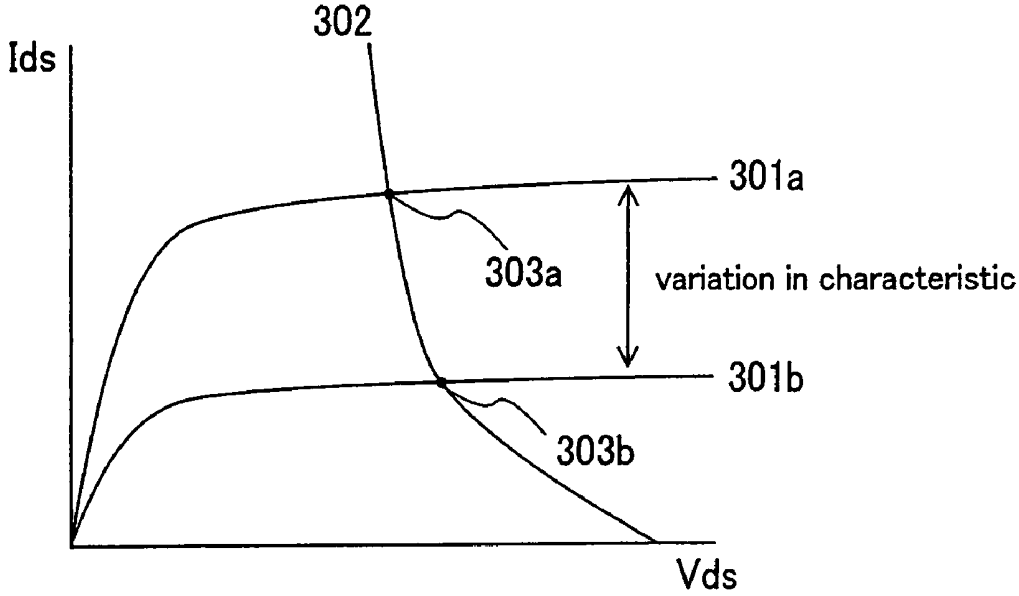
PRIOR ART

FIG.2



PRIOR ART

FIG.3



PRIOR ART

FIG.4

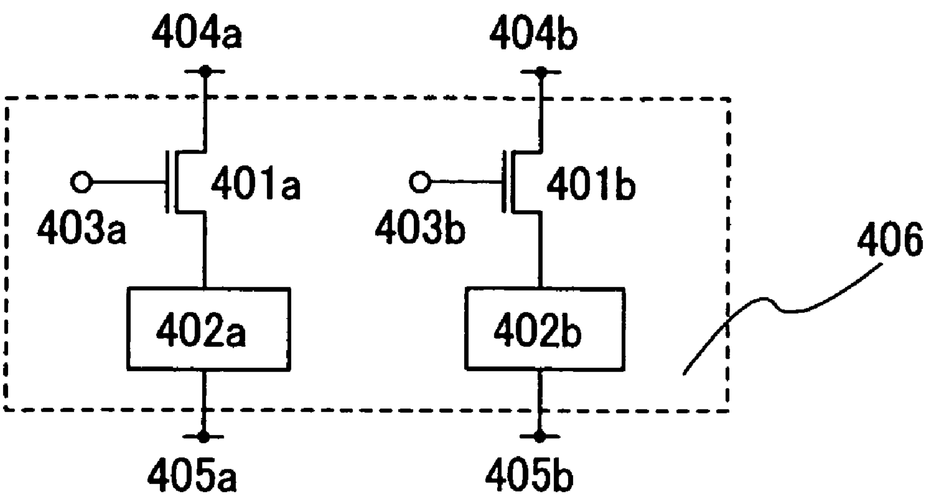


FIG.5

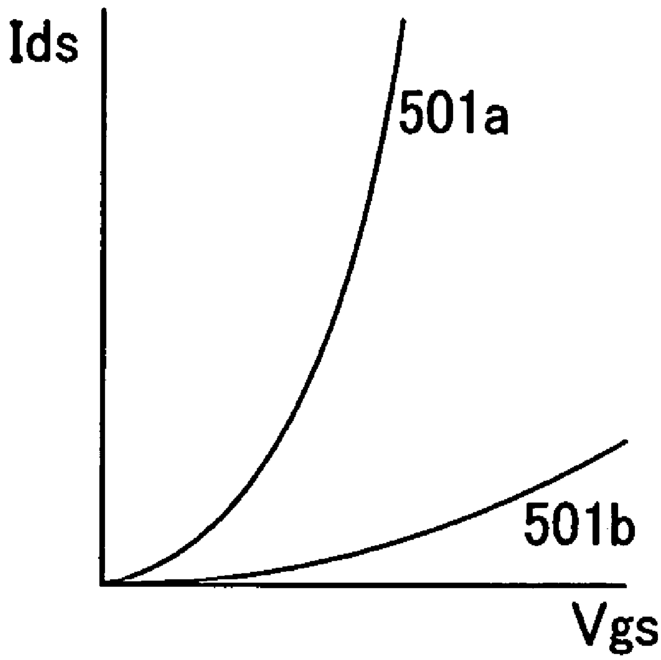


FIG.6

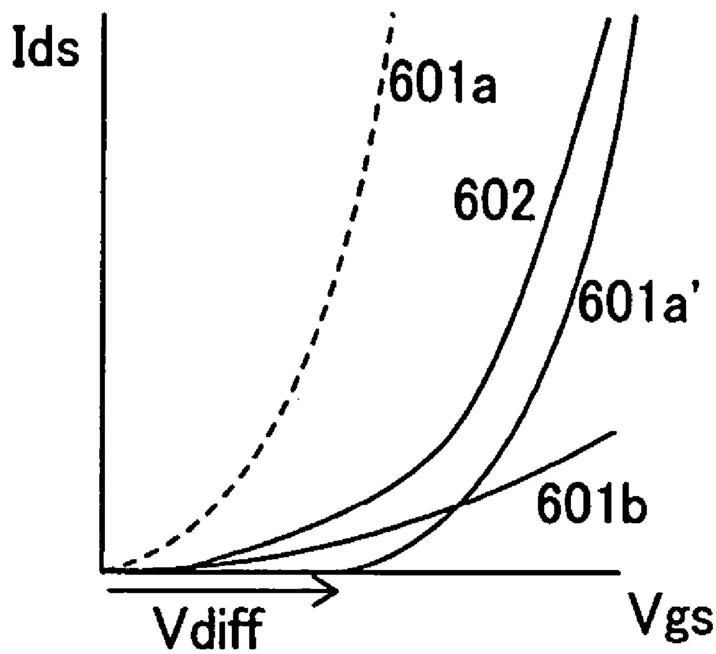


FIG.7A

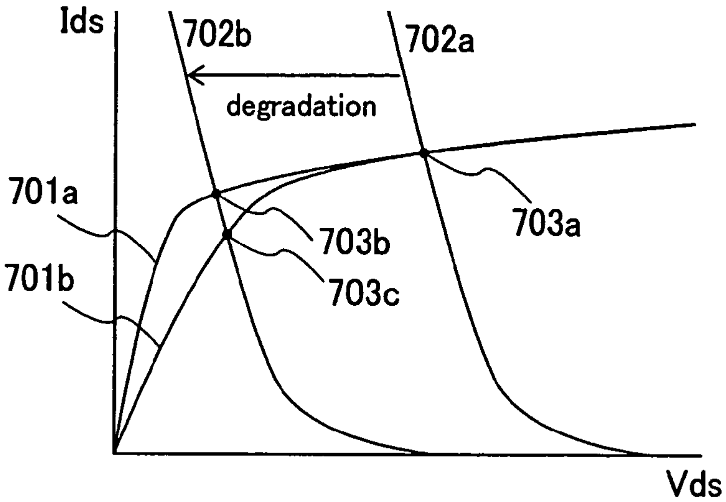

Ids
702b
702a
degradation
701a
703b
703a
703c
701b
Vds

FIG.7B

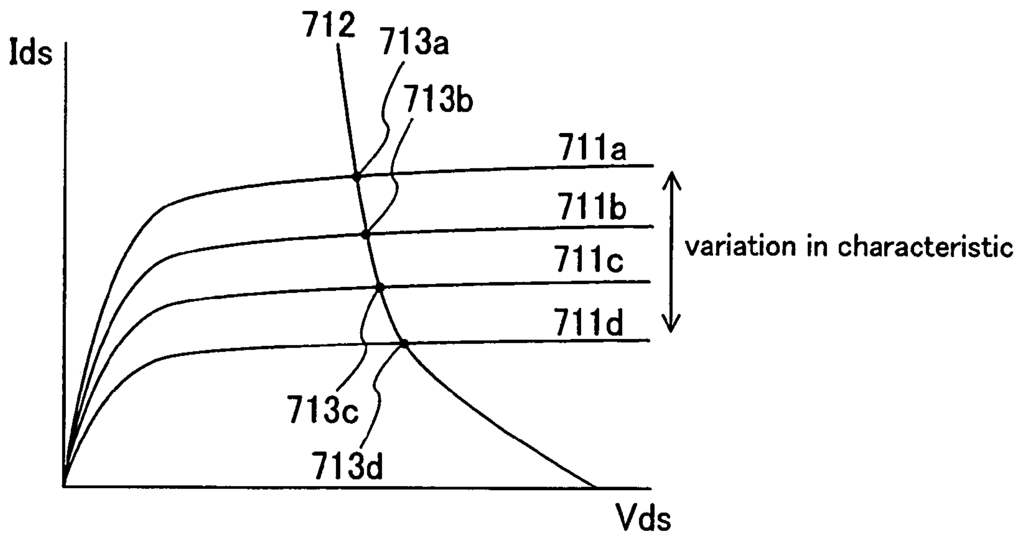

712
713a
Ids
713b
711a
711b
variation in characteristic
711c
711d
713c
713d
Vds

FIG.8A

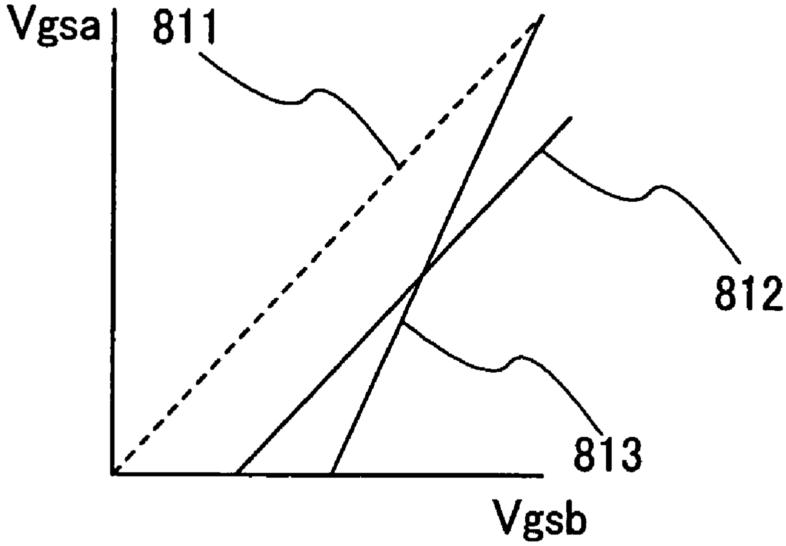


FIG.8B

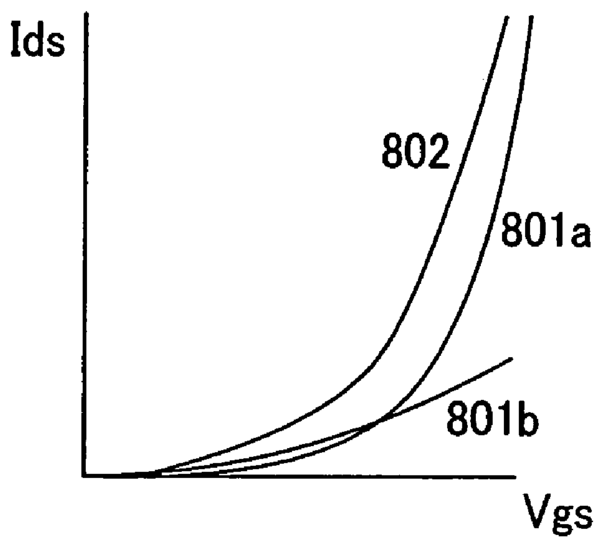


FIG.9

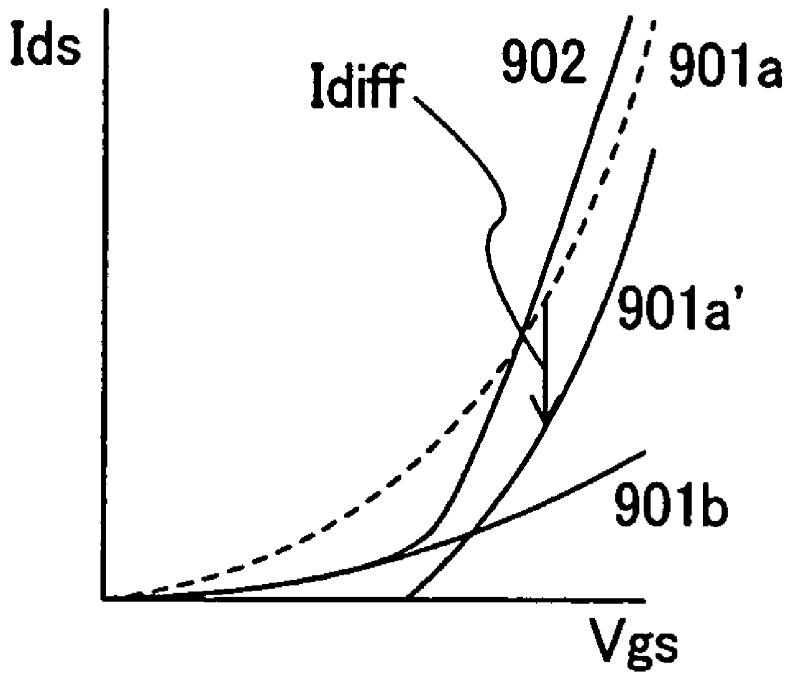


FIG.10

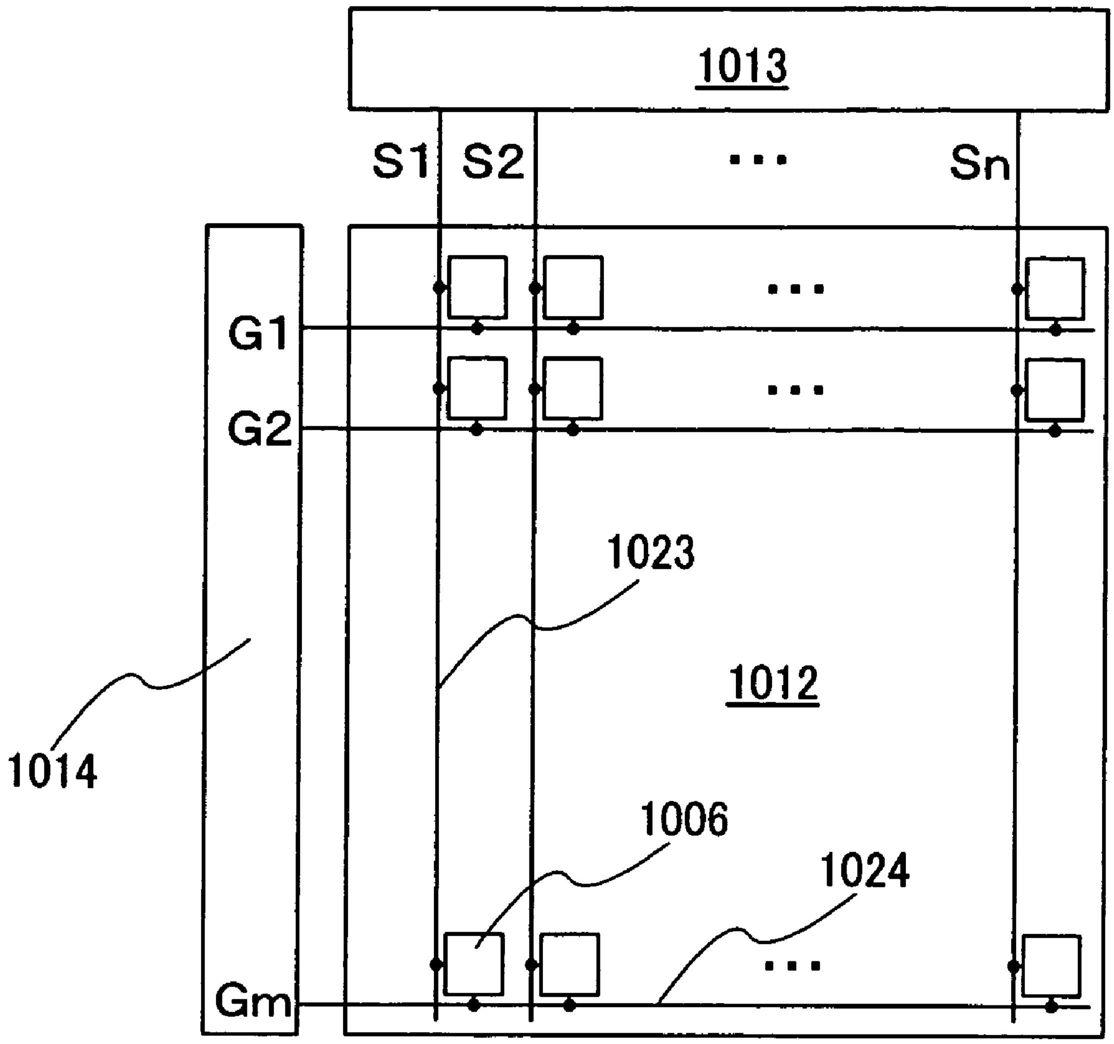
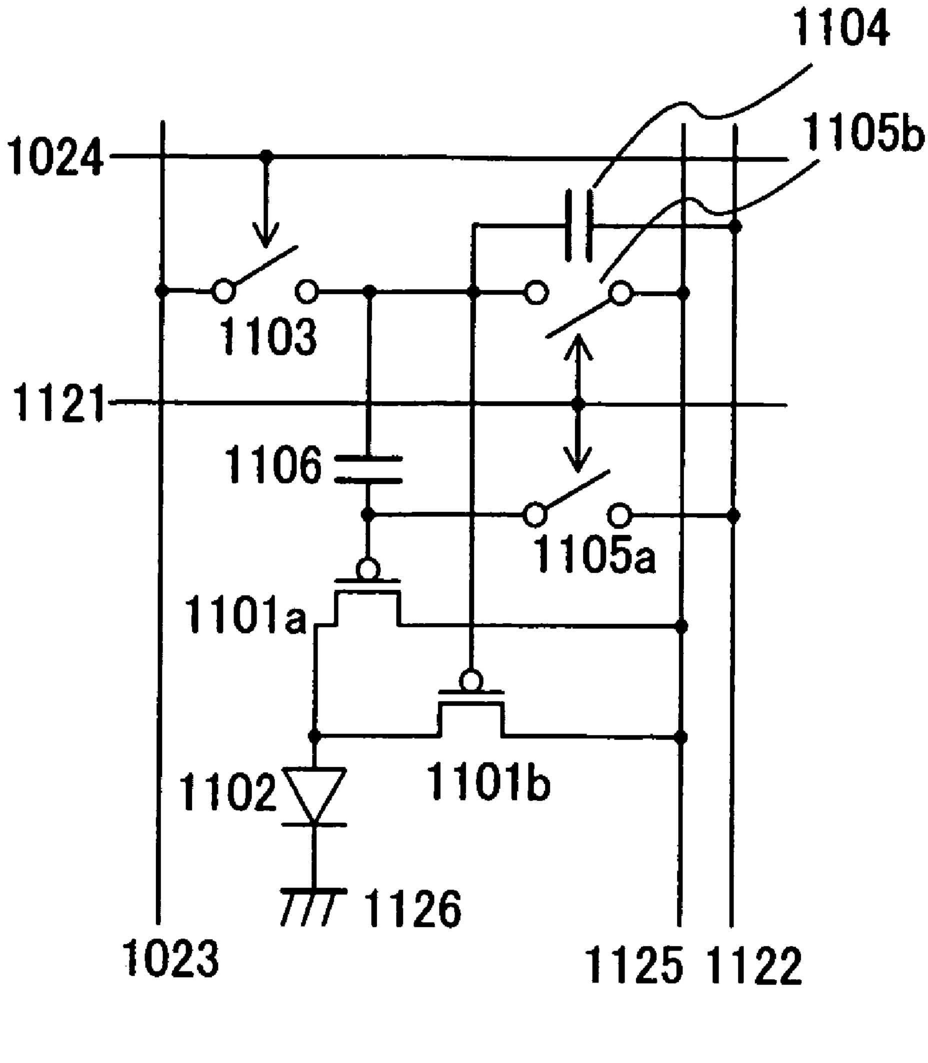


FIG.11



1104
1024
1105b
1103
1121
1106
1105a
1101a
1101b
1102
1126
1023
1125
1122

FIG.12

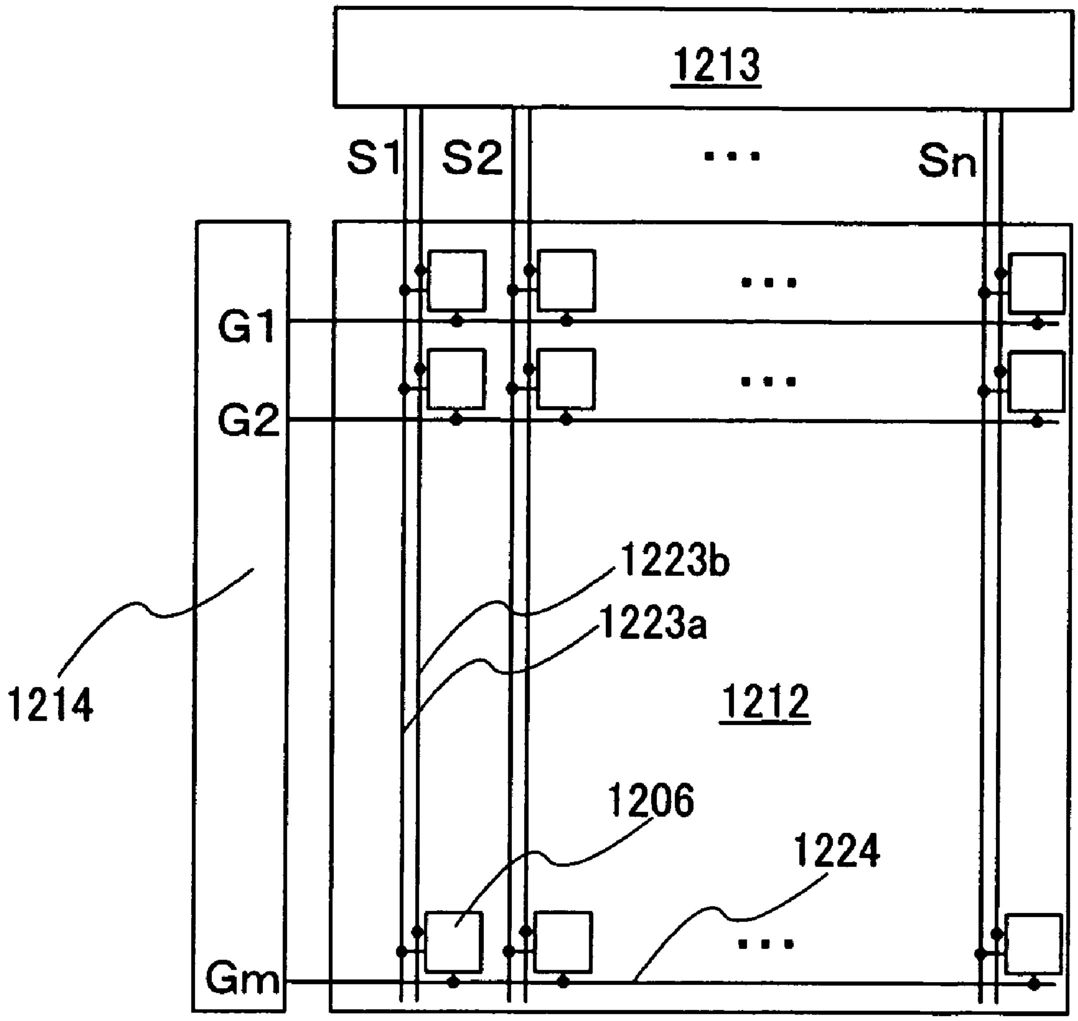


FIG.13

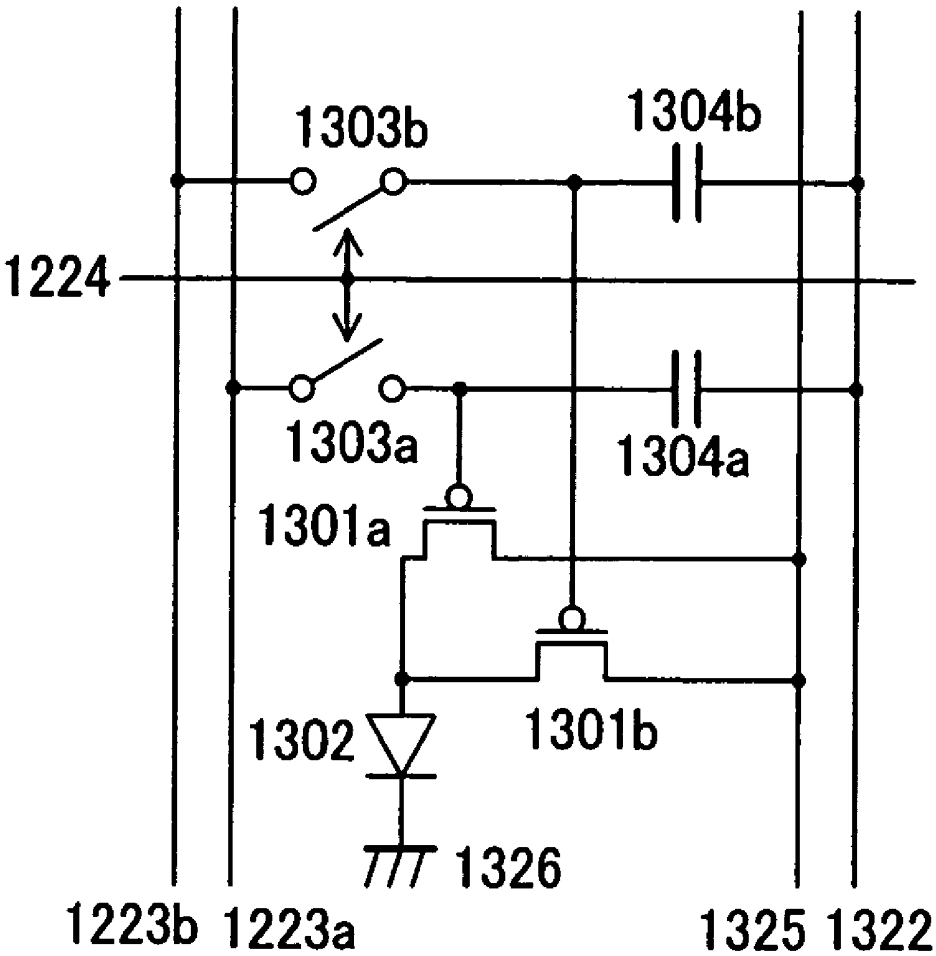

1303b
1304b
1224
1303a
1304a
1301a
1301b
1302
1326
1223b
1223a
1325
1322

FIG.14

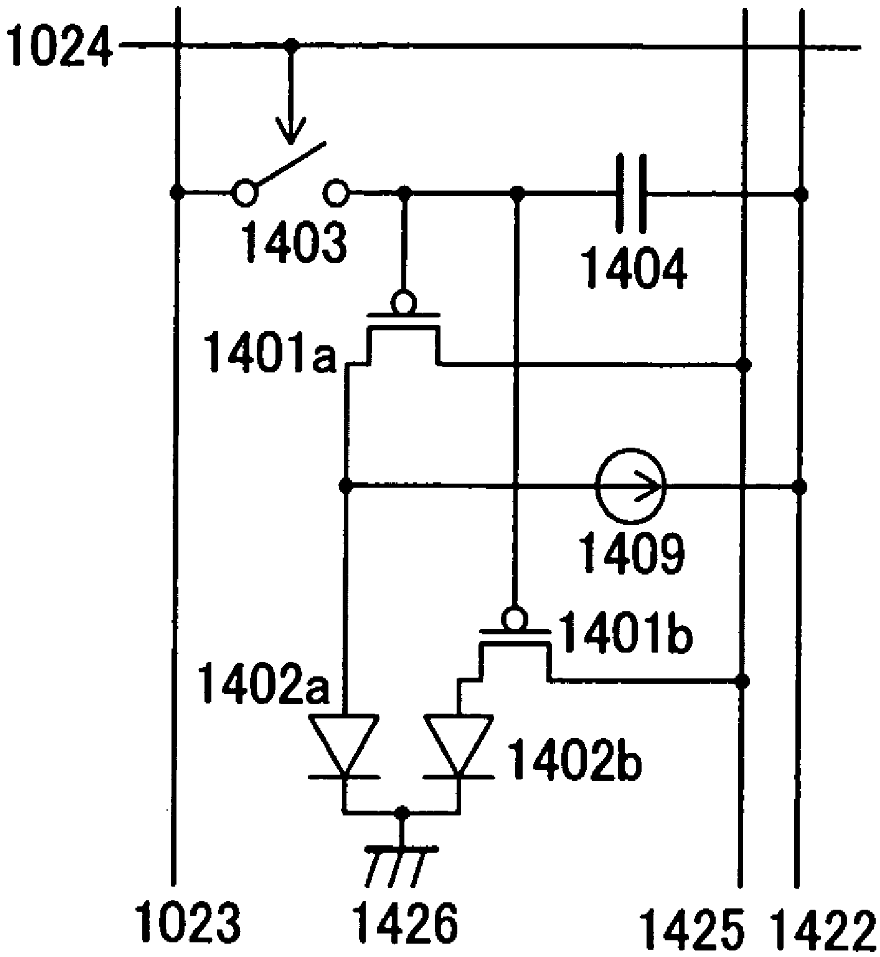

1024
1403
1404
1401a
1409
1401b
1402a
1402b
1023
1426
1425
1422

FIG.15A

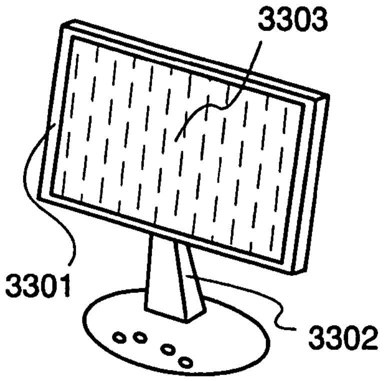


FIG.15B

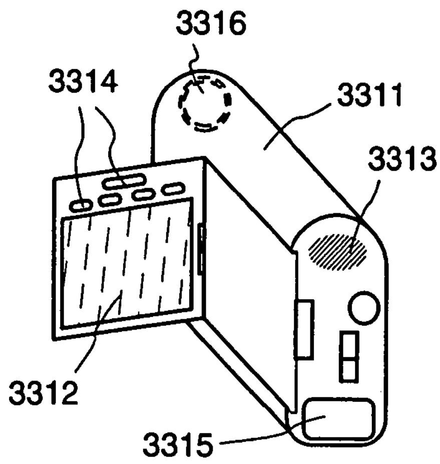


FIG.15C

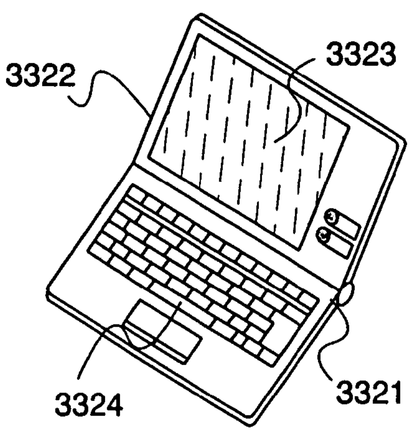


FIG.15D

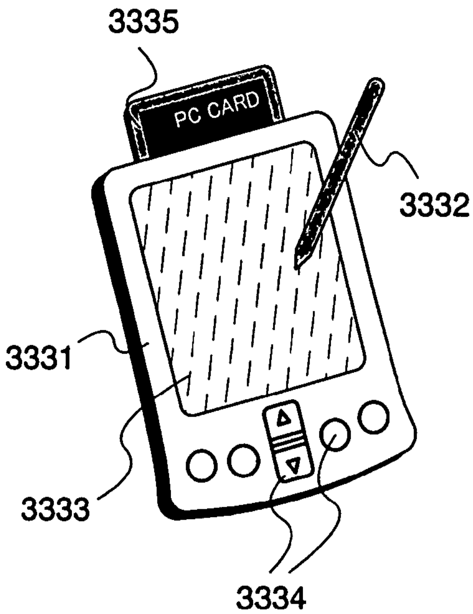


FIG.15E

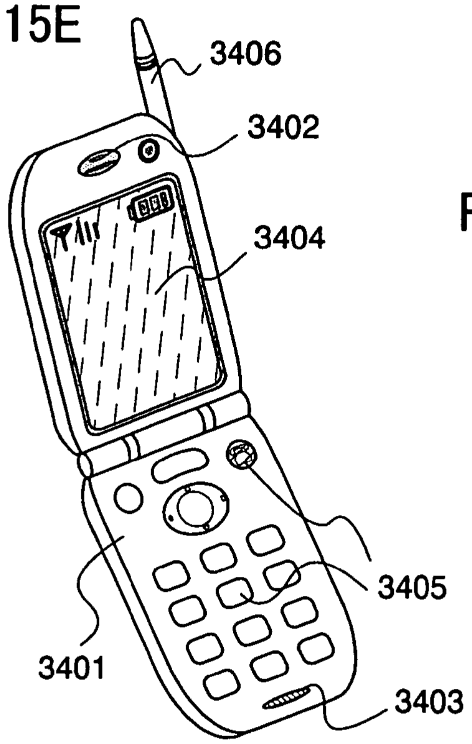
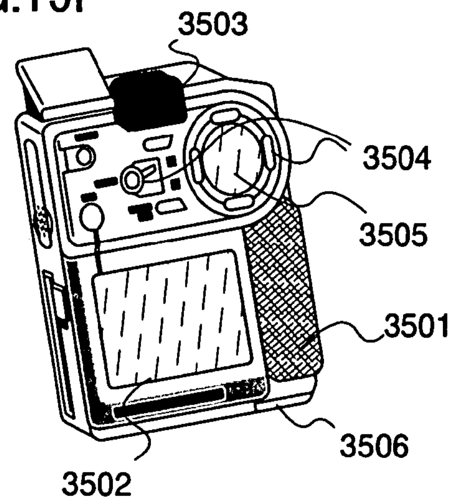


FIG.15F



DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a display device having a transistor. More specifically, the invention relates to a display device having an EL element and a thin film transistor (hereinafter referred to as a TFT) and the like formed on an insulator. Further, the invention relates to an electronic device having such a display device.

2. Description of the Related Art

In recent years, a display device having a light emitting element such as an electro luminescence (EL) element is actively developed. The light emitting element emits light by itself and does not use backlight which is required in a liquid crystal display (LCD) and the like, therefore, it is highly visible and suitable for fabricating in a thin form. Furthermore, its viewing angle is almost unlimited.

Generally, an EL element emits light when a current is supplied. Therefore, a different pixel configuration from LCD is suggested (refer to Non-patent Document 1).

[Non-Patent Document 1]

"Material technology and fabrication of elements regarding an organic EL display", Technical Information Institute, January 2002, p. 179-195

SUMMARY OF THE INVENTION

In aforementioned Non-patent Document 1, by operating a driving TFT in a saturation region, a luminance is not easily reduced even when an EL element is degraded. However, a voltage with an estimated degradation has to be applied in advance, therefore, there are such problems as a high power consumption and heat generation caused by high voltage. Further, in the case of operating driving TFTs in a saturation region, luminance varies due to the variation of the driving TFTs. In view of the aforementioned problems, the invention provides a display device which is not affected by degradation of the EL elements, capable of operating with a low voltage, and has a circuit configuration that can ameliorate the effect of the variation of driving TFTs.

As a source and a drain of a TFT can be of the same structure, they are referred to as a first electrode and a second electrode in this specification. A state that a voltage over a threshold voltage is applied between the gate and source of a TFT and a current flows between the source and drain is referred to as being ON. Further, a state that a voltage below the threshold voltage is applied between the gate and source of a TFT and a current does not flow between the source and drain is referred to as being OFF. Note that a TFT is used as an element forming a display device in this specification, however, the invention is not limited to this. For example, a MOS transistor, an organic transistor, a bipolar transistor, a molecular transistor and the like may be used instead. A mechanical switch may be used as well.

In this specification, an EL element is used as a light emitting element, however, the invention is not limited to this. For example, a light emitting diode and the like may be used.

In a display device in which a driving TFT **101** and an EL element **102** are connected as shown in FIG. **1**, the gate of the driving TFT **101** is connected to a signal terminal **103**, a first terminal is connected to a first power supply terminal **104**, a second terminal is connected to a first terminal of an EL element **102**, a second terminal of the EL element **102** is connected to a second terminal of a power supply terminal **105**. In the aforementioned display device, the driving TFT **101** controls a current flowing to the EL element **102** and determines luminance of the EL element **102**. By operating the driving TFT **101** in a saturation region, a current Ids between the source and drain of the driving TFT **101** can be controlled by a voltage Vgs between the gate and source thereof. In FIG. **1**, the driving TFT **101** may be an N-channel TFT or a P-channel TFT.

It should be noted that a terminal does not have to be actually provided as long as a wiring is electrically connected, although it is referred to as a terminal for convenience in this specification. Moreover, a voltage between the gate and source of the TFT is referred to as Vgs, a voltage between the source and drain of the TFT is referred to as Vds, a current between the drain and source of the TFT is referred to as Ids, and a threshold voltage of the TFT is referred to as Vth in this specification.

In the case of operating the driving TFT in a saturation region, the following two problems occur. The source terminal and the drain terminal are determined depending on a voltage applied to the driving TFT **101**, therefore, a terminal on the first power supply terminal **104** side in FIG. **1** may be either a source terminal or a drain terminal. The source terminal and the drain terminal are determined depending on a voltage applied to the first and second electrodes of the driving TFT **101** and a polarity whether the driving TFT **101** is Nch TFT or Pch TFT.

A first problem is that the driving TFT **101** tends to be operated in a linear region especially in a high gray-scale in which a large current flows into the EL element **102**. FIG. **2** shows Vds-Ids characteristic lines **201***a* and **201***b* of the driving TFT **101** and V-I characteristic lines **202***a* and **202***b* of the EL element **102** in load lines. The characteristic line **201***a* shows the case of a high gray-scale where Vgs is high and Ids is large and the characteristic line **201***b* shows the case of a low gray-scale where Vgs is low and Ids is small. Further, the characteristic line **202***a* shows the case before the EL element **102** is degraded, and the characteristic line **202***b* shows the case after the EL element **102** is degraded. Intersections of the characteristic lines **201***a* and **201***b*, and the characteristic lines **202***a* and **202***b* correspond to operation points **203***a* to **203***d*. When transferring from the characteristic line **202***a* to the characteristic line **202***b* due to the degradation of the EL element **102**, the operation points **203***a* and **203***b* transfer to the operation points **203***c* and **203***d*. At this time, Vds of the driving TFT **101** is lowered. In the case of the characteristic line **201***a* of the high gray-scale in particular, a driving state is changed with the operation point **203***a* in a saturation region transfers to the operation point **203***c* in a linear region as shown in FIG. **2** when Vds is lowered. This is because higher Vds of the characteristic line **201***a* is included in a linear region since Vgs is high. It should be noted that Vgs=Vds is a border between a linear region and a saturation region, which is shown in a dotted line **204** in FIG. **2**. In a linear region, Ids changes drastically when Vds changes, which changes a current to flow into the EL element **102**. Thus, luminance changes and display quality is lowered because of an image persistence and the like. In a linear region, Ids does not change much when Vgs changes, therefore a luminance cannot be controlled easily by controlling Vgs. In order to avoid these problems, a voltage with an estimated degradation is applied so as not to be operated in a linear region, however, such problems occur as a high power consumption, a heat generation, and a faster degradation of a TFT element.

In the characteristic line **201***b* of the low gray-scale with small Ids, the driving TFT operates in a saturation region even when the operation point **203***b* transfers to the operation point **203***d*. This is because lower Vds of the characteristic line **201***b* is included in a saturation region since Vgs is low.

A second problem is that the EL element **102** is easily affected by variation in characteristics of TFTs especially in a low gray-scale where a small current flows to the EL element **102**. FIG. **3** shows Vds-Ids characteristic lines **301***a* and **301***b* of the driving TFT **101** and V-I characteristic line **302** of the EL element **102** in load lines. The characteristic lines **301***a* and **301***b* show the case where a characteristic of the driving TFT **101** varies. Intersections of the characteristic lines **301***a*, **301***b* and **302** correspond to operation points **303***a* and **303***b*. Characteristics of TFTs are not uniform, but have variation in Vth, for example. When the characteristic line **301***a* transfers to the characteristic line **301***b* due to the variation in characteristic of the driving TFT **101**, the operation point **303***a* transfers to the operation point **303***b*, which changes Ids. Ids is in proportion to $(Vgs-Vth)^2$, however, it is easily affected by the variation in Vth since Vgs is low in the low gray-scale with small Ids. This causes luminance variation of a display device and decrease of display quality.

In the high gray-scale with large Ids, Ids is not easily affected by the variation in Vth since Vgs is high.

In the invention, a high current capacity TFT is used in a high gray-scale (display) while a low current capacity TFT is used in a low gray-scale (display) as a driving TFT.

A high current capacity TFT is used as a driving TFT in a high gray-scale because it can supply a large current even with a lower Vgs, therefore, it does not operate in a linear region easily even when Vds is lowered. Therefore, luminance is not reduced when the EL element is degraded and operation with low voltage is possible. Thus, low power consumption and low heat generation can be realized, which prevents degradation of a TFT element.

A low current capacity TFT supplies current when high Vgs is applied. A low current capacity TFT is used for low gray-scale as a driving TFT because an effect of variation in characteristics of a TFT, in Vth particularly can be ameliorated by operating with a high Vgs. The use of this TFT is efficient particularly in the low gray-scale in which Vgs is low, and can enhance a display quality. Further, by designing a channel length L of the TFT long in order to suppress a current capacity, a variation in characteristics can be ameliorated.

A configuration of the invention is described now. A display device of the invention comprises at least a signal line which is inputted an analog signal, a scan line, a plurality of transistors, and a light emitting element. The display device further comprises a first transistor connected to a first signal line and the scan line, a first driving transistor connected to the light emitting element, a second transistor connected to a second signal line and the scan line, and a second driving transistor connected to the light emitting element.

A display device of the invention comprises at least a signal line which is inputted an analog signal, a scan line, a plurality of transistors, and a light emitting element. The display device further comprises a first transistor connected to a first signal line and the scan line, a first capacitor connected to the first transistor and a power supply line, a first driving transistor of which gate electrode is connected to the first capacitor and of which one electrode is connected to the light emitting element, a second transistor connected to a second signal line and the scan line, a second capacitor connected to the second transistor and the power supply line, and a second driving transistor of which gate electrode is connected to the second capacitor and of which one electrode is connected to the light emitting element.

In the aforementioned configuration, the first and the second driving transistors may have different current capacities. As another configuration, display in high gray-scale can be performed by making the current capacity of the first driving transistor higher than that of the second driving transistor. Further, display in low gray-scale can be performed by making the current capacity of the second driving transistor lower than that of the first driving transistor.

Furthermore, in the aforementioned configuration, a voltage between the gate and drain of the first driving transistor may be different from that of the second driving transistor.

The display device of the invention may comprise a unit for selecting a plurality of driving transistors connected to the light emitting element according to the luminance thereof.

According to the invention, by using a plurality of driving TFTs having different characteristics, an effect by the degradation of an EL element and variation in characteristic of the driving TFTs can be small and an operation at a low voltage is realized.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a circuit diagram showing light emission of an EL element.

FIG. **2** is a load line diagram showing characteristics of the circuit in FIG. **1**.

FIG. **3** is a load line diagram showing characteristics of the circuit in FIG. **1**.

FIG. **4** is a diagram showing a configuration of the display device of the invention.

FIG. **5** is a diagram showing characteristics of a driving TFT.

FIG. **6** is a diagram showing operations of the display device of the invention.

FIGS. **7**A and **7**B are load line diagrams showing operations of the display device of the invention.

FIGS. **8**A and **8**B are diagrams showing operations of the display device of the invention.

FIG. **9** is a diagram showing an operation of the display device of the invention.

FIG. **10** is a diagram showing an embodiment of the invention.

FIG. **11** is a diagram showing an embodiment of the invention.

FIG. **12** is a diagram showing an embodiment of the invention.

FIG. **13** is a diagram showing an embodiment of the invention.

FIG. **14** is a diagram showing an embodiment of the invention.

FIGS. **15**A to **15**F are examples of electronic devices to which the invention is applicable.

DETAILED DESCRIPTION OF THE INVENTION

Embodiment Mode 1

This application is based on Japanese Patent Application serial no. 2003-139665 filed in Japan Patent Office on 16 May, 2003, the contents of which are hereby incorporated by reference.

Although the present invention will be fully described by way of example with reference to the accompanying drawings, it is to be understood that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as being included therein. Note that like components are denoted by like numerals in different drawings as of the configuration of the invention.

FIG. **4** shows an embodiment mode of the invention. A display device includes one or more of a pixel **406**, and the pixel **406** comprises EL elements **402***a* and **402***b* respectively, driving TFTs **401***a* and **401***b* for driving the EL elements **402***a* and **402***b*, signal terminals **403***a* and **403***b* connected to gates of the driving TFTs **401***a* and **401***b* respectively, first power supply terminals **404***a* and **404***b* connected to first terminals of the driving TFTs **401***a* and **401***b* respectively, and second power supply terminals **405***a* and **405***b* connected to second terminals of the EL elements **402***a* and **402***b* respectively. Second terminals of the driving TFTs **401***a* and **401***b* are connected to first terminals of the EL elements **402***a* and **402***b* respectively.

The driving TFT **401***a* and the driving TFT **401***b* have different characteristics. By using TFTs of different characteristics, a display device can be operated favorably in both a high gray-scale and a low gray-scale. Characteristics of TFTs can be made different by making the size or shape of the TFTs different, making the kind of dopant or the amount of doping of the TFTs different, and making the number of TFTs connected in series or parallel different.

It should be noted that other elements may be provided between the gates of the driving TFTs **401***a* and **401***b* and the signal terminals **403***a* and **403***b* respectively, between the first terminals of the driving TFTs **401***a* and **401***b* and the first power supply terminals **404***a* and **404***b* respectively, between the second terminals of the EL elements **402***a* and **402***b* and the second power supply terminals **405***a* and **405***b* respectively, and between the second terminals of the driving TFTs **401***a* and **401***b* and the first terminals of the EL elements **402***a* and **402***b* respectively. For example, by providing switches between the first terminals of the driving TFTs **401***a* and **401***b* and the first power supply terminals **404***a* and **404***b* respectively, emission and non-emission of the EL elements **402***a* and **402***b* can be controlled regardless of the states of the signal terminals **403***a* and **403***b*.

The driving TFTs **401***a* and **401***b* may be an N-channel TFT or a P-channel TFT.

The EL elements **402***a* and **402***b*, the first power supply terminals **404***a* and **404***b*, and the second power supply terminals **405***a* and **405***b* can be common respectively, but may be separated. By separating them, operations in the high gray-scale and the low gray-scale can be controlled separately. For example, an element area of the EL element **402***a* is designed wide for displaying the high gray-scale and that of the EL element **402***b* is designed narrow for displaying the low gray-scale separately. An EL element of narrower area generally has higher resistance, and a smaller current flows in the lower gray-scale, therefore, potential of operation points of the EL elements can be close to each other in the high gray-scale and the low gray-scale. Each Vds of the driving TFTs **401***a* and **401***b* corresponds to the voltage that deducted the fall in voltage in the EL elements **402***a* and **402***b* from the difference between the first power supply terminals **404***a* and **404***b*, and the second power supply terminals **405***a* and **405***b*. When potential of the operation points of the EL elements are close to each other in the high gray-scale and the low gray-scale, Vds of the driving TFTs **401***a* and **401***b* can be close to each other. Typically, Ids of TFT tends to rise slightly when Vds rises even in a saturation region, which is an obstacle for an accurate luminance control. By controlling Vds so as to be close to each other in the high gray-scale and the low gray-scale, more accurate luminance control can be performed.

The signal terminals **403***a* and **403***b* are separated, however, they may be one common terminal as well.

An operation of the display panel of the invention is described with reference to FIG. **5**.

FIG. **5** shows a relation between Vgs and Ids of the driving TFTs **401***a* and **401***b*. As an example, a high current capacity TFT is used as the driving TFT **401***a* and a low current capacity TFT is used as the driving TFT **401***b*. A characteristic line **501***a* corresponds to Vgs-Ids characteristic of the driving TFT **401***a* and the characteristic line **501***b* corresponds to Vgs-Ids characteristic of the driving TFT **401***b*. It should be noted that Ids flows into the EL elements **402***a* and **402***b* in FIG. **4**.

In an EL element, current and luminance are in proportion generally. Therefore, a luminance can be controlled by controlling Ids. The luminance of a display device corresponds to a sum of the currents flowing into the EL elements **402***a* and **402***b*.

Each Vgs of the driving TFT **401***a* and the driving TFT **401***b* is controlled separately. Here, Vgs of the driving TFT **401***a* is referred to as Vgsa, and Vgs of the driving TFT **401***b* is referred to as Vgsb. The driving TFTs **401***a* and **401***b* controlled separately supply currents Idsa and Idsb into the EL elements **402***a* and **402***b* corresponding to Vgsa and Vgsb respectively. A current Idsa+Idsb determines the luminance of the display device.

In the high gray-scale of high luminance, Ids of the driving TFT **401***a* is made higher than that of the driving TFT **401***b*, while in the low gray-scale of low luminance, Ids of the driving TFT **401***b* is made higher than that of the driving TFT **401***a*.

FIG. **6** shows an example where the gates of the driving TFTs **401***a* and **401***b* have different voltages. Vgsa and Vgsb are determined so as to satisfy the following formula.

$$Vgsa = Vgsb - Vdiff \qquad \text{[Formula 1]}$$

A characteristic line **601***a*' shows the case where Vgsa is applied to the gate of the driving TFT **401***a* and a characteristic line **601***b* shows the case where Vgsb is applied to the gate of the driving TFT **401***b*. Note that the characteristic line **601***a*' corresponds to a characteristic line **601***a* in which Vgsb is applied to the gate of the driving TFT **401***a* is shifted by Vdiff.

A current Ids in a saturation region is expressed by the following formula when a drain current of the driving TFT **401***a* is Idsa' and a drain current of the driving TFT **401***b* is Idsb.

$$\begin{aligned} Idsa' &= \frac{Wa}{La}\mu aCa\frac{(Vgsa - Vtha)^2}{2} \\ &= \frac{Wa}{La}\mu aCa\frac{(Vgsb - Vdiff - Vtha)^2}{2} \\ Idsb &= \frac{Wb}{Lb}\mu bCb\frac{(Vgsb - Vthb)^2}{2} \end{aligned} \qquad \text{[Formula 2]}$$

Here, Wa, Wb, La, Lb, μa, μb, Ca, Cb, Vtha, and Vthb are gate width, gate length, mobility, capacitance per unit area of an oxide film, and threshold voltage of the driving TFTs **401***a* and **401***b* respectively.

A sum Iel of the current flowing into the EL elements **402***a* and **402***b* can be expressed by the following formula.

$$Iel = Idsa' + Idsb = \frac{Wa}{La}\mu aCa\frac{(Vgsb - Vdiff - Vtha)^2}{2} + \frac{Wb}{Lb}\mu bCb\frac{(Vgsb - Vthb)^2}{2} \quad \text{[Formula 3]}$$

Further, Iel can be expressed by a characteristic line **602** in FIG. **6**. This Iel determines the luminance of a display device.

The driving TFT **401***a* has a higher current capacity than the driving TFT **401***b*. Idsa' is comparatively larger in a high gray-scale where a consumption current is large, while Idsb is comparatively larger in a low gray-scale where a consumption current is small and an effect of variation in characteristics of the driving TFTs is preferably small. By selectively using driving TFTs according to the gray-scale, a display device which is not largely affected by the degradations of the EL elements **402***a* and **402***b* and the variation in characteristics of the driving TFTs, and consumes less power can be provided.

Idsa' becomes almost zero when the formula |Vgsb−Vdiff−Vtha|=0 is satisfied, therefore, luminance of a display device is almost dependent on the current supplied by the driving TFT **401***b*. Further, as Vgsa and Vgsb get higher, a current supplied by the driving TFT **401***a* becomes larger than the current supplied by the driving TFT **401***b*. As described above, the current supplied by the driving TFT **401***b* is large in the low gray-scale and the current supplied by the driving TFT **401***a* is large in the high gray-scale.

An advantage of the case of using a high current capacity TFT in the high gray-scale is shown by load lines in FIG. **7**A. When Vds-Ids characteristic in the case of using a high current capacity TFT as the driving TFT **401***a* is a characteristic line **701***a*, Vds-Ids characteristic in the case of using a low current capacity TFT is a characteristic line **701***b*. Further, V-I characteristic before the EL element **402***a* is degraded is a characteristic line **702***a* and V-I characteristic after degradation is a characteristic line **702***b*. Intersections of the characteristic lines **701***a* and **701***b*, and the characteristic lines **702***a* and **702***b* corresponds to operation points **703***a* to **703***c*. At this time, Vgs of a driving TFT is controlled so that Ids of the characteristic lines **701***a* and **701***b* become the same at the operation point **703***b*. In the high current capacity TFT, characteristic of current rises sharply in a linear region. As lower Vds enters a saturation region, the high current capacity TFT does not operate in a linear region easily even when the EL element **402***a* degrades and Vds is lowered. In FIG. **7**A, an operation point **703***b* corresponds to the case of using a high current capacity TFT and an operation point **703***c* corresponds to the case of using a low current capacity TFT when the EL element **402***b* is degraded.

An advantage in the case of using a low current TFT in the low gray-scale is shown by a load line in FIG. **7**B. When Vds-Ids characteristic in the case of using a high current capacity TFT as the driving TFT **401***b* varies in the region from a characteristic line **711***a* to a characteristic line **711***d*, Vds-Ids characteristic in the case of using a low current capacity TFT varies in the region from a characteristic line **711***b* to the characteristic line **711***c*, which is narrower than the case of using a high current TFT. Further, V-I characteristic of the EL element **402***b* corresponds to a characteristic line **712**. Intersections of the characteristic lines **711***a* to **711***d* and the characteristic line **712** correspond to operation points **713***a* to **713***d*. The operation point varies in the case of using a high current capacity TFT in the region from **713***a* to **713***d*, while it varies in the region from the operation points **713***b* to **713***c* in the case of using a low current capacity TFT, which is narrower than the case of using a high current TFT.

A reason why the variation is narrower in the case of using a low current capacity TFT is described now. Ids of a TFT in a saturation region can be expressed by the following formula.

$$Ids = \frac{W}{L}\mu C\frac{(Vgs - Vth)^2}{2} \quad \text{[Formula 4]}$$

Here, W, L, μ, C, and Vth correspond to gate width, gate length, mobility, capacitance per unit area of an oxide film, and threshold voltage respectively. When W/L is small, current capacity is lowered. By the above formula, the lower the current capacity of the driving TFT **401***b* is, the higher Vgs is applied even with the same Ids. By applying higher Vgs, an effect of the variation in Vth to Ids can be small, which makes the variation in Ids small.

Vgs is high in high gray-scale, therefore, an effect of Vth is small. Thus, a high current TFT may be used as the driving TFT **401***a*. Further, Vgs is low in the low gray-scale, therefore, a driving TFT is easily operated in a saturation region. Thus, a low current capacity TFT may be used as the driving TFT **401***b*.

In this embodiment mode, the driving TFT **401***a* which provides a high current capacity is used as a power supply in the high gray-scale, while the driving TFT **401***b* which provides a low current capacity is used as a power supply in the low gray-scale. By selectively using the driving TFTs according to the gray-scale, a display device in which luminance is not easily reduced even when the EL elements **402***a* and **402***b* are degraded and which is not easily affected by the variation of the TFTs can be provided.

An additional voltage for the voltage fall caused by the increased resistance of the EL elements **402***a* and **402***b* in the case where the EL elements **402***a* and **402***b* are degraded is applied in advance between the first power supply terminals **404***a* and **404***b* and the second power supply terminals **405***a* and **405***b* besides the driving voltage of the EL elements **402***a* and **402***b* and the voltage for the driving TFTs **401***a* and **401***b* to reach a saturation region. In this manner, the driving TFTs **401***a* and **401***b* do not operate in a linear region even when Vds of the driving TFTs **401***a* and **401***b* are lowered by the increased voltage fall of the EL elements **402***a* and **402***b*. Thus, luminance is not reduced. However, by applying a voltage for the voltage fall caused by the increased resistance of the EL elements **402***a* and **402***b*, power consumption may be increased. In this embodiment mode, by mainly using a high current capacity TFT in the high gray-scale, lower Vds of the driving TFT is included in a saturation region. As the lower Vds is in a saturation region, degradations of the EL elements **402***a* and **402***b* do not have much effect even when the first power supply terminals **404***a* and **404***b* and the second power supply terminals **405***a* and **405***b* have small voltage between them. As described above, a display device which consumes less power, generates less heat, and of which TFTs are not degraded easily can be provided.

An example of a method for applying a potential difference Vdiff between Vgsa and Vgsb is described now. A capacitor having potential difference in each end is provided between a gate and signal terminals **403***a* and **403***b* of one or both of the driving TFT **401***a* and **401***b*. As a result, one or both of the gates of the driving TFTs **401***a* and **401***b* which is provided with a capacitor is applied a voltage which is a sum of the voltage of the signal terminals **403***a* and **403***b* and the potential difference between both ends of the capacitor. In this example, a potential difference Vdiff can be applied to the gates of the driving TFTs **401***a* and **401***b* by using a capacitor even when the signal terminals **403***a* and **403***b* are one terminal. Provided that the signal lines **403***a* and **403***b* are common, control of the driving TFTs **401***a* and **401***b* can be easy.

Embodiment Mode 2

An embodiment mode of the invention is described with reference to FIGS. **8**A and **8**B. In order to set Vgs of the driving TFTs **401***a* and **401***b* at different voltages, a voltage of the driving TFT **401***a* is shifted in Embodiment Mode 1. A relation between Vgs of the driving TFT **401***a* and Vgs of the driving TFT **401***b* is shown in FIG. **8**A. Here, Vgs of the driving TFT **401***a* is Vgsa and Vgs of the driving TFT **401***b* is Vgsb. When a characteristic line **811** shows the case of applying the same voltage as Vgsa and Vgsb, it corresponds to a characteristic line **812** in Embodiment Mode 1. In this embodiment mode, a different method for setting a voltage from Embodiment Mode 1 is described.

Vgsa is set so as to be low relatively to Vgsb in low gray-scale, while Vgsb is set so as to be close to Vgsa in higher gray-scale. A voltage setting in this embodiment mode is shown by a characteristic line **813**.

FIG. **8**B shows a Vgs-Ids characteristic line **801** a of the driving TFT **401***a* which is applied the aforementioned Vgs, a Vgs-Ids characteristic line **801***b* of the driving TFT **401***b*, and a characteristic line **802** of a sum of the current of the driving TFTs **401***a* and **401***b*. Ids of the driving TFT **401***b* becomes larger in the low gray-scale while Ids of the driving TFT **401***a* becomes larger in the high gray-scale. A display device in which luminance is not easily reduced even when the EL elements **401***a* and **401***b* are degraded and which is not easily affected by variation of the driving TFTs **401***a* and **401***b* can be provided.

It is preferable that the driving TFTs **401***a* and **401***b* operate in a saturation region with lower Vds so that luminarice is not changed due to the degradation of the EL elements **402***a* and **402***b*. At this time, a saturation region begins from Vds that is equal to Vgs, therefore, Vgs is preferred to be as low as possible in order to avoid an effect of a degradation of the EL elements **402***a* and **402***b*. Vgs changes according to the gray-scale and becomes a maximal value in the highest gray-scale. That is to say, it is efficient that Vgs of the driving TFTs **401***a* and **401***b* in the highest gray-scale be as low as possible. In order to make Vgs the lowest while making the currents of the driving TFTs **401***a* and **401***b* the largest in the highest gray-scale, Vgs in the highest gray-scale are set to be the same.

According to this embodiment mode, an effect of variation of TFTs can be small in the low gray-scale, and an effect of a degradation of an EL element can be small in the high gray-scale. Further, Vgs can be made as low as possible in the gray-scale which is affected the most by the degradation, therefore, the effect of the degradation can be even smaller.

Embodiment Mode 3

An embodiment mode of the invention is described with reference to FIG. **9**. Vgs of the driving TFTs **401***a* and **401***b* are set at different voltages in Embodiment Modes 1 and 2. In this embodiment mode, the driving TFT **401***a* can be mainly used in the high gray-scale and the driving TFT **401***b* can be mainly used in the low gray-scale even when Vgs of the driving TFTs **401***a* and **401***b* are the same.

It is assumed that a current supplied from the driving TFT **401***a* is Idsa and a current supplied from the driving TFTs **401***b* is Idsb. In this embodiment mode, a current that deducted a constant current Idiff from Idsa is supplied to the EL element **402***a*. A current Iel supplied to the EL elements **402***a* and **402***b* can be expressed by the following formula.

$$Iel=Idsa-Idiff+Idsb \ldots (Idsa>Idiff)\quad Iel=Ids \ldots (Idsa\leqq Idiff) \qquad \text{[Formula 5]}$$

FIG. **9** shows a Vgs-Ids characteristic line **901***a* of the driving TFT **401***a* which is applied Vgs, a characteristic line **901***a*' that deducted Idiff from the characteristic line **901***a*, a Vgs-Ids characteristic line **901***b* of the driving TFT **401***b*, and a characteristic line **902** which is a sum of the characteristic line **901***a*' and the characteristic line **901***b*. Here, the characteristic line **901***a* corresponds to Idsa, the characteristic line **901***b* corresponds to Idsb, and the characteristic line **902** corresponds to Iel. Ids of the driving TFT **401***b* is comparatively larger in the low gray-scale, while Ids of the driving TFT **401***a* is comparatively larger in the high gray-scale. Thus, a display device in which a luminance is not easily reduced when the EL elements **402***a* and **402***b* are degraded and which is not easily affected by a variation in characteristics of the driving TFTs **401***a* and **401***b* can be provided.

Unlike Embodiment Mode 1 in which Vgs of the driving TFT **401***a* is shifted and Embodiment Mode 2 in which Vgs of the driving TFTs **401***a* and **401***b* are controlled separately, Vgs of the driving TFTs **401***a* and **401***b* are equal in this embodiment mode. When Vgs are equal, the signal terminals **403***a* and **403***b* can be common and a gray-scale can be controlled simply.

Embodiment Mode 4

In Embodiment Modes 1 to 3, three or more driving TFTs may be used. In the case of using three driving TFTs for example, a gray-scale is divided into three levels: low gray-scale, middle gray-scale, and high gray-scale, then a driving TFT having an appropriate characteristic is provided to each level. By using three or more driving TFTs, an effect of degradation and variation can be suppressed in the case of a light emission at an extremely low luminance and a light emission at a high luminance.

In the case of a display device which is used both in darkness and brightness such as a portable device, a light emission at an extremely low luminance is required in darkness and a light emission at high luminance is required in brightness. In the case of using three driving TFTs for example, two driving TFTs are used at each of the extremely low luminance and the high luminance. In the light emission at an extremely low luminance, a first driving TFT which provides a low current capacity and a second driving TFT which provides a middle current capacity are used. The first driving TFT is used in a lower gray-scale at the extremely low luminance, while the second driving TFT is used in a higher gray-scale therein. Further, in the light emission at a high luminance, the second driving TFT which provides a middle current capacity and a third driving TFT which provides a high current capacity are used. The second driving TFT is used in a lower gray-scale in the high gray-scale, while the third driving TFT is used in a higher gray-scale at the high luminance. At the extremely low luminance, a power supply voltage can be low in order to maintain an operation in a saturation region even when Vds is low, thus a power consumption can be reduced. By using three or more driving TFTs as described above, an optimal drive regardless of a luminance can be produced. It is needless to say that three or more driving TFTs may be used at the same time in a single luminance level.

EMBODIMENT

An embodiment of the invention is described now.

Embodiment 1

In this embodiment, a structure of the display device described in Embodiment Mode 1 is described. FIG. **10** is a structure of the display device. The display device comprises a pixel portion **1012** in which a plurality of pixels **1006** are arranged in matrix of m rows and n columns, and a signal driver circuit **1013** and a row selection driver circuit **1014** in the periphery of the pixel portion **1012**. Each signal line **1023** denoted as S1 to Sn is connected to the plurality of pixels **1006** according to the columns and also connected to the signal driver circuit **1013**. A row selection line **1024** denoted as G1 to Gm is connected to the plurality of pixels **1006** according to the rows, and also connected to the row selection driver circuit **1014**. The display device comprises a power supply line and the like other than the aforementioned components, however, they are not shown in FIG. **10**.

FIG. **11** shows a configuration of the pixel **1006**. The pixel **1006** comprises driving TFTs **1101***a* and **1101***b*, an EL element **1102**, a write switch **1103**, a first capacitor (pixel capacitor) **1104**, a voltage shift capacitor switches **1105***a* and **1105***b*, and a second capacitor (voltage shift capacitor) **1106**. A second terminal of the EL element **1102** is connected to a cathode **1126**, drains of the driving TFTs **1101***a* and **1101***b* are connected to a first terminal of the EL element **1102**, and the sources thereof are connected to an anode **1125**. The gate of the driving TFT **1101***a* is connected to a second terminal of the voltage shift capacitor **1106** and also connected to a wiring (pixel capacitor line) **1122** via the voltage shift capacitor switch **1105***a*. The gate of the driving TFT **1101***b* and a first terminal of the voltage shift capacitor **1106** are connected to a signal line **1023** via the write switch **1103** and also connected to the anode **1125** via the voltage shift capacitor switch **1105***b*, and further connected to a first terminal of the pixel capacitor **1104**. A second terminal of the pixel capacitor **1104** is connected to the pixel capacitor line **1122**. The write switch **1103** is controlled by the scan line (row selection line) **1024** and the voltage shift capacitor switches **1105***a* and **1105***b* are controlled by a wiring (voltage shift capacitor control signal line) **1121**.

An operation of the pixel **1006** in this embodiment is described now.

An arbitrary voltage Vdiff is applied to the voltage shift capacitor **1106**. It should be noted that the voltage Vdiff is a difference between Vgs of the driving TFT **1101***a* and that of the driving TFT **1101***b*. A potential difference Vdiff is supplied to the anode **1125** and the pixel capacitor line **1122** and the voltage shift capacitor switches **1105***a* and **1105***b* are turned ON by the voltage shift capacitor control signal line **1121**. After a charge corresponding to a voltage Vdiff is charged in the voltage shift capacitor **1106**, the voltage shift capacitor switches **1105***a* and **1105***b* are turned OFF by the voltage shift capacitor control signal line **1121**. By the aforementioned operation, a voltage difference Vdiff can be applied to both ends of the voltage shift capacitor **1106**. It should be noted that the write switch **1103** is preferably OFF during the aforementioned operation, however, the invention is not limited to this.

The write switch **1103** is turned ON by the row selection line **1024** while the potential difference Vdiff is applied to both ends of the voltage shift capacitor **1106**. At this time, voltage Vsignal which is appropriate for a luminance of the EL element **1102** is applied to the signal line **1023**. After a first terminal of the pixel capacitor **1104** reaches Vsignal, the write switch **1103** is turned OFF by the row selection line **1024**. By the aforementioned operation, a gate of the driving TFT **1101***b* is applied Vsignal and a gate of the driving TFT **1101***a* is applied Vsignal−Vdiff.

By the aforementioned operation, the EL element **1102** emits light. As characteristics of the driving TFT **1101***a* and the driving TFT **1101***b* are different and Vgs of the driving TFT **1101***a* and that of the driving TFT **1101***b* are different, a display device having the characteristics described in Embodiment Mode 1 can be provided.

Further, different Vgs can be supplied to the driving TFTs **1101***a* and **1101***b* rather simply.

A reason why a potential difference between the anode **1125** and the pixel capacitor line **1122** is used in order that the voltage shift capacitor **1106** may have a potential difference is described now. The anode **1125** is required to be controlled in accordance with a characteristic of the EL element **1102**. Further, Vdiff is also required to be controlled in accordance with characteristics of the driving TFTs **1101***a* and **1101***b* and of the EL element **1102**. A potential of the pixel capacitor line **1122**, however, is generally arbitrary and may be set at an appropriate potential and can be determined in accordance with the anode **1125** and Vdiff.

Embodiment 2

In this embodiment, a structure of the display device described in Embodiment Mode 2 is described. FIG. **12** shows an example of a structure of the display device. The display device comprises a pixel portion **1212** in which a plurality of pixels **1206** are arranged in matrix of m rows and n columns, and a signal driver circuit **1213** and a row selection driver circuit **1214** in the periphery of the pixel portion **1212**. Signal lines **1223***a* and **1223***b* denoted as S1 to Sn are connected to the plurality of pixels **1206** according to the columns and also connected to the signal driver circuit **1213**. A row selection line **1224** denoted as G1 to Gm is connected to the pixel **1206** according to the rows, and also connected to the row selection driver circuit **1214**. The display device comprises a power supply line and the like other than the aforementioned components, however, they are not shown in FIG. **12**.

FIG. **13** shows an example of a configuration of the pixel **1206**. The pixel **1206** comprises driving TFTs **1301***a* and **1301***b*, an EL element **1302**, write switches **1303***a* and **1303***b*, and pixel capacitors **1304***a* and **1304***b*. A second terminal of the EL element **1302** is connected to a cathode **1326**, drains of the driving TFTs **1301***a* and **1301***b* are connected to a first terminal of the EL element **1302**, sources thereof are connected to an anode **1325**. Gates of the driving TFTs **1301***a* and **1301***b* are connected to first terminals of the pixel capacitors **1304***a* and **1304***b* respectively, and also connected to signal lines **1223***a* and **1223***b* respectively via write switches **1303***a* and **1303***b* respectively. Second terminals of the pixel capacitors **1304***a* and **1304***b* are connected to a pixel capacitor line **1322**. The write switches **1303***a* and **1303***b* are controlled by the row selection line **1224**.

An operation of the pixel **1206** is described now.

The write switches **1303***a* and **1303***b* are turned ON by the row selection line **1224**. At this time, the signal lines **1223***a* and **1223***b* are applied voltages Vsignala and Vsignalb corresponding to a luminance of the EL element **1302**. Vsignala and Vsignalb are set at different voltages here. After first terminals of the pixel capacitors **1304***a* and **1304***b* reach Vsignala and Vsignalb, the write switches **1303***a* and **1303***b* are turned OFF by the row selection line **1224**. By the aforementioned operation, gates of the driving TFTs **1301***a* and **1301***b* are applied Vsignala and Vsignalb.

By the aforementioned operation, the EL element **1302** emits light. As characteristics of the driving TFTs **1301***a* and **1301***b* are different and Vgs of the driving TFT **1301***a* and that of the driving TFT **1301***b* are different, a display device having the characteristics described in Embodiment Mode 2 can be provided.

Further, Vgs of the driving TFT **1301***a* and that of the driving TFT **1301***b* can be set separately in accordance with a gray-scale, therefore, it is flexibly controlled. Moreover, a reliability can be enhanced because of a simple configuration.

Embodiment 3

In this embodiment, a structure of the display device described in Embodiment Mode 3 is described. A structure of the display device is described in Embodiment 1 with reference to FIG. **10**. Note that a configuration of the pixel **1006** is different here from Embodiment 1.

FIG. **14** shows a configuration of the pixel **1006**. The pixel **1006** comprises driving TFTs **1401***a* and **1401***b*, EL elements **1402***a* and **1402***b*, a write switch **1403**, and a pixel capacitor **1404**. Second terminals of the EL elements **1402***a* and **1402***b* are connected to a cathode **1426**, drains of the driving TFTs **1401***a* and **1401***b* are connected to first terminals of the EL elements **1402***a* and **1402***b* respectively, and sources thereof are connected to an anode **1425**. The first terminal of the EL element **1402***a* is also connected to a current source **1409**. The current source **1409** is connected to a pixel capacitor line **1422**, however, the invention is not limited to this. Gates of the driving TFTs **1401***a* and **1401***b* are connected to a first terminal of a pixel capacitor **1404** and also connected to a signal line **1023** via a write switch **1403**. A second terminal of the pixel capacitor **1404** is connected to the pixel capacitor line **1422**. The write switch **1403** is controlled by a row selection line **1024**.

An operation of the pixel **1006** in this embodiment is described now.

The write switch **1403** is turned ON by the row selection line **1024**. At this time, a voltage Vsignal which is appropriate for a luminance of the EL elements **1402***a* and **1402***b* is applied to the signal line **1023**. After the first terminal of the pixel capacitor **1404** reaches Vsignal, the write switch **1403** is turned OFF by the row selection line **1024**. By the aforementioned operation, gates of the driving TFTs **1401***a* and **1401***b* are applied Vsignal.

By the aforementioned operation, the EL elements **1402***a* and **1402***b* emit light. As characteristics of the driving TFTs **1401***a* and **1401***b* are different and a current supply to the EL element **1402***a* is decreased due to the current source **1409** connected to the drain of the driving TFT **1401***a*, a display device having the characteristics described in Embodiment Mode 3 can be provided.

Further, the driving TFTs **1401***a* and **1401***b* can be used separately in a high gray-scale and a low gray-scale rather simply.

The current source **1409** can be realized easily by using a TFT. By setting Vgs of a TFT so as to operate in a saturation region, a current can be reduced regardless of a drain voltage of the driving TFT **1401***a*. Further, the drain voltage is lowered when a current supply to the driving TFT **1401***a* is small, and a TFT of the current source **1409** operates in a linear region, thus a current to be reduced itself becomes small.

A capacitor line and an anode may be common in Embodiments 2 and 3. Further, three or more driving TFTs may be used in Embodiments 1 to 3.

Embodiment 4

The display device of the invention can be used for a variety of applications. In this embodiment, examples of electronic devices that the invention can be applied to are described.

Such electronic devices include a portable information terminal (an electronic book, a mobile computer, a portable phone and the like), a video camera, a digital camera, a personal computer, a television and the like. Examples of the aforementioned electronic devices are shown in FIGS. **15**A to **15**F.

FIG. **15**A illustrates an EL display including a housing **3301**, a support base **3302**, a display portion **3303** and the like. The display device of the invention can be used in the display portion **3303**.

FIG. **15**B illustrates a video camera including a body **3311**, a display portion **3312**, an audio input portion **3313**, operation switches **3314**, a battery **3315**, an image receiving portion **3316** and the like. The display device of the invention can be used in the display portion **3312**.

FIG. **15**C illustrates a personal computer including a body **3321**, a housing **3322**, a display portion **3323**, a keyboard **3324** and the like. The display device of the invention can be used in the display portion **3323**.

FIG. **15**D illustrates a portable information terminal including a body **3331**, a stylus **3332**, a display portion **3333**, operation buttons **3334**, an external interface **3335** and the like. The display device of the invention can be used in the display portion **3333**.

FIG. **15**E illustrates a portable phone including a body **3401**, an audio output portion **3402**, an audio input portion **3403**, a display portion **3404**, operation switches **3405**, an antenna **3406** and the like. The display device of the invention can be used in the display portion **3404**.

FIG. **15**F illustrates a digital camera including a body **3501**, a display portion A **3502**, an eyepiece portion **3503**, operation switches **3504**, a display portion B**3505**, a battery **3506** and the like. The display device of the invention can be used in the display portions A**3502** and B**3505**.

As described above, an application range of the invention is quite wide, and the invention can be applied to a variety of fields of electronic devices.

What is claimed is:

1. A display device comprising:

a first signal line;

a second signal line;

a scan line;

a light emitting element;

a first transistor connected to the first signal line and the scan line;

a first driving transistor of which a gate electrode is connected to the first transistor, a drain electrode of the first driving transistor being connected to the light emitting element and a source electrode of the first driving transistor being connected to an anode;

a second transistor connected to the second signal line and the scan line; and

a second driving transistor of which a gate electrode is connected to the second transistor, a drain electrode of the second driving transistor being connected to the light emitting element and a source electrode of the second driving transistor being connected to the anode.

2. The display device according to claim **1**, further comprising a unit for selecting driving transistors connected to the light emitting element in accordance with a luminance of the light emitting element.

3. The display device according to claim **1**, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

4. A display device comprising:

a first signal line;

a second signal line;

a scan line;

a light emitting element;

a power supply line;

a first transistor connected to the first signal line and the scan line;

a first capacitor connected to the first transistor and the power supply line;

a first driving transistor of which a gate electrode is connected to the first capacitor, a drain electrode of the first driving transistor being connected to the light emitting element and a source electrode of the first driving transistor being connected to an anode;

a second transistor connected to the second signal line and the scan line;

a second capacitor connected to the second transistor and the power supply line; and

a second driving transistor of which a gate electrode is connected to the second capacitor, a drain electrode of the second driving transistor being connected to the light emitting element and a source electrode of the second driving transistor being connected to the anode.

5. The display device according to claim **4**, further comprising a unit for selecting driving transistors connected to the light emitting element in accordance with a luminance of the light emitting element.

6. The display device according to claim **4**, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

7. A display device comprising:

a first signal line;

a second signal line;

a scan line;

a light emitting element;

a first transistor connected to the first signal line and the scan line;

a first driving transistor of which a gate electrode is connected to the first transistor, a drain electrode of the first driving transistor being connected to the light emitting element and a source electrode of the first driving transistor being connected to an anode;

a second transistor connected to the second signal line and the scan line; and

a second driving transistor of which a gate electrode is connected to the second transistor, a drain electrode of the second driving transistor being connected to the light emitting element and a source electrode of the second driving transistor being connected to the anode,

wherein the first driving transistor and the second driving transistor have different current capacities.

8. The display device according to claim **7**, wherein the first driving transistor has a higher current capacity than the second driving transistor and used for a high gray-scale display.

9. The display device according to claim **7**, wherein the second driving transistor has a lower current capacity than the first driving transistor and used for a low gray-scale display.

10. The display device according to claim **7**, further comprising a unit for selecting driving transistors connected to the light emitting element in accordance with a luminance of the light emitting element.

11. The display device according to claim **7**, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

12. A display device comprising:

a first signal line;

a second signal line;

a scan line;

a light emitting element;

a power supply line;

a first transistor connected to the first signal line and the scan line;

a first capacitor connected to the first transistor and the power supply line;

a first driving transistor of which a gate electrode is connected to the first capacitor, a drain electrode of the first driving transistor being connected to the light emitting element and a source electrode of the first driving transistor being connected to an anode;

a second transistor connected to the second signal line and the scan line;

a second capacitor connected to the second transistor and the power supply line; and

a second driving transistor of which a gate electrode is connected to the second capacitor, a drain electrode of the second driving transistor being connected to the light emitting element and a source electrode of the second driving transistor being connected to the anode,

wherein the first driving transistor and the second driving transistor have different current capacities.

13. The display device according to claim **12**, wherein the first driving transistor has a higher current capacity than the second driving transistor and used for a high gray-scale display.

14. The display device according to claim **12**, wherein the second driving transistor has a lower current capacity than the first driving transistor and used for a low gray-scale display.

15. The display device according to claim **12**, further comprising a unit for driving transistors connected to the light emitting element in accordance with a luminance of the light emitting element.

16. The display device according to claim 12, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

17. A display device comprising:
a first signal line;
a second signal line;
a scan line;
a light emitting element;
a first transistor connected to the first signal line and the scan line;
a first driving transistor of which a gate electrode is connected to the first transistor, a drain electrode of the first driving transistor being connected to the light emitting element and a source electrode of the first driving transistor being connected to an anode;
a second transistor connected to the second signal line and the scan line; and
a second driving transistor of which a gate electrode is connected to the second transistor, a drain electrode of the second driving transistor being connected to the light emitting element and a source electrode of the second driving transistor being connected to the anode,
wherein a voltage between a gate and a drain of the first driving transistor and a voltage between a gate and a drain of the second driving transistor are different.

18. The display device according to claim 17, further comprising a unit for driving transistors connected to the light emitting element in accordance with a luminance of the light emitting element.

19. The display device according to claim 17, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

20. A display device comprising:
a first signal line;
a second signal line;
a scan line;
a light emitting element;
a power supply line;
a first transistor connected to the first signal line and the scan line;
a first capacitor connected to the first transistor and the power supply line;
a first driving transistor of which a gate electrode is connected to the first capacitor, a drain electrode of the first driving transistor being connected to the light emitting element and a source electrode of the first driving transistor being connected to an anode;
a second transistor connected to the second signal line and the scan line;
a second capacitor connected to the second transistor and the power supply line; and
a second driving transistor of which a gate electrode is connected to the second capacitor, a drain electrode of the second driving transistor being connected to the light emitting element and a source electrode of the second driving transistor being connected to the anode,
wherein a voltage between a gate and a drain of the first driving transistor and a voltage between a gate and a drain of the second driving transistor are different.

21. The display device according to claim 20, further comprising a unit for driving transistors connected to the light emitting element in accordance with a luminance of the light emitting element.

22. The display device according to claim 20, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

23. A display device comprising:
a signal line;
a scan line;
a first light emitting element;
a second light emitting element;
a transistor connected to the signal line and the scan line;
a first driving transistor connected to the transistor, a drain electrode of the first driving transistor being connected to the first light emitting element and a source electrode of the first driving transistor being connected to an anode;
a current source connected to the first driving transistor; and
a second driving transistor connected to the transistor, a drain electrode of the second driving transistor being connected to the second light emitting element and a source electrode of the second driving transistor being connected to the anode.

24. The display device according to claim 23, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

25. A display device comprising:
a signal line;
a scan line;
a first light emitting element;
a second light emitting element;
a transistor connected to the signal line and the scan line;
a first driving transistor connected to the transistor, a drain electrode of the first driving transistor being connected to the first light emitting element and a source electrode of the first driving transistor being connected to an anode;
a current source connected to the first driving transistor; and
a second driving transistor connected to the transistor, a drain electrode of the second driving transistor being connected to the second light emitting element and a source electrode of the second driving transistor being connected to the anode,
wherein the first driving transistor and the second driving transistor have different current capacities.

26. The display device according to claim 25, wherein the display device is used for an electronic device selected from the group consisting of an EL display, a video camera, a personal computer, a portable information terminal, a portable phone, and a digital camera.

27. The display device according to claim 23, wherein the first light emitting element and the second light emitting element are in a same pixel.

28. The display device according to claim 25, wherein the first light emitting element and the second light emitting element are in a same pixel.

* * * * *

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[标]申请(专利权)人(译)	株式会社半导体能源研究所		
申请(专利权)人(译)	半导体能源研究所有限公司.		
当前申请(专利权)人(译)	半导体能源研究所有限公司.		
[标]发明人	MIYAGAWA KEISUKE		
发明人	MIYAGAWA, KEISUKE		
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摘要(译)

通过在饱和区域中操作驱动TFT，当EL元件劣化时，亮度不容易降低。然而，这些问题出现在高电压，高功耗和发热的情况下。在饱和区域中操作驱动TFT的情况下，亮度由于驱动TFT的变化而变化。鉴于上述问题，在高灰度级中使用高电流容量TFT，在低灰度级中使用低电流容量TFT。高电流容量TFT可以提供具有较低Vgs的大电流，因此，即使当Vds降低时，它也不容易在线性区域中操作。因此，即使当EL元件劣化时也不容易降低亮度，并且实现低电压操作。当施加高Vgs时，低电流容量TFT提供电流。对于高Vgs，可以改善TFT特性，特别是Vth的特性变化的影响。