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(54) **Capacitor discharging method for preventing afterimages in an active matrix liquid crystal display**
Kondensatorentladeverfahren zum Verhindern von Nachbildern in einer Flüssigkristallanzeige mit aktiver Matrix
Procédé de décharge d’un condensateur pour empêcher des images restants sur un affichage à cristaux liquides à matrice active

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• PATENT ABSTRACTS OF JAPAN vol. 014, no. 498 (P-1124), 30 October 1990 (1990-10-30) -& JP 02 204718 A (SONY CORP), 14 August 1990 (1990-08-14)

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Description

[0001] The present invention belongs to technical fields of electrooptic devices and electronic devices, and more particularly, belongs to technical fields of an electrooptic device having various capacitors in which charges are accumulated, a driving method therefor, an electronic device, and a projection display device.

[0002] Electrooptic devices are known which can be driven by a so-called active matrix driving method by having pixel electrodes arranged in a matrix, thin film transistors (Thin Film Transistor; hereinafter appropriately referred to as “TFT") connected to the pixel electrodes, scanning lines and data lines provided in parallel in rows and columns, and the like.

[0003] Such electrooptic devices further include a TFT array substrate on which the TFTs, the pixel electrodes, and the like described above are formed, a counter substrate opposing the TFT array substrate and having a common electrode, and an electrooptic substance, such as liquid crystal, sandwiched between the TFT array substrate and the counter substrate (hereinafter represented by "liquid crystal"). By supplying a driving voltage, a driving signal, an image signal, and the like to a scanning-line driving circuit and a data-line driving circuit that are connected to the scanning lines and the data lines, a predetermined electric field is applied to the liquid crystal through the pixel electrodes, and the light transmittance ratio is changed in each pixel by the resulting state change of the liquid crystal, so that an image can be displayed.

[0004] However, conventional electrooptic devices have the following problem. While a driving voltage, a driving signal, an image signal, and the like are necessary to drive an electrooptic device, as described above, no special consideration is given to a way to turn off these various signals when the device is powered off. Therefore, irregular charges inevitably remain everywhere inside the electrooptic device during operation of the electrooptic device.

[0005] In a state in which such charges remain inside the electrooptic device, when the device is powered on again, an image resulting from the charges sometimes appears on an image. For example, in a case in which letters "ABC" are displayed on an image immediately before the device is powered off, when the device is powered on next, the letters "ABC" in the preceding use appear like afterimages.

[0006] Incidentally, it is first considered that charges remain in capacitors (so-called "liquid crystal capacitors") formed by the TFT array substrate, the liquid crystal, and the counter substrate described above. In a case in which the electrooptic device has storage capacitors, the above-described problem tends to be more pronounced. The storage capacitors are capacitors that improve the potential holding characteristics of pixel electrode and enhance image quality by holding a voltage applied to the pixel electrodes for a predetermined period until the next image signal is applied to the pixel electrodes. However, such provision of storage capacitors is equal to the addition of new places in which charges are accumulated inside the electrooptic device, and the above problem appears more pronouncedly.

[0007] In addition, in recent electrooptic devices, the cell gap between the TFT array substrate and the counter substrate is further reduced, and the structure of the storage capacitors is complicated in order to achieve size reduction and high definition. Consequently, it is more difficult to remove accumulated charges, and there is a greater fear that the above problem will arise.

[0008] European patent application number 0605846, published on 13th July 1994, discloses an active matrix liquid crystal display device which prevents residual build-up of charge over time in the liquid crystal pixels. The pixels are driven by respective transistors, which are connected to respective data lines and scanning lines. The data lines are connected to the output of respective transmission gates, the inputs of which are connected to the inputs of a switch element. In order to remove the built-up charge across the pixels, the switch element is closed periodically so as to pass a voltage applied to the common electrode of the matrix display onto the data lines via the transmission gates.

[0009] The present invention has been made in view of the earlier stated problem, and an object of the present invention is to provide an electrooptic device that can perform high-quality image display so that an afterimage or the like due to charges accumulated therein is not formed on an image, a driving method therefor, an electronic device, and a projection display device.

[0010] In order to overcome the above problem, an electrooptic device in accordance with that claimed in independent claim 1 is provided.

[0011] In a mode of the electrooptic device of the present invention, the switching arrangement includes first switching elements provided in the data lines to selectively drop the potentials of the data lines to the ground potential.

[0012] In the electrooptic device of the present invention, the potentials of the data lines can be dropped to the ground potential by the first switching elements. Therefore, it is possible to remove charges accumulated in line capacitors of the data lines or in the pixel electrodes connected to the data lines through the first thin film transistors. Furthermore, when the common electrode is formed on the entire surface of the second substrate, the above-described capacitors between the first and second substrates, that is, the liquid crystal capacitors can be properly discharged by dropping the potentials of the data lines only to the ground potential. This is because it is occasionally conceivable that spontaneous discharging easily occurs in such a full-surface common electrode and the common electrode is naturally set to the ground potential.

[0013] Therefore, in this mode, charges inside the liquid crystal capacitors can be removed only with the re-
In another mode of the electrooptic device of the present invention, the switching arrangement further includes, in addition to the first switching elements, a second switching element provided in a common potential line for maintaining the common electrode at a fixed potential to selectively drop the potential, of the common potential line to the ground potential.

In this mode, since the potentials of the common potential line and the common electrode can also be dropped to the ground potential by the second switching element, charges accumulated inside the electrooptic device, including the liquid crystal capacitors, can be removed more effectively.

The present invention includes the switching arrangement for discharging inside the capacitors formed by the pixel electrodes, the electrooptic substance, and the common electrode. For example, in a case in which the electrooptic substance is liquid crystal, “liquid crystal capacitors” generally correspond to the “capacitors” (hereinafter, the “liquid crystal capacitors” will be typically used as the “capacitors”). By operating such a switching arrangement at least one point in time immediately after the electrooptic device is powered on and at a time point immediately before the electrooptic device is powered off, charges inside the liquid crystal capacitors can be removed.

Therefore, since the present invention allows charges inevitably accumulated during operation of the electrooptic device to be removed effectively, an after-image or the like due to the charges will not be formed on an image, and high-quality image display is possible.

The electrooptic device of the present invention that does not allow charges to remain provides the following operational advantages. That is, for example, when charges are accumulated in the above liquid crystal capacitors, a direct-current component is constantly applied to the liquid crystal. When this continues, the liquid crystal is sometimes deteriorated. Moreover, the first substrate and the second substrate are usually bonded at their peripheries with a sealing material and alignment films are generally formed on the sides thereof in contact with the liquid crystal. When the above charges remain in the liquid crystal capacitors, the sealing material and the alignment films may be deteriorated.

In the present invention, since charges inside the electrooptic device can be removed, such deterioration of the liquid crystal, the sealing material, the alignment films can be prevented.

A further mode of the electrooptic device of the present invention further includes a precharge circuit for supplying a precharge signal at a predetermined voltage level to the data lines through a precharge line, and the switching arrangement includes a third switching element provided in the precharge line to selectively drop the potential of the precharge line to the ground potential.

In this mode, the third switching element having functions substantially similar to those in the above is provided in the precharge line extending from the precharge circuit to the data lines. Since charge accumulated inside the electrooptic device can also be removed through the data lines and the precharge line, high-quality image display is possible.

A further mode of the electrooptic device of the present invention further includes a control means for executing control so that the potential of the switching arrangement is dropped to the ground potential at least one point in time after the electrooptic device is powered on and at a time point immediately after the electrooptic device is powered off.

In this mode, for example, the control means can execute control so that the potential of the switching arrangement is dropped to the ground potential after the electrooptic device is powered on. In this case, for example, charges accumulated inside the electrooptic device can be removed in advance of an actual use. By executing similar control before the electrooptic device is powered off, charges accumulated during the use can be removed, and the charges do not have any influence at the next use.

As described above, this mode allows the switching arrangement to be operated at the most preferable timing. In this mode, of course, for example, it is possible to perform one control operation before the electrooptic device is powered on and to perform one control operation after the electrooptic device is powered on.

A further mode of the present invention further includes storage capacitors connected to the first thin film transistors.

In this mode, since the storage capacitors are provided, the potential holding characteristics of the pixel electrodes can be improved, and this contributes to high-quality image display. This is an operational advantage primarily expected by the provision of the storage capacitors.

However, the provision of such storage capacitors is equivalent to the addition of new portions in the electrooptic device in which charges are easily accumulated when the power is turned off. Therefore, this is not necessarily preferable from the point of preventing an afterimage on an image that is sometimes viewed after the power is turned on and off, as described in the background of the invention.

In this mode, charges accumulated inside the electrooptic device are removed by providing the first to third switching elements on the data lines, the common potential line, and the precharge line included in the switching element, as described above. This means that, even when unnecessary charges are accumulated in the storage capacitors, they can be removed effectively.

Therefore, in this mode, a higher image quality can be enjoyed by the above-described improvement of the potential holding characteristics that is inherent in the storage capacitors, and the problem due to the provision of storage capacitors can be solved at the same time. In this way, this mode achieves generally high-quality im-
In this mode, in particular, it is preferable that the pixel electrodes be arranged in a matrix, that the scanning lines and the data lines be arranged in a form corresponding to the matrix, and that the storage capacitors be formed on the first thin film transistors and corresponding to a region in which the scanning lines and the data lines are arranged.

In such a configuration, the storage capacitors constitute a multilayer structure with the first thin film transistors, and are formed as if they are crowded into non-aperture regions. Consequently, it is possible to increase the aperture ratio of the electrooptic device and to display brighter images. While the matrix form can be assumed, for example, a form in which a plurality of pixel electrodes are arranged in rows and columns to make a substantially rectangular form as a whole, the non-aperture regions (that is, regions substantially identical to regions in which the scanning lines and the data lines are arranged) are formed in a lattice in this case. In this configuration, the storage capacitors are formed in a lattice as a whole.

However, such storage capacitors have a more "complicated" structure, and charges accumulated therein are not easily removed. Since the present invention can effectively remove charges, as described above, it can effectively cope with such a problem.

As described above, this configuration can achieve a high-quality image display as a whole because of the operational advantage of bright image display and the operational advantage of reduction of noise on images due to accumulated charges.

In a further mode of the electrooptic device of the present invention, the switching arrangement is formed on the first substrate and is formed of a second thin film transistor, and a semiconductor layer that forms the second thick film transistor is the same as semiconductor layers that form the first thin film transistors.

In this example, the semiconductor layer that forms the second thin film transistor serving as the switching arrangement in the present invention and the semiconductor layers that form the first thin film transistors are the same, that is, can be simultaneously formed during the same production process, and therefore, production cost can be reduced. That the semiconductor layers that are the most substantial parts of the thin film transistors can be thus produced commonly means that other parts necessary to constitute the thin film transistors, for example, a gate insulating film and a gate electrode, can be produced commonly. Therefore, production cost can be further reduced.

Incidentally, the above-described simultaneous formation can be easily achieved by, for example, collectively patterning original films by photolithography.

Of course, operation reliability can be improved by making the switching element of a thin film transistor.

In a second aspect of the invention, an electrooptic-device driving method in accordance with that claimed in independent claim 9 is provided.

The potentials of the data lines may be dropped to the ground potential at least one point in time after the electrooptic device is powered on and a time point before the electrooptic device is powered off. Hence, charges accumulated in the liquid crystal capacitors and the like can be removed through the data lines. In this case, it is quite possible that charges in the liquid crystal capacitors will be removed only by dropping the potentials of the data lines to the ground potential, as described in the above mode of the electrooptic device in which the potentials of the data lines are dropped to the ground potential.

A mode of the electrooptic-device driving method of the present invention further includes a step of additionally setting a common potential line to the ground potential, the common potential line being connected to the substrate to maintain a common electrode formed above a counter substrate opposing the substrate with an electrooptic substance therebetween at a fixed potential.

In the mode of the electrooptic-device driving method of the present invention, since the common potential line and the common electrode are also set at the ground potential, charges accumulated inside the electrooptic device can be removed more effectively. Therefore, it is possible to display images of higher quality than the above.

When the data lines and the common potential line are set to the ground potential, in the present invention, it is not particularly limited which line is first set. Of course, the present invention also includes a case in which the data lines and the common potential line are simultaneously set to the ground potential.

A third aspect of the present invention provides an electronic device, which includes the above-described electrooptic device of the present invention (including various modes).

Since the electronic device of the present invention includes the above electrooptic device of the present invention, charges accumulated therein can be removed effectively. Therefore, it is possible to achieve various electronic devices, such as a liquid crystal television, a portable telephone, an electronic notebook, a word processor, a view-finder or direct-view video tape recorder, a workstation, a picture phone, a POS terminal, and a touch panel, which can display high-quality images without displaying any image due to the charges on the screen.

In order to solve the above problem, in a fourth aspect, a projection display device of the present invention includes a light valve constituted by the above electrooptic device (including various modes), a light source for introducing projection light into the light valve, and an optical system for projecting the projection light emitted from the light valve.

In the projection display device of the present invention, the electrooptic device of the present invention...
is applied to a light valve that constitutes a projection display device (liquid crystal projector) as an example of the above-described electronic device.

These functions and other advantages of the present invention will be apparent from the following description of embodiments.

Embodiments of the present invention will now be described by way of further example only and with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of a TFT array substrate and components formed thereon, as viewed from the side of a counter substrate.

Fig. 2 is a cross-sectional view, taken along line H-H' in Fig. 1.

Fig. 3 is a plan view schematically showing the configurations of circuits, such as pixel electrodes, scanning lines, and data lines, formed on the TFT array substrate, and manners of connections between the circuits configuration and various peripheral circuits.

Fig. 4 is a block diagram showing the circuit configuration of a color liquid crystal projector as an example of a projection display device.

Fig. 5 is a schematic sectional view of the color liquid crystal projector as the example of a projection display device.

Fig. 6 is a flowchart showing the flow of a procedure for turning off a projection display device according to an embodiment of the present invention.

Fig. 7 is a flowchart showing the flow of a procedure for turning off a projection display device.

Fig. 8 is flowchart showing the flow of a procedure for turning on the projection display device.

Fig. 9 is a plan view of a plurality of adjoining pixels on a TFT array substrate of an electrooptic device according to an embodiment of the present invention, on which substrate data lines, scanning lines, pixel electrodes, and the like are formed.

Fig. 10 is a cross-sectional view, taken along line A-A' in Fig. 9.

An embodiment of the present invention will be described below with reference to the drawings. In the following embodiment, an electrooptic device of the present invention is applied to a liquid crystal device, and the liquid crystal device is further applied to a projection display device.

An electrooptic device according to an embodiment thereof will be first described with reference to Figs. 1 to 3. Fig. 1 is a plan view of a TFT array substrate and components formed thereon, as viewed from the side of a counter substrate 20, and Fig. 2 is a cross-sectional view, taken along line H-H' in Fig. 1. Fig. 3 is a plan view schematically showing the configurations of circuits, such as pixel electrodes, scanning lines, and data lines, formed on the TFT array substrate, and manners of connections between the circuits and various peripheral circuits.

First, the electrooptic device of the embodiment is generally shaped by placing a TFT array substrate 10 and a counter substrate 20 opposed to each other, as shown in Figs. 1 and 2. A liquid crystal layer 50 is sealed between the TFT array substrate 10 and the counter substrate 20, and the TFT array substrate 10 and the counter substrate 20 are bonded together with a sealing material 52 provided in a sealing region around an image display region 10a.

The liquid crystal layer 50 is made of, for example, a liquid crystal in which one or several kinds of nematic liquid crystals are mixed, and has a predetermined alignment state between a pair of alignment films 16 and 21 made of, for example, ultraviolet curing acrylic resin, and is square in plan view so that it surrounds the image display region 10a. A liquid-crystal inlet 52a for introducing liquid crystal into a space between both the substrates is provided in a portion of the sealing material 52, as shown in the lower part of Fig. 1. In a completed electrooptic device, a sealing member 54 made of, for example, ultraviolet curing acrylic resin is provided corresponding to the position of the liquid-crystal inlet 52a in order to prevent the liquid crystal introduced in the space from leaking outside.

In Fig. 2, an alignment film 16 is formed on pixel electrodes 9a on the TFT substrate 10 after TFTs for pixel switching and lines, such as scanning lines and data lines, are formed. On the other hand, counter electrodes 21 made of a transparent conductive material, such as ITO (Indium Tin Oxide), are placed on the counter substrate 20, and an upper shielding film 23 shaped like a lattice is placed on the counter electrodes 21 corresponding to the pixel electrodes 9a arranged in a matrix on the TFT array substrate 10. An alignment film 22 is formed on the upper shielding film 23. In order to maintain a predetermined cell gap between the TFT array substrate 10 and the counter substrate 20, the sealing material 52 is mixed with a gap material (not shown) serving as a kind of spacer. In general, the gap material is composed of, for example, glass fibers or glass beads, and has a substantially spherical shape.

In the electrooptic device of the embodiment having such an outer shape, various circuits shown in Fig. 3 are provided on the TFT substrate 10. In Fig. 3, a plurality of scanning lines 3a and a plurality of data lines 6a are formed in parallel in rows and columns inside the image display region 10a so as to form a lattice, and pixel electrodes 9a are arranged in a matrix corresponding to the lattice. The scanning lines 3a are made of, for example, a doped silicon film, and the data lines 6a are made of, for example, a metal film, such as an aluminum film, or an alloy film. The pixel electrodes 9a are made of a...
transparent conductive material such as ITO or IZO (Indium Zinc Oxide).

The image display region 10a is defined by the entire region in which these scanning lines 3a, data lines 6a, and pixel electrodes 9a are formed. In the electrooptic device, each of the pixel electrodes 9a is defined as one pixel, as shown in the figures.

The scanning lines 3a, the data lines 6a, and the pixel electrodes 9a are connected via TFTs 30 serving as switching elements (corresponding to the “first thin film transistors” in the present invention), as shown in Fig. 3. That is, the data lines 6a, the pixel electrodes 9a, and the scanning lines 3a are connected to sources, drains, and gates of the TFTs 30, respectively. Accordingly, when a scanning signal is supplied to a scanning line 3a existing in a certain row, a TFT 30 existing in the row is ON, and an image signal supplied through a data line 6a is written in a pixel electrode 9a. Consequently, a predetermined electric field corresponding to the image signal is applied to the liquid crystal layer 50.

In the electrooptic device of the embodiment, each pixel electrode 9a is accompanied with a storage capacitor 70. The storage capacitors 70 is composed of a pair of electrodes having a dielectric film therebetween. One of the electrodes is connected to the drain of the TFT 30, and the other electrode is connected to a capacitor line 300 maintained at a fixed potential. Accordingly, when the TFT 30 is turned on and a predetermined image signal is applied to the pixel electrode 9a, a predetermined electric field corresponding to the image signal is simultaneously stored in the storage capacitor 70. Therefore, the potential holding characteristics of the pixel electrode 9a and the liquid crystal layer 50 are markedly improved, and a high-quality image display becomes possible.

On the other hand, a data-line driving circuit 101 and scanning-line driving circuits 104 are formed outside (on the periphery of) the image display region 10a on the TFT array substrate 10, as shown in Figs. 1 and 3. A plurality of data lines 6a are connected to the data-line driving circuit 101, and a plurality of scanning lines 3a are connected to the scanning-line driving circuits 104.

More specifically, the data-line driving circuit 101 is provided with an X-side shift register circuit (not shown) or the like. As peripheral circuits and lines for the data-line driving circuit 101, a sample-and-hold circuit 110 having TFTs 111 serving as analog switches that operate in response to a signal output from the X-side shift register circuit, six image-signal lines 120 corresponding to six-phase image signals VID1 to VID6, and the like are formed. Although all are not shown in Fig. 1, a start signal DX, clock signals CLX1 to CLXn (n represents the number of phases), and clock signals CLX1- to CLXn- reverse thereto, and the like are supplied from the outside to the data-line driving circuit 101 via external-circuit connecting terminals 102, depending on the number of phases of the X-side shift register circuit. On the other hand, a start signal DY, a clock signal CLY, and a clock signal CLY-reverse thereto, and the like are supplied from the outside to the scanning-line driving circuits 104 via external-circuit connecting terminals 102. In Fig. 3, because of the paper width, only one external-circuit connecting terminal 102 is connected to the scanning-line driving circuits 104, and other terminals are not shown.

In such data-line driving circuit 101 and its peripheral circuits, the TFTs 111 operate in response to a signal output from the X-side shift register circuit, and image signals VID1 to VID6 supplied via the image-signal lines 120 can be supplied to the data lines 6a at a predetermined timing. In the scanning-line driving circuits 104, a scanning-line signal is supplied to a scanning line 3a in each row at a predetermined timing, and the TFTs 30 are turned on and off in each line. As described above, when the TFT 30 is turned on, an image signal supplied through the data line 6a can be supplied to the pixel electrode 9a.

In Fig. 3 and the like, two scanning-line driving circuits 104 are prepared at both ends of the scanning lines 3a, making it possible to overcome the problem of delay of scanning signals to be sent to the scanning lines 3a. However, the present invention is not limited to such a manner, and only one scanning-line driving circuit 104 may be provided when such a problem does not become apparent.

In addition, in the electrooptic device of the embodiment, a conductive material 106 is provided at at least one corner of the counter substrate 20 for electric conduction between the TFT array substrate 10 and the counter substrate 20. A common potential line 701 is connected to the conductive material 106 with one end connected to the external-circuit connecting terminal 102, and a so-called LCCOM (Liquid Crystal COMmon) with potential fixed at a certain value is supplied thereto. Therefore, the counter electrodes 21 on the counter substrate 20 are maintained at the LCCOM potential. The above-described capacitor lines 300 are also connected to the common potential line 701, as shown in Fig. 3, and are maintained at a fixed potential (= LCCOM potential).

In the embodiment, in particular, TFTs 801 and 802 serving as switching elements (corresponding to the “second thin film transistor” in the present invention) are connected to the data lines 6a and the common potential line 701, respectively, as shown in Fig. 3.

The TFTs 801 and 802 are connected at one end to a grounded GND line 810. It is determined whether the data lines 6a or the common potential line 701 are connected to the GND line 810, that is, whether the data lines 6a or the common potential line 701 are grounded, depending on the input from a control signal supplied through a control line 811. The electrooptic device of the embodiment may also include other structures, for example, a check circuit for checking the quality, defects, and the like of the electrooptic device during production and shipment.

The specific configuration of the electrooptic device, each of the pixel electrodes 9a is defined as one pixel, as shown in the figure.
device of the embodiment is described above. In the embodiment, the electrooptic device is further applied as a light valve in a projection display device as an example of an electronic device. Fig. 4 is a block diagram showing the circuit configuration of a color liquid crystal projector as an example of a projection display device, and Fig. 5 is a schematic sectional view of the color liquid crystal projector.

First, the circuit configuration of the projection color display device of the first embodiment will be described with reference to the block diagram in Fig. 4. Figs. 4 shows the circuit configuration of one of the three light valves in the projection color display device. The above-described electrooptic device is used in each of the three light valves.

Since the three light valves substantially have the same configuration, a description will be given of the circuit configuration for only one light valve. Strictly, signals input to the three light valves are different (that is, the light valves are driven by corresponding R, G, and B signals). Moreover, the circuit configuration of the G light valve is different from those of the R and B light valves in that the order of image signals is reversed in each field or frame, or the horizontal or vertical scanning direction is reversed, in order to display inverted images.

In Fig. 4, the projection color display device includes a display-information input source 1000, a display-information processing circuit 1002, a driving circuit 1004, a light valve 100, a clock generation circuit 1008, a power-supply circuit 1010, and a control circuit 1012.

The display-information input source 1000 includes a memory, such as a ROM (Read Only Memory), a RAM (Random Access Memory), or an optical disk device, a synchronizing circuit for synchronously outputting image signals, and the like, and outputs display information, such as a predetermined-format image signal, to the display-information processing circuit 1002 in response to clock signals from the clock generation circuit 1008.

The display-information processing circuit 1002 includes various known processing circuits, such as amplifying and inverting circuits, a phase expansion circuit, a rotation circuit, a gamma correction circuit, and a clamp circuit, sequentially generates digital signals from display information input in response to clock signals, and outputs the digital signals with clock signals CLK to the driving circuit 1004.

The driving circuit 1004 corresponds to the data-line driving circuit 101 and the scanning-line driving circuit 104 described above, and drives the light valve 100. The power-supply circuit 1010 supplies a predetermined power to each of the above circuits. The control circuit 1012 integratedly controls the circuits in order to achieve a harmonious operation of the above circuits. Of course, the control circuit 1012 may have a configuration which can receive modifications of control to execute control, as required, in order to perform processing under a predetermined sequence control, or according to a program prepared in an appropriate program language to achieve a predetermined result.

The driving circuit 1004 may be mounted on the TFT array substrate 10 that constitutes the light valve 100, and the display-information processing circuit 1002 may also be mounted thereon.

The overall configuration (in particular, an optical configuration) of the projection color display device of the embodiment will now be described with reference to Fig. 5.

In Fig. 5, a liquid crystal projector 1100 as an example of a projection display device of the embodiment is a projector in which three liquid crystal modules, each including a liquid crystal device in which the driving circuit 1004 and the like are mounted on a TFT array substrate, are prepared as R, G, and B light valves 100R, 100G, and 100B.

In the liquid crystal projector 1100, when projection light is emitted from a lamp unit 1102 of a white light source such as a metal halide lamp, it is separated into light components R, G, and B corresponding to the three primary colors R, G, and B by three mirrors 1106 and two dichroic mirrors 1108, and the light components are guided to the corresponding light valves 100R, 100G, and 100B. In this case, in particular, the B light is guided through a relay lens system 1121 including an incident lens 1122, a relay lens 1123, and an emergent lens 1124 in order to prevent light loss due to its long optical path. The light components modulated by the light valves 100R, 100G, and 100B corresponding to the three primary colors are combined again by a dichroic prism 1112, and are then projected as a color image onto a screen 1120 through a projection lens 1114.

A ventilating fan 1141 is mounted in the projection color display device to blow air to the light valves 100R, 100G, and 100B. The ventilating fan 1141 aims to reduce the accumulation of heat in the light valves 100R, 100G, and 100B mainly caused by high-intensity light emitted from the lamp unit 1102. Furthermore, the ventilating fan 1141 continues rotation for a while after the light valves 100R, 100G, and 100B are powered off. This is because a considerable amount of heat is accumulated in the light valves 100R, 100G, and 100B immediately after the use of the projection display device of this embodiment. Accordingly, in the first embodiment, there is a time lag between a time point at which the light valves 100R, 100G, and 100B are powered off and a time point at which the projection display device is powered off.

A driving method for the electrooptic device or the projection display device having such a configuration, in particular, a method for powering off the device is shown in Fig. 6. Fig. 6 is a flowchart showing the flow of a procedure for powering off the projection display device of the embodiment.

In order to power off the projection display device of the embodiment, first, an operation of turning off the power switch is manually performed by a device user (Step S11). In this case, the lamp unit 1102 is powered
off, and light is not projected onto the light valves 100R, 100G, and 100B. Therefore, image display is not performed. Subsequently, processes shown in Fig. 6 are performed automatically by the device, more specifically, by the control circuit 1012 according to a predetermined program.

[0079] That is, first, external input signals to the light valves 100R, 100G, and 100B are blocked (Step S12). Herein, the external input signals (Step S12) refer to signals output through the display-information output source 1000 and the display-information processing circuit 1002 shown in Fig. 4. In short, they refer to signals representing images (of course, including motion pictures) to be displayed during normal operation of the projection display device. It is needless to say that other sources of image signals are, for example, signals read from a video tape or a DVD loaded in a video recorder or a DVD player connected to the projection display device of the first embodiment.

[0080] Secondly, the above-described TFTs 801 and 802 are closed to drop the potentials of the data lines 6a and the common potential line 701 to a ground potential (Step S13). In this case, since the potentials of the data lines 6a and the common potential line 701 are dropped to the ground potential by closing the TFTs 801 and 802, charges held between the TFT array substrate 10 and the counter substrate 20 having the liquid crystal layer 50 therebetween, that is, between the pixel electrodes 9a and the counter electrodes 21 are removed through the data lines 6a, the counter electrodes 21, and the conductive material 106. Furthermore, in the embodiment, since the capacitor lines 300 are connected to the common potential line 701, charges accumulated in the storage capacitors 70 can also be removed by dropping the potentials of the common potential line 701 to the ground potential.

[0081] Subsequently, a driving voltage and a driving signal are turned off (the electrooptic device is powered off) (Step S14), and finally, the ventilating fan 1141 is powered off (Step S15), so that the operation of powering off the projection display device is completed.

[0082] The driving voltage refers to a voltage applied to drive the light valves 100R, 100G, and 100B, and more specifically, to two kinds of voltages, namely, a +V volt and a -V volt shifted by an absolute value V from the above-described LCCOM potential (precisely, a (LCCOM+V) volt and a (LCCOM-V) volt), for example, when a so-called 1H inversion driving method is performed. In this case, since the level of the voltage to be applied to the liquid crystal layer 50 can be inverted in each field, deterioration of the liquid crystal can be prevented. Furthermore, the driving signal refers to signals, such as the start signals DX and DY and the clock signals CLX1 to CLXn, that drive the data-line driving circuit 101, the scanning-line driving circuits 104, and the like at a predetermined timing, as described above. Incidentally, it can be considered that the light valves and the electrooptic device are practically powered off at the same time as these driving voltages and driving signals are turned off.

[0083] Since the potentials of the data lines 6a and the common potential line 701 can be dropped to the ground potential by the TFTs 801 and 802 in this way in the electrooptic device or the projection display device of the embodiment, charges accumulated in the liquid crystal capacitors, the storage capacitors 70, and the like in the electrooptic device can be effectively removed. By performing such operation immediately before the electrooptic device is powered off, as shown in Fig. 6, the above-described charges accumulated during operation can be removed effectively. Therefore, it is possible to prevent an afterimage due to the above charges from being displayed on an image in subsequent use (that is, when the power is turned on again and the device is restarted). As described above, the embodiment allows high-quality images to be displayed.

[0084] While the potentials of the data lines 6a and the common potential line 701 are dropped to the ground potential before the electrooptic device is powered off in the above embodiment, the present invention is not limited to such an embodiment. In some cases, the above operation may be performed after the electrooptic device is powered on. Furthermore, the present invention does not positively reject an exceptional manner in which the potentials of the data lines 6a and the common potential line 701 are dropped to the ground potential during operation.

[0085] As referred above, while the electrooptic device having the TFTs 801 and 802 is applied to the light valves 100R, 100G, and 100B of the projection display device in the above embodiment, the present invention is not limited to such an embodiment. For example, it is, of course, possible to apply the electrooptic device of the present invention to various electronic devices such as a, liquid crystal display and a display of a portable telephone. This identically applies to the other embodiments which will be described later.

[0086] While the potentials of the data lines 6a and the common potential line 701 are dropped to the ground potential in the above embodiment, the present invention is not limited to such an embodiment.

[0087] For example, in a case in which a precharge circuit is provided to supply a precharge signal at a predetermined voltage level to a plurality of data lines 6a through a precharge line prior to an image signal, a switching element for grounding the precharge line (corresponding to the "third switching element" in the present invention), or a circuit including the element may be provided. It is obvious that such a manner can provide operational advantages substantially similar to those in the above embodiment.

[0088] In addition, while the TFTs 801 and 802 are formed on the TFT array substrate 10 together with the pixel electrodes 9a, the scanning lines 3a, the data lines 6a, and the like in the above embodiment, the present invention is not limited to such an embodiment. For ex-
ample, switching elements or the like substantially similar to the TFTs 801 and 802 may be provided outside the TFT array substrate 10, and a ground potential may be supplied to the data lines 6a, the common potential line 701, and the like by the switching elements and the external connecting terminals 102. However, in the above manner in which the TFTs 801 and 802 are formed on the TFT array substrate 10, for example, the TFTs 801 and 802 and the pixel-switching TFTs 30 serving as the first thin film transistors can be formed simultaneously, and therefore, the production labor and cost can be reduced, compared with a case in which they are separately formed. Moreover, this can be considered contributory to size reduction of the device. That is, it is worthy of special note that the first embodiment can provide such advantages.

A second electrooptic device driving method, which in itself does not form part of the present invention, will be described below with reference to Fig. 7. Fig. 7 is a flowchart showing the flow of a procedure for powering off a projection display device. The structures of an electrooptic device or a projection display device of this second method are identical to those in the above-described embodiment. As is evident from the following description, even when the TFTs 801 and 802, the ground lines 810, and the control line 811, which are characterizing elements of the earlier described embodiment, are not provided in the second method, this does not have any influence on the operational advantages.

In the second method, first, operations of turning off a power switch and of cutting off external input signals to light valves 100R, 100G, and 100B are identically performed in Steps S11 and S12 in Fig. 7.

In the second embodiment, in particular, an image signal representing image display of the single-color, that is, a "single-color signal" is supplied to pixel electrodes 9a after the above operations (Step S23). This operation is performed through data lines 6a by the actions of a control circuit 101, display-information source 1000, display-information processing circuit 1002, image signal line 120, a sample-and-hold circuit 110, a data-line driving circuit 101, and the like. A specific form of the single-color signal is determined by the driving mode of the light valves 100R, 100G, and 100B. That is, in a normally white mode in which the alignment state of liquid crystal molecules that constitute a liquid crystal layer 50 changes in a direction to reduce the light transmittance depending on the applied voltage, the single-color signal is a "full-white level signal". Conversely, in a normally black mode, the signal is a "full-black level signal". In the second embodiment, the single-color signal is supplied to all the pixel electrodes 9a lying inside an image display region 10a.

By applying such a single-color signal, a state in which voltage is not applied to the pixel electrodes 9a appears. Therefore, charges accumulated, in liquid crystal capacitors and storage capacitors 70 lying inside the image display region 10a can be removed effectively.

Subsequently, a driving voltage and a driving signal are turned off (the electrooptic device is powered off) (Step S14), and finally, a ventilating fan 1141 is powered off (Step S15), in a manner similar to that in the previously described embodiment. Consequently, the operation of powering off the projection display device of the second method is completed.

While the potentials of the data lines 6a and the common potential line 701 are not dropped to the ground potential in the second method, which is different from the above embodiment, a similar operational advantage can be achieved, that is, charges accumulated in the electrooptic device can be removed, by using the single-color signal. In this respect, while discharging is achieved by hardware in the previously described embodiment, it is achieved by software in the second method.

Anyway, in the second method, an afterimage or the like due to charges during operation will not be displayed on an image in a subsequent use, in a manner similar to that in the previously described embodiment.

As is evident from the above description, in the second method, it is not always necessary to provide switching elements such as the TFTs 801 and 802 described in the first embodiment. This is because the control operation of applying a single-color signal, such as a full-white level signal or a full-black level signal, to the pixel electrodes 9a, can be executed in the electrooptic device in the existing state by changing a program or the like of the control circuit 1012 without providing the elements. The scope of the invention includes a manner in which the potentials of the data lines 6a, the common potential line 701, and the like are dropped to the ground potential by providing the TFTs 801 and 802 and in which a single-color signal is applied as in the second method together. In this case, since charges accumulated in the electrooptic device can be removed by software and hardware processing, it can be easily expected that the quality of image display will be improved.

While only the manner in which the electrooptic device is powered off has been described above, the present invention is not limited to such a manner. For example, similar operations may also be performed when the electrooptic device is powered on.

In Fig. 8, which relates to the second method, which is not a part of the present invention, when an operation of turning on a power switch is first manually performed by the device user (Step SS1), a driving voltage and a driving signal for the light valves 100R, 100G, and 100B are turned on (Step SS2), and after that the above-described "single-color signal" is then input to the light valves (Step SS3). At this time, charges in the preceding use are removed. Subsequently, the lamp unit is powered on (Step SS4), and external input signals are turned on (Step SS5).

In this case, although the time point at which a single-color signal is applied is different from that in Fig. 7 that has been referred to in the above description, an
action of discharging accumulated in the electrooptic device before normal use is similarly performed. Therefore, operational advantages substantially similar to those in the above can also be achieved.

(More Detailed Inner Configuration of Electrooptic Device)

[0100] The inner configuration of the electrooptic device, which cannot be mentioned above, that is, more detailed structures of TFTs, pixel electrodes, scanning lines, data lines, and the like will be described below with reference to Figs. 9 and 10.

[0101] The electrooptic device of this embodiment includes a transparent TFT array substrate 10, and a transparent counter substrate 20 opposing the TFT array substrate 10, as shown in Fig. 10. The TFT array substrate 10 is formed of, for example, a quartz substrate, a glass substrate, or a silicon substrate, and the counter substrate 20 is formed of, for example, a glass substrate or a quartz substrate.

[0102] As shown in Fig. 10, pixel electrodes 9a are provided on the TFT array substrate 10, and an alignment film 16 subjected to a predetermined alignment process, such as rubbing, is provided thereon. The pixel electrodes 9a are formed of a transparent conductive film such as an ITO (Indium Tin Oxide) film. On the other hand, a counter electrode 21 is provided on the entire surface of the counter substrate 20, and an alignment film 22 subjected to a predetermined alignment process, such as rubbing, is provided thereunder. The counter electrode 21 is also formed of a transparent conductive film, such as an ITO film, in a manner similar to that of the above pixel electrodes 9a. The above-described alignment films 16 and 22 are formed of a transparent organic film such as a polyimide film.

[0103] On the other hand, in Fig. 9, a plurality of pixel electrodes 9a is provided in a matrix on the TFT array substrate 10 (their outlines are shown by dotted portions 9a'), and data lines 6a and scanning lines 3a are provided along the lengthwise and breadthwise boundaries of the pixel electrodes 9a. The data lines 6a are formed of a metal film, such as an aluminum film, or an alloy film. The scanning lines 3a are placed to oppose channel regions 1a' of semiconductor layers 1a, shaded by upward oblique lines in the figure, and the scanning lines 3a function as gate electrodes. That is, TFTs 30 for pixel switching in which main line portions of the scanning lines 3a serving as gate electrodes oppose the channel regions 1a' are provided at the intersections of the scanning lines 3a and the data lines 6a.

[0104] Each TFT 30 has an LDD (Lightly Doped Drain) structure, as shown in Fig. 10, and includes as components the scanning line 3a functioning as a gate electrode, as described above, the channel region 1a' of the semiconductor layer 1a which is made of, for example, a polysilicon film and in which a channel is formed by an electric field from the scanning line 3a, an insulating film 2 including a gate insulating film for insulating the scanning line 3a and the semiconductor layer 1a, and a lightly doped source region 1b, a lightly doped drain region 1c, a heavily doped source region 1d, and a heavily doped drain region 1e in the semiconductor layer 1a.

[0105] As described above, production cost can be reduced by simultaneously forming the semiconductor layer 1a of such a TFT 30 and the semiconductor layers of the TFTs 801 and 802.

[0106] While it is preferable that the TFT 30 has an LDD structure, as shown in Fig. 10, it may have an offset structure in which impurities are not implanted in the lightly doped source region 1b and the lightly doped drain region 1c, or it may be a self-aligned TFT in which high-concentration impurities are implanted by using the gate electrode formed of a part of the scanning line 3a as a mask so as to form heavily doped source and drain regions in a self-aligned manner. While this embodiment adopts a single gate structure in which only one gate electrode of the pixel-switching TFT 30 is placed between the heavily-doped source region 1d and the heavily doped drain region 1e, two or more gate electrodes may be placed therebetwen by thus providing the TFT with the dual gate structure, the triple gate structure, or the structure having more gates, a leakage current can be avoided at joint portions between the channel region and the source and drain regions, and the current in an OFF state can be reduced. The semiconductor layer 1a that constitutes the TFT 30 may be a non-single crystal layer or a single crystal layer. The single crystal layer may be formed by a known method such as bonding. By making the semiconductor layer 1a of a single crystal layer, in particular, performance of peripheral circuits can be enhanced.

[0107] In Fig. 10, a storage capacitor 70 is formed by placing a relay layer 71 serving as a pixel-electrode capacitor electrode connected to the heavily doped drain region le of the TFT 30 and the pixel electrode 9a to oppose, through dielectric film 75, a part of a capacitor line 300 serving as a fixed-potential capacitor electrode. The storage capacitor 70 allows the potential holding characteristics of the pixel electrode 9a to be improved markedly.

[0108] The relay layer 71 is formed of, for example, a conductive polysilicon film, and functions as a pixel-potential capacitor electrode. The relay layer 71 may be made of a single-layer film or a multilayer film containing metal or alloy, in a manner similar to that in the capacitor line 300 which will be described later. The relay layer 71 functions as a pixel-potential capacitor electrode, and also serves to relay and connect the pixel electrode 9a and the heavily doped drain region le of the TFT 30 through contact holes 83 and 85. By thus using the relay layer 71, the pixel electrode 9a and the heavily doped drain region 1e can be properly connected through more than two serial contact holes having a relatively small diameter while overcoming technical difficulty in connecting them.
through one contact hole even when the distance there-

between is long, for example, 2000 nm. This can increase
the pixel aperture ratio. Moreover, it is possible to prevent
overetching when contact holes are formed.

[0109] The capacitor line 300 is formed of, for example,
a conductive film containing metal or alloy, and functions
as a fixed-potential capacitor electrode. The capacitor
line 300 overlaps, in plan view, with a region in which the
scanning line 3a is formed, as shown in Fig. 9. More
specifically, the capacitor line 300 includes a main line
portion extending along the scanning line 3a, projecting
portions projecting upward from the intersections with
the data line 6a along the data line 6a, and a narrow
portion that is slightly constricted corresponding to the
contact hole 85. The projecting portions increase the area
in which the storage capacitor 70 is formed, by using the
area on the scanning line 3a and the area beneath the
data line 6a.

[0110] Preferably, such a capacitor line 300 is formed of
a conductive shielding film containing a high-melting
metal, and functions not only as the fixed-potential ca-
pacitor electrode of the storage capacitor 70, but also as
a shielding layer for shielding the TFT 30 from incident
light on the upper side of the TFT 30.

[0111] A dielectric film 75 is formed of a silicon oxide
film such as a HTO (High Temperature Oxide) film or a
LTO (Low Temperature Oxide) film, or a silicon nitride
film having a relatively small thickness of, for example,
approximately 5 nm to 200 nm. In order to enlarge the
storage capacitor 70, the thinner dielectric film 75 is pref-
erable as long as a sufficient reliability of the film is en-
sured.

[0112] In the electrooptic device of this embodiment,
the storage capacitors 70 have an extremely "complicat-
ed" structure in this way. That is, the storage capacitors
70 have a multilayer structure such that they lie on the
TFTs 30 and beneath the data lines 6a, as shown in Fig.
10, and as if they are crowded into the non-aperture re-
gions, in other words, such that they form a lattice as a
whole through the pixels, as shown in Fig. 9.

[0113] It is certain that such a structure provides ex-
tremely great operational advantages of higher aperture
ratio and brighter high-quality image display. However,
it is also difficult to remove charges accumulated in the
storage capacitors 70 having such a "complicated" struc-
ture.

[0114] However, in this embodiment, charges accu-
ulated in such storage capacitors 70 can be effectively
removed by using the TFTs 801 and 802 or applying a
single-color signal, as described above. Therefore, it is
possible to strongly minimize the probability that an af-
terimage or the like due to the charges will be displayed
on an image.

[0115] In Figs. 9 and 10, a lower shielding film 11a is
also provided below the TFTs 30. The lower shielding
film 11a is patterned in a lattice form to define aperture
regions of the pixels. The aperture regions are also de-
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11

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mined by the data lines 6a and the capacitor lines 300
crossing the data lines 6a in Fig. 9. It is preferable that
the lower shielding film 11 a extend from the image display
region to the periphery to be connected to a constant-po-
tential source, in order to prevent a potential change from
adversely affecting the TFTs 30, in a manner similar to
that of the above capacitor lines 300.

[0116] A lower insulating film 12 is provided beneath
the TFTs 30. The lower insulating film 12 serves to insu-
late the TFTs 30 from the lower shielding film 11a, and
is formed on the entire surface of the TFT array substrate
10 in order to prevent the characteristics of the pix-
el-switching TFTs 30 from being changed, for example,
by roughness due to surface grinding and contamination
remaining after cleaning of the TFT array substrate 10.

[0117] In addition, a first interlayer insulating film 41
having a contact hole 81 that communicates with the
heavily doped source region 1d and a contact hole 83
that communicates with the heavily doped drain region
is formed respectively on the scanning line 3a.

[0118] The relay layer 71 and the capacitor line 300
are formed on the first interlayer insulating film 41, and
a second interlayer insulating film 42 having a contact
hole 81 that communicates with the heavily doped source
region 1d and a contact hole 85 that communicates with
the relay layer 71 is formed thereon.

[0119] In this embodiment, ions implanted in the poly-
silicon films that form the semiconductor layer 1a and the
scanning line 3a may be activated by burning the first
interlayer insulating film 41 at approximately 1000°C. On
the other hand, stress produced adjacent to the interface
between the second interlayer insulating film 42 and the
 capacitor line 300 may be reduced by not subjecting the
second interlayer insulating film 42 to such burning.

[0120] The data line 6a is formed on the second inter-
layer insulating film 42, and a third interlayer insulating
film 43 having a contact hole 85 that communicates with
the relay layer 71 is formed thereon.

[0121] The surface of the third interlayer insulating film
43 is planarized by, for example, CMP (Chemical Me-
chanical Polishing) in order to reduce alignment failure
of the liquid crystal layer 50 due to steps formed by var-
ious lines and elements lying thereunder. Instead of thus
planarizing the third interlayer insulating film 43, or in
addition thereto, planarization may be performed by bur-
ying lines, such as the data lines 6a, the TFTs 30, and
the like in grooves formed in at least one of the TFT array
substrate 10, the lower insulating film 12, the first inter-
layer insulating film 41, and the second interlayer insu-
lating film 42.

[0122] The present invention is not limited to the above
embodiments, and appropriate modifications are possi-
ble without departing from the scope of the invention.
The technical field of the present invention also includes
an electrooptic device, a driving method therefor, an elec-
tronic device, and a projection display device thus modi-
fied.
Claims

1. An electrooptic device comprising:

a first substrate (10) having pixel electrodes (9a), first thin film transistors (30) electrically connected to said pixel electrodes, and scanning lines (3a) and data lines (6a) electrically connected to said first thin film transistors;

a second substrate (20) opposing said first substrate and having a common electrode (21);

an electrooptic substance (50) held between said first substrate and said second substrate; and

a switching arrangement (801, 802) for discharging inside capacitors constituted by said pixel electrodes on said first substrate, said electrooptic substance and said common electrode on said second substrate;

characterised in that said switching arrangement, in response to control signals (CONTROL SIGNAL), is configured selectively either to drop potentials of said data lines to a ground potential, without also dropping the potential of said common electrode (21) to ground potential, or to drop potentials of said data lines and said common electrode to ground potential.

2. The electrooptic device according to claim 1, wherein said switching arrangement includes first switching elements (801) provided in said data lines to drop the potentials of said data lines to ground potential.

3. The electrooptic device according to claim 1 or 2, wherein said switching element includes a second switching element (802) provided in a common potential line (LCCOM) for maintaining said common electrode at a fixed potential to selectively drop the potential of said common potential line to ground potential.

4. The electrooptic device according to any one of claims 1 to 3, further comprising:

a precharge circuit for supplying a precharge signal at a predetermined voltage level to said data lines through a precharge line, wherein said switching element includes a third switching element provided in said precharge line to selectively drop the potential of said precharge line to a ground potential.

5. The electrooptic device according to any one of claims 1 to 4, further comprising:

control means (1012) for executing control so that the potential of said switching arrangement is dropped to a ground potential at least one point in time after said electrooptic device is powered on and before said electrooptic device is powered off.

6. The electrooptic device according to any one of claims 1 to 5, further comprising:

storage capacitors (70) electrically connected to said first thin film transistors.

7. The electrooptic device according to claim 6, wherein said pixel electrodes are arranged in a matrix, said scanning lines and said data lines are arranged in a form corresponding to the matrix, and said storage capacitors are formed above said first thin film transistors and corresponding to a region in which said scanning lines and said data lines are arranged.

8. The electrooptic device according to any one of claims 1 to 7, wherein said switching arrangement is formed on said first substrate and is formed of a second thin film transistor (801, 802), and a semiconductor layer (1a) that forms said second thin film transistor is the same as semiconductor layers that form said first thin film transistors.

9. An electrooptic-device driving method of driving an electrooptic device that comprises:

a first substrate (10) having pixel electrodes (9a), thin film transistors (30) electrically connected to said pixel electrodes (9a), and scanning lines (3a) and data lines (6a) electrically connected to said thin film transistors;

a second substrate (20) opposing said first substrate and having a common electrode (21);

an electrooptic substance (50) held between said first substrate and said second substrate; and

a switching arrangement (801, 802) for discharging inside capacitors constituted by said pixel electrodes on said first substrate, said electrooptic substance and said common electrode on said second substrate;

characterized in that said driving method comprises a step, in response to control signals (CONTROL SIGNAL), of selectively either dropping the potentials of said data lines to a ground potential without also dropping the potential of said common electrode (21) to ground potential, or dropping potentials of said data lines and said common electrode to ground potential.

10. An electronic device having an electrooptic device according to any one of claims 1 to 8.

11. A projection display device comprising:

a light valve constituted by an electrooptic de-
vice according to any one of claims 1 to 8; a light source for introducing projection light into said light valve; and an optical system for projecting the projection light emitted from said light valve.

Revendications

1. Dispositif électro-optique comprenant:
   un premier substrat (10) ayant des électrodes de pixels (9a), des premiers transistors à couche mince (30) en connexion électrique avec lesdites électrodes de pixels, et des lignes de balayage (3a) et des lignes de données (6a) en connexion électrique avec lesdits premiers transistors à couche mince ; un deuxième substrat (20) opposé audit premier substrat et ayant une électrode commune (21); une substance électro-optique (50) maintenue entre ledit premier substrat et ledit deuxième substrat; et un dispositif de commutation (801, 802) pour la décharge, à l’intérieur des condensateurs formés par lesdites électrodes de pixels sur ledit premier substrat, de ladite substance électro-optique et de ladite électrode commune sur ledit deuxième substrat; caractérisé en ce que ledit dispositif de commutation est configuré sélectivement pour, en réponse à des signaux de commande (SIGNAL DE COMMANDE), soit faire chuter les potentiels desdites lignes de données à un potentiel de masse sans faire également chuter le potentiel de ladite électrode commune (21) au potentiel de masse, ou soit faire chuter les potentiels desdites lignes de données et de ladite électrode commune à un potentiel de masse.

2. Dispositif électro-optique selon la revendication 1, où ledit dispositif de commutation comprend des premiers éléments de commutation (801) fournis dans lesdites lignes de données afin de faire chuter les potentiels desdites lignes de données au potentiel de masse.

3. Dispositif électro-optique selon les revendications 1 ou 2, où ledit élément de commutation comprend un deuxième élément de commutation (802) fournit dans une ligne de potentiel commune (LCCOM) afin de maintenir ladite électrode commune à un potentiel fixe afin de faire chuter sélectivement le potentiel de ladite ligne de potentiel commune au potentiel de masse.

4. Dispositif électro-optique selon l’une quelconque des revendications 1 à 3, comprenant en outre :
   un circuit de précharge pour fournir un signal de précharge d’un niveau de tension prédéfini à l’attention desdites lignes de données via une ligne de précharge, ledit élément de commutation comprenant un troisième élément de commutation fournit dans ladite ligne de précharge afin de faire chuter sélectivement le potentiel de ladite ligne de précharge à un potentiel de masse.

5. Dispositif électro-optique selon l’une quelconque des revendications 1 à 4, comprenant en outre :
   un moyen de commande (1012) pour exécuter une commande de manière à faire chuter le potentiel dudit dispositif de commutation à un potentiel de masse au moins lors d’un instant dans le temps où ledit dispositif électro-optique est mis sous tension et avant que ledit dispositif électro-optique ne soit mis hors tension.

6. Dispositif électro-optique selon l’une quelconque des revendications 1 à 5, comprenant en outre :
   des condensateurs de maintien (70) en connexion électrique avec lesdits premiers transistors à couche mince.

7. Dispositif électro-optique selon la revendication 6, lesdites électrodes de pixels étant disposées en une matrice, lesdites lignes de balayage et lesdites lignes de données étant disposées en une forme correspondant à la matrice, et lesdits condensateurs de maintien étant formés au-dessus desdits premiers transistors à couche mince et correspondant à une zone dans laquelle lesdites lignes de balayage et lesdites lignes de données sont disposées.

8. Dispositif électro-optique selon l’une quelconque des revendications 1 à 7, où ledit dispositif de commutation est formé sur ledit premier substrat et est formé par un deuxième transistor à couche mince (801, 802), et où une couche semi-conductrice (1a) qui forme ledit deuxième transistor à couche mince est la même que les couches semi-conductrices qui forment lesdits premiers transistors à couche mince.

9. Procédé de commande d’un dispositif électro-optique comprenant :
   un premier substrat (10) ayant des électrodes de pixels (9a), des transistors à couche mince (30) en connexion électrique avec lesdites électrodes de pixels (9a), et des lignes de balayage (3a) et des lignes de données (6a) en connexion électrique avec lesdits transistors à couche mince;
un deuxième substrat (20) opposé audit premier substrat et ayant une électrode commune (21) ; une substance électro-optique (50) maintenue entre lesdits premier et deuxième substrats ; et un dispositif de commutation (801, 802) pour décharger, à l'intérieur des condensateurs formés par lesdites électrodes de pixels sur ledit premier substrat, ladite substance électro-optique et ladite électrode commune sur ledit deuxième substrat ;
caractérisé en ce que ledit procédé de commande comprend, en réponse à des signaux de commande (SIGNAL DE COMMANDE), une étape consistant à sélectivement soit faire chuter les potentiels desdites lignes de données à un potentiel de masse sans également faire chuter le potentiel de ladite électrode commune (21) à un potentiel de masse, ou soit à faire chuter les potentiels desdites lignes de données et de ladite électrode commune à un potentiel de masse.

10. Dispositif électronique ayant un dispositif électro-optique selon l'une quelconque des revendications 1 à 8.

11. Dispositif d'affichage par projection comprenant :
ein modulateur de lumière formé par un dispositif électro-optique selon l'une quelconque des revendications 1 à 8 ;
eine source lumineuse pour introduire de la lumière de projection dans ledit modulateur de lumière ; et
un système optique pour projeter la lumière de projection émise par ledit modulateur de lumière.

Patentansprüche

1. Elektrooptische Vorrichtung, umfassend:
ein erstes Substrat (10) mit Pixelelektroden (9a), ersten Dünnfilmtransistoren (30), die elektrisch an die Pixelelektroden angeschlossen sind, und Abtasteleitungen (3a) und Datenleitungen (6a), die elektrisch an die ersten Dünnfilmtransistoren angeschlossen sind;
ein zweites Substrat (20), das dem ersten Substrat gegenüber liegt und eine gemeinsame Elektrode (21) aufweist; eine elektrooptische Substanz (50), die zwischen dem ersten Substrat und dem zweiten Substrat gehalten wird; und
eine Schaltanordnung (801, 802) zum Entladen von Innenkondensatoren, die durch die Pixelelektroden auf dem ersten Substrat, die elektrooptische Substanz und die gemeinsame Elektrode auf dem zweiten Substrat gebildet werden; 
dadurch gekennzeichnet, dass die Schaltanordnung, als Reaktion auf Steuersignale (CONTROL SIGNAL), so konfiguriert ist, dass selektiv entweder Potenziale der Datenleitungen auf ein Erdpotential fallen, ohne dass auch das Potential der gemeinsamen Elektrode (21) auf das Erdpotential fällt, oder die Potenziale der Datenleitungen und der gemeinsamen Elektrode auf das Erdpotential fallen.

2. Elektrooptische Vorrichtung nach Anspruch 1, wobei die Schaltanordnung erste Schaltelemente (801) enthält, die in den Datenleitungen bereitgestellt sind, um die Potenziale der Datenleitungen auf ein Erdpotential fallen zu lassen.

3. Elektrooptische Vorrichtung nach Anspruch 1 oder 2, wobei das Schaltelement ein zweites Schaltelement (802) enthält, das in einer gemeinsamen Potenzialleitung (LCCOM), die dazu dient, die gemeinsame Elektrode bei einem unveränderlichen Potential zu halten, bereitgestellt ist, um das Potential der gemeinsamen Potenzialleitung selektiv auf das Erdpotential fallen zu lassen.

4. Elektrooptische Vorrichtung nach einem der Ansprüche 1 bis 3, des Weiteren umfassend:
eine Vorladeschaltung zum Zuleiten eines Vorladesignals bei einem vorbestimmten Spannungspegel zu den Datenleitungen über eine Vorladeleitung; wobei das Schaltelement ein drittes Schaltelement enthält, das in der Vorladeleitung bereitgestellt ist, um das Potential der Vorladeleitung selektiv auf ein Erdpotential fallen zu lassen.

5. Elektrooptische Vorrichtung nach einem der Ansprüche 1 bis 4, des Weiteren umfassend:
ectromittel (1012) zum Ausführen einer Steuerung, so dass das Potential der Schaltanordnung zumindest zu einem Zeitpunkt nach dem Einschalten der elektrooptischen Vorrichtung und vor dem Ausschalten der elektrooptischen Vorrichtung auf ein Erdpotential fallen gelassen wird.

6. Elektrooptische Vorrichtung nach einem der Ansprüche 1 bis 5, des Weiteren umfassend:
Speicherkondensatoren (70), die elektrisch an die ersten Dünnfilmtransistoren angeschlossen sind.

7. Elektrooptische Vorrichtung nach Anspruch 6, wobei
die Pixelektroden in einer Matrix angeordnet sind, die Abtastleitungen und die Datenleitungen in einer Form angeordnet sind, die der Matrix entspricht, und die Speicherkondensatoren über den ersten Dünnfilmtransistoren gebildet sind und einem Bereich entsprechen, in dem die Abtastleitungen und die Datenleitungen angeordnet sind.

8. Elektrooptische Vorrichtung nach einem der Ansprüche 1 bis 7, wobei die Schaltanordnung auf dem ersten Substrat gebildet ist und aus einem zweiten Dünnfilmtransistor (801, 802) gebildet ist, und eine Halbleiterschicht (1a), die den zweiten Dünnfilmtransistor bildet, dieselbe wie die Halbleiterschichten ist, die die ersten Dünnfilmtransistoren bilden.

9. Ansteuerverfahren für eine elektrooptische Vorrichtung zum Ansteuern einer elektrooptischen Vorrichtung, das umfasst:

   ein erstes Substrat (10) mit Pixelektroden (9a), Dünnfilmtransistoren (30), die elektrisch an die Pixelektroden (9a) angeschlossen sind, und Abtastleitungen (3a) und Datenleitungen (6a), die elektrisch an die Dünnfilmtransistoren angeschlossen sind;
   ein zweites Substrat (20), das dem ersten Substrat gegenüber liegt und eine gemeinsame Elektrode (21) aufweist;
   eine elektrooptische Substanz (50), die zwischen dem ersten und zweiten Substrat gehalten wird; und
   eine Schaltanordnung (801, 802) zum Entladen von Innenkondensatoren, die durch die Pixelektroden auf dem ersten Substrat, die elektrooptische Substanz und die gemeinsame Elektrode auf dem zweiten Substrat gebildet werden;

dadurch gekennzeichnet, dass das Ansteuerverfahren einen Schritt, als Reaktion auf Steuersignale (CONTROL SIGNAL), umfasst, um selektiv entweder die Potenziale der Datenleitungen auf ein Erdpotenzial fallen zu lassen, ohne dass auch das Potenzial der gemeinsamen Elektrode (21) auf ein Erdpotenzial fällt, oder die Potenziale der Datenleitungen und der gemeinsamen Elektrode auf das Erdpotenzial fallen zu lassen.

10. Elektronische Vorrichtung mit einer elektrooptischen Vorrichtung nach einem der Ansprüche 1 bis 8.

11. Projektionsanzeigevorrichtung, umfassend:

   ein Lichtventil, das durch eine elektrooptische Vorrichtung nach einem der Ansprüche 1 bis 8 gebildet wird; eine Lichtquelle zum Einleiten von Projektionslicht in das Lichtventil; und ein optisches System zum Projizieren des Projektionslichts, das von dem Lichtventil ausgestrahlt wird.
FIG. 6

START

S11 TURN OFF POWER SWITCH [POWER OFF LAMP UNIT]

S12 CUT OFF EXTERNAL INPUT SIGNAL TO LIGHT VALVE (ELECTROOPTIC DEVICE)

S13 DROP POTENTIALS OF DATA LINES AND COMMON POTENTIAL LINE TO GROUND POTENTIAL [CLOSE TFTS 801 AND 802]

S14 TURN OFF DRIVING VOLTAGE AND DRIVING SIGNAL [POWER OFF ELECTROOPTIC DEVICE]

S15 POWER OFF VENTILATING FAN

END
FIG. 7

START

S11 TURN OFF POWER SWITCH [POWER OFF LAMP UNIT]

S12 CUT OFF EXTERNAL INPUT SIGNAL TO LIGHT VALVE (ELECTROOPTIC DEVICE)

S23 INPUT SINGLE-COLOR SIGNAL

S14 TURN OFF DRIVING VOLTAGE AND DRIVING SIGNAL [POWER OFF ELECTROOPTIC DEVICE]

S15 POWER OFF VENTILATING FAN

END
FIG. 8

START

S51 TURN ON POWER SWITCH

S52 PUT DRIVING VOLTAGE AND DRIVING SIGNAL IN ON STATE [TURN ON ELECTROOPTIC DEVICE]

S53 INPUT SINGLE-COLOR SIGNAL

S54 POWER ON LAMP UNIT

S55 TURN ON EXTERNAL INPUT SIGNAL

END