



(19)

Europäisches Patentamt  
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Office européen des brevets



(11)

EP 1 331 511 B1

(12)

## EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention  
of the grant of the patent:  
**07.06.2006 Bulletin 2006/23**

(51) Int Cl.:  
**G02F 1/1343 (2006.01)** **G02F 1/1368 (2006.01)**  
**G02F 1/1335 (2006.01)**

(21) Application number: **01976713.6**

(86) International application number:  
**PCT/JP2001/009111**

(22) Date of filing: **17.10.2001**

(87) International publication number:  
**WO 2002/033482 (25.04.2002 Gazette 2002/17)**

**(54) METHODS OF PRODUCING ACTIVE MATRIX SUBSTRATE AND LIQUID CRYSTAL DISPLAY DEVICE**

VERFAHREN ZUM ERZEUGEN EINES AKTIVEN MATRIXSUBSTRATS UND EINER  
FLÜSSIGKRISTALLANZEIGEEINRICHTUNG

PROCEDES DE PRODUCTION DE SUBSTRAT A MATRICE ACTIVE ET D'UN DISPOSITIF  
D'AFFICHAGE A CRISTAUX LIQUIDES

(84) Designated Contracting States:  
**DE FR GB**

- **SHIMIZU, Masaharu,**  
c/o SEIKO EPSON CORP.  
Suwa-shi,  
Nagano 392-8502 (JP)

(30) Priority: **17.10.2000 JP 2000316957**  
**16.10.2001 JP 2001318207**

(74) Representative: **Sturt, Clifford Mark et al**  
**Miller Sturt Kenyon**  
**9 John Street**  
**London WC1N 2ES (GB)**

(43) Date of publication of application:  
**30.07.2003 Bulletin 2003/31**

(56) References cited:  
**JP-A- 8 076 106** **JP-A- 8 313 726**  
**JP-A- 10 148 710** **JP-A- 10 301 129**  
**US-A- 5 706 064**

(60) Divisional application:  
**06075687.1**

- **PATENT ABSTRACTS OF JAPAN** vol. 1999, no. 02, 26 February 1999 (1999-02-26) & JP 10 301129 A (NEC CORP), 13 November 1998 (1998-11-13)
- **PATENT ABSTRACTS OF JAPAN** vol. 1997, no. 03, 31 March 1997 (1997-03-31) & JP 08 313726 A (SEIKO EPSON CORP), 29 November 1996 (1996-11-29)
- **PATENT ABSTRACTS OF JAPAN** vol. 1996, no. 07, 31 July 1996 (1996-07-31) & JP 08 076106 A (CANON INC), 22 March 1996 (1996-03-22)
- **PATENT ABSTRACTS OF JAPAN** vol. 1998, no. 11, 30 September 1998 (1998-09-30) & JP 10 148710 A (SEIKO EPSON CORP), 2 June 1998 (1998-06-02)

(73) Proprietor: **SEIKO EPSON CORPORATION**  
**Shinjuku-ku,**  
**Tokyo 163-0023 (JP)**

(72) Inventors:

- **KIGUCHI, Hiroshi,**  
c/o SEIKO EPSON CORP.  
Suwa-shi,  
Nagano 392-8502 (JP)
- **KATAGAMI, Satoru,**  
c/o SEIKO EPSON CORP  
Suwa-shi,  
Nagano 392-8502 (JP)
- **KAWASE, Tomomi,**  
c/o SEIKO EPSON CORP.  
Suwa-shi,  
Nagano 392-8502 (JP)
- **ARUGA, Hisashi,**  
c/o SEIKO EPSON CORP.  
Suwa-shi,  
Nagano 392-8502 (JP)

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## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** This invention relates to a method of manufacture of an active matrix substrate, on which are formed thin film transistors (TFTs), thin film diodes (TFDs), and other active elements in matrix form, as well as a method of manufacture of a liquid crystal display device using this active matrix substrate.

#### 2. Description of the Related Art

**[0002]** Liquid crystal display devices, having a structure in which liquid crystals are enclosed between an active matrix substrate and an opposing substrate, are well-known. In such a liquid crystal display device, active elements and pixel electrodes to select and drive these elements are provided on the active matrix substrate, and an opposing electrode is provided on the opposing substrate. In order to effect color display in such a liquid crystal display device, a transmissive color filter, having red (R), green (G) and blue (B) tints, is arranged for individual display pixels.

**[0003]** In Japanese Patent Laid-open No. H9-292633, the formation of a color filter by imparting hardening ink to the aperture regions between TFTs formed on a substrate using an ink jet method, and the formation on this color filter of transparent pixel electrodes, are described.

**[0004]** However, in the Japanese Patent Laid-open No. H9-292633, formation of the ink layer and formation of the pixel electrodes must be performed separately, involving greater complexity in the manufacturing process.

**[0005]** In order to prevent the active element electrodes from being covered by ink jet discharge prior to formation of the pixel electrodes, the ink jet discharge must be performed after forming a passivation film and light-blocking layer on the entire upper surface of the active elements; however, contact holes must be formed in this passivation film and light-blocking layer for pixel electrodes connected to the active element electrodes, involving greater complexity in the manufacturing process.

**[0006]** On the other hand, in Japanese Patent Laid-open No. 8-313726, colored layers may be used as both a color filter and as pixel electrodes by making them conductive. By this means, formation of the ink layer and formation of the pixel electrodes can be performed in the same operation, and there is no longer a need to form contact holes in a passivation film and light-blocking layer.

**[0007]** However, in the Japanese Patent Laid-open No. H8-313726, patterning is performed by using a conductive resist as the color filter; however, the range of materials which can be selected in order to simultaneously satisfy the three requirements of optimal color ad-

justment, conductivity, and resist properties is extremely limited. For example, if an ordinary photopolymer-type color resist is mixed with conductive material, the occurrence of radicals due to the photoinitiator may be impeded, so that realization of such a material is difficult.

**[0008]** Also, because exposure, development, and other processes are indispensable for patterning using resist, complexity in the manufacturing process is unavoidable. And, patterning must be used to eliminate unnecessary resist, so that color materials and conductive materials are inevitably wasted.

**[0009]** US 5706064 discloses a method of manufacturing a substrate for a display device comprising forming a switching element on a substrate, forming a polysilane layer on the substrate, irradiating the polysilane layer with ultraviolet light to form a latent pattern image, dipping the substrate into a dipping solution which is absorbed by exposed portions of the polysilane and vitrifying the exposed portions. A conductive color filter layer functioning as a pixel electrode may be formed by the above process. The dipping step may be replaced by an ink-jet technique.

### SUMMARY OF THE INVENTION

**[0010]** In order to resolve the above problems, according to the present invention there is provided a method of manufacture of an active matrix substrate, in which active elements are formed in a matrix, characterised by: depositing an insulating film to a prescribed height over portions of said active elements so that said insulating film surrounds pixel areas over which said insulating film is not deposited; and depositing a conductive colored layer acting both as a pixel electrode layer and as a color filter layer over said pixel areas to a predetermined height, so as to form pixel electrodes to be electrically connected to said active elements; wherein said step of depositing a conductive colored layer includes using an ink jet method to discharge ink in which color material and conductive material are intermixed onto said pixel areas.

**[0011]** After forming a reflective layer provided with optical reflectivity at the position at which the conductive colored layer is formed, the process to discharge the ink may be used to manufacture a reflective active matrix substrate.

**[0012]** Also, a semi-transmissive active matrix substrate may be manufactured by forming a gap, which transmits light in the layer thickness direction, in the reflective layer.

**[0013]** In the method of manufacture of the reflective or semi-transmissive active matrix elements, it is preferable that a first insulating layer be formed in positions to cover electrodes other than the one electrode electrically connected to the conductive colored layer in the active element, and that after forming on the first insulating layer the reflective layer, which electrically connects the conductive colored layer to the one electrode, and the insulating film, which constitutes a black matrix, the process

in which the ink is discharged be executed.

**[0014]** In the method of manufacture of reflective or semi-transmissive active matrix elements, it is preferable that the first insulating layer be formed at positions to cover the entire surface of the active elements, and that the reflective layer be electrically connected to the single electrode via contact holes formed at positions corresponding to the single electrodes in the first insulating layer.

**[0015]** In the manufacturing method, it is preferable that the pixel electrodes formed by discharge of the ink have at least three types of color.

**[0016]** In the manufacturing method, the active elements may be thin film transistors (TFTs), or may be thin film diodes (TFDs).

**[0017]** A method of manufacturing liquid crystal display devices of this invention is characterized in that a liquid crystal layer is injected between an active matrix substrate manufactured by the method and an opposing substrate positioned to oppose the active matrix substrate.

**[0018]** Also, a method of manufacture of electronic equipment of this invention is characterized in that a liquid crystal display device manufactured by the method is used as a display means.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]**

Fig. 1 shows one example of the manufacturing process of a first embodiment;

Fig. 2 shows one example of the manufacturing process of the first embodiment;

Fig. 3 shows one example of the manufacturing process of the first embodiment;

Fig. 4 shows one example of the manufacturing process of the first embodiment;

Fig. 5(a) is a plane view, and Fig. 5(b) is a cross-sectional view along line A-A', of the active matrix substrate and liquid crystal display device in a second embodiment;

Fig. 6 is a cross-sectional view of a process for manufacturing an active matrix substrate and liquid crystal display device in a third embodiment;

Fig. 7 is a cross-sectional view of a process for manufacturing an active matrix substrate and liquid crystal display device in a modification of the third embodiment;

Fig. 8 is a cross-sectional view of a process for manufacturing an active matrix substrate and liquid crystal display device in another modification of the third

embodiment;

Fig. 9 shows one example of the manufacturing process of a fourth embodiment;

Fig. 10 shows one example of the manufacturing process of the fourth embodiment;

Fig. 11 shows one example of the manufacturing process of the fourth embodiment;

Fig. 12 shows one example of the manufacturing process of the fourth embodiment;

Fig. 13 shows one example of the manufacturing process of a modification of the fourth embodiment;

Fig. 14 shows one example of the manufacturing process of a modification of the fourth embodiment;

Fig. 15 shows one example of the manufacturing process of a modification of the fourth embodiment; and,

Fig. 16 is a perspective view of a notebook-type personal computer which is electronic equipment manufactured by the manufacturing method of an embodiment of this invention.

**[0020]** In the figures, the symbols 201, 401 and 601 are thin film transistor substrates; 801 is a thin film diode substrate; 202 and 602 are TFTs (thin film transistors); 802 is a TFD (thin film diode); 206 through 208, 406 through 408, 606 through 608, and 806 through 808 are conductive colored layers; 209 and 409 are drain regions; 611 is a drain electrode; 412 and 812 are conductive layers; 210, 410, 610 and 810 are active matrix substrates; 217, 417, 617 and 817 are opposing substrates; 218, 418 and 618 are opposing electrodes; 818 is a scan line; 219, 419, 619, and 819 are liquid crystals; 220, 420, 620, and 820 are insulating films; 221, 421, 621, and 821 are alignment films; 200, 400, 600, 800, and 300 are liquid crystal display devices; and 500 is a personal computer (electronic equipment).

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0021]** Below, embodiments of this invention are explained in detail, referring to the drawings.

##### 1. First Embodiment

**[0022]** The first embodiment is an embodiment which uses TFTs as active elements.

## 1-1. Manufacturing Process

**[0023]** Fig. 1 through Fig. 4 are figures showing an example of a manufacturing process of the first embodiment; in each figure, (a) is a plane view, and (b) is a cross-sectional view along line A-A' of (a). First, TFTs 202 are formed on the thin film transistor substrate 201. These TFTs 202 comprise a gate line 203, source line 204, insulating film 205, and other components (Fig. 1).

**[0024]** Next, as shown in Fig. 2, an insulating film 220 is formed to become a protective film for the source lines 204. This insulating film 220 covers a portion of the TFTs 202 (the source lines 204), and is also formed so as to surround the pixel, and thereby functions as a black matrix. By forming this insulating film to a prescribed height, the insulating film later acts as a bank to prevent ink discharged in an ink jet from overflowing into other pixels.

**[0025]** It is preferable that the insulating film 220 be formed so as to cover those electrodes of the TFTs 202 (source and gate electrodes) other than the drain electrode which is to be electrically connected by the conductive colored layer. By this means, when the conductive ink is applied, the conductive ink is connected only to the drain regions, and is not connected to the source or drain electrodes.

**[0026]** Further, it is preferable that the insulating film 220 be formed along the source lines 204 and gate lines 203 which intersect in a matrix form. By this means, the positions of the source lines and gate lines coincide with the black matrix, and an aperture ratio can be maximized. And, by forming the insulating film 220 so as to cover the source lines 204 and gate lines 203, short-circuiting of the source lines 204 or gate lines 203 by the conductive colored layer can be prevented.

**[0027]** Next, as shown in Fig. 3, contact holes are opened in the insulating film 205, and then red conductive ink, green conductive ink, and blue conductive ink are discharged into each pixel by an ink jet method. As this conductive ink, for example, ink with fine conductive particles intermixed and dispersed can be used. Ink discharged by the ink jet method is naturally dried in air, and hardened using a hot plate and/or oven. By this means, conductive colored layers 206 through 208 are formed, and an active matrix substrate 210 is completed.

**[0028]** In this embodiment, the inks which serve as the color filter are conductive. Conductive inks can for example be prepared by mixing fine particles of transparent conductive materials such as ITO (indium tin oxide) or SnO<sub>2</sub> (tin oxide) into an ink.

**[0029]** The conductive colored layers 206 through 208 thus formed by imparting conductivity to the ink can be used both as a color filter provided on the thin film transistor substrate, and also as pixel electrodes to drive the liquid crystals. To this end, these conductive colored layers 206 through 208 and the drain regions 209 of the TFTs 202 are connected via the contact holes.

**[0030]** Then, as shown in Fig. 4, the alignment film 222 is deposited in a layer and subjected to rubbing process-

ing. On the inside of the opposing substrate 217, only an opposing electrode 218 comprising a transparent conductive film and an alignment film 221 are provided. Liquid crystals 219 are injected between the thin film transistor substrate 201 and the opposing substrate 217, to form the liquid crystal display device 200.

**[0031]** In this embodiment, a color filter comprising conductive inks is provided on the thin film transistor substrate. As a result, the need to form a color filter on the opposing substrate is eliminated, and the cost of manufacturing the opposing substrate can be reduced. Also, there is greater tolerance in aligning the thin film transistor substrate with the opposing substrate.

**[0032]** Further, by this embodiment the conductive inks serving as the color filter also serve as pixel electrodes, so that the processes of forming and patterning pixel electrodes can be eliminated. As a result, costs can be reduced, and production yields can be increased.

**[0033]** Also, this embodiment has the following advantages compared with a configuration in which, for example, a color filter is formed comprising color resist or the like on top of pixel electrodes of ITO. That is, after the color filter is formed on top of the pixel electrodes, a voltage is applied to the color filter when driving the liquid crystals, and voltage division results in reduction of the voltage applied to the liquid crystals (the effective voltage), which may cause degradation of image quality. On the other hand, in this embodiment the conductive colored layers 206 through 208 serve as both pixel electrodes and as the color filter, so that this problem of image quality degradation can be effectively prevented.

**[0034]** Further, by this embodiment the aperture ratio can be increased compared with a configuration in which the color filter is formed on top of the pixel electrodes. In a configuration in which the color filter is formed on top of the pixel electrodes, a margin for alignment of the pixel electrodes and the color filter is required; but in this embodiment, no such alignment margin is necessary, and so the aperture ratio can be increased.

## 1-2. Conductive Colored Layers

**[0035]** As in the embodiment, the conductive colored layers can be formed by dispersing pigments or other coloring material and ITO or other conductive material in a solvent.

**[0036]** When dispersing coloring material and conductive material in a solvent, the fraction of solid components of the coloring material, conductive material and the like must be held below a fixed value. This is because if the fraction of solid components in the conductive ink is high, the pot life (time over which a usable liquid state is maintained) is shortened. That is, solid components of coloring material or conductive material may coagulate, preventing discharge of the conductive ink by the ink jet method or worsening the discharge characteristics, and impeding production at the factory or the like.

**[0037]** Hence it is preferable that the solid component

fraction be approximately 10% or less, and more preferable that the solid component fraction be approximately 6% or less. In order to reduce the solid component fraction, the amount of conductive material included in the resist may be reduced; however, too much reduction will cause the resistivity of the conductive colored layers to increase. Hence the relation between pot life and resistivity must be balanced optimally when determining the solid component fraction.

**[0038]** When dispersing pigments or the like in a solvent, there are no particular limitations, but as red-color pigments, for example, perylene pigments, anthraquinone pigments, dianthraquinone pigments, azo pigments, diazo pigments, quinacridone pigments, anthracene pigments and the like may be used. As green-color pigments, phthalocyanine halide pigments and the like may be used. As blue-color pigments, metal phthalocyanine pigments, indanthrone pigments, indophenol pigments and the like may be used. In addition, purple, yellow, cyan, magenta, and other pigments may also be employed.

### 1-3. Conductivity

**[0039]** The conductive colored layers of this embodiment also have a prescribed impedance (resistance and capacitance). Hence there is the problem that the effective voltage applied to the liquid crystals is reduced due to the intervention of the conductive colored layers between the drain region and the liquid crystals. It is therefore preferable that the resistivity of the conductive colored layers be made as low as possible.

**[0040]** The resistivity of the conductive colored layers depends on the size of the liquid crystal panel, the desired display characteristics and other factors, but should preferably be approximately  $1 \times 10^7 \Omega \cdot \text{cm}$  or less, and more preferably approximately  $1 \times 10^6 \Omega \cdot \text{cm}$  or less.

### 1-4. Shape of Fine Conductive Particles and Related Issues

**[0041]** It is preferable that the conductive material included in the colored layers be in the form of fine particles. This is in order to minimize the reduction in transmissivity of the color resist arising from inclusion of the conductive material. For a similar reason, it is preferable that the dispersed conductive material be transparent. Hence ITO,  $\text{SnO}_2$  and the like are optimal as conductive materials. Or, these can be mixed with carbon, gold, or silver for use.

**[0042]** When forming conductive material into fine particles, it is preferable that the shape of the fine particles be disc-shaped or rod-shaped rather than spherical. This is because if particles are formed in disc or rod shapes, the area of overlap between neighboring fine particles can be made large, and as a result electrical currents can flow more freely, and the resistivity can be lowered. That is, the fraction of dispersed fine conductive particles

should be raised in order to lower the resistivity; but if it is raised too high, the transmissivity may be decreased, color characteristics may be worsened, or the above-described shortened pot life or other problems may arise.

5 If particles have disc, rod, or other shapes such that the overlapping areas of neighboring particles are large, then the resistivity can be lowered without greatly increasing the fraction of fine conductive particles.

**[0043]** In order to achieve uniform dispersion of the 10 conductive material, it is preferable that the fine conductive particles be subjected to hydrophobic processing, and that the particle surfaces be made hydrophobic. If the fine conductive particles have a hydrophilic surface, because many pigments and other coloring material have 15 a hydrophobic surface, secondary coagulation of fine hydrophilic particles may occur, so that it may not be possible to obtain a uniform disperse state. Hydrophobic processing is performed using coupling agents, for example; as coupling agents, silane, titanium oxide, chromium, and various other materials can be used.

**[0044]** The black matrix in this embodiment is arranged 20 as a light-blocking layer between the pixels of the color filter, arranged in a stripe pattern, mosaic pattern, triangle pattern, four-pixel pattern, or other pattern.

### 25 1-5. Black Matrix

**[0045]** In this embodiment, it is preferable that the 30 insulating film constituting the black matrix be a silicon oxide film. Silicon oxide film is widely used as an insulating film in processes to manufacture thin film transistors, LSIs and other devices, and offer excellent heat and chemical resistance.

**[0046]** That is, compared with the materials used in 35 conventional black matrixes, the manufacturing process is compatible with that used for thin film transistors and the like. Particularly when the black matrix is formed on the thin film transistor substrate, such compatibility may be a problem. This is because the black matrix is formed 40 using the same manufacturing process as that used for thin film transistors.

**[0047]** Hence if the silicon oxide film which is widely used in the manufacture of thin film transistors is used 45 as the black matrix material, then no great consideration need be given to the etching fluid, temperature or other factors used after the black matrix formation process. Consequently selection of the chemicals and the like used in the manufacturing process becomes easier. Even when the insulating film in thin film transistors and 50 the black matrix have a multilayer structure, the same material is used in both, so that the adverse effects of strain induced by stress or other factors can be reduced.

**[0048]** The silicon oxide film constituting the black matrix can also serve as the insulating film (source line protective film) of the thin film transistors.

**[0049]** In this embodiment, in addition to the silicon oxide film, titanium oxide film or other films of material equivalent to silicon oxide can be adopted; various materials

can be employed, so long as there is good manufacturing process compatibility with thin film transistors and other components.

**[0050]** In this embodiment, it is preferable that pigments be used as the coloring material comprised by the insulating film. This is because pigments have comparatively good heat resistance, so that when the heat resistance of the color filter and other components is improved, the heat resistance of the coloring material should also be similarly improved. However, the coloring material comprised by the insulating film is not limited to this; for example, dyes may be used as well. In this embodiment, carbon is conceivable as a black-color pigment for inclusion in the insulating film.

## 2. Second Embodiment

**[0051]** In the second embodiment, a metal or other conductive layer intervenes between the conductive colored layers and the thin film transistor drain regions.

**[0052]** Fig. 5(a) is a plane view, and Fig. 5(b) is a cross-sectional view along line A-A', of an active matrix substrate and liquid crystal display device of the second embodiment. The method of manufacture differs from the first embodiment in that, after opening contact holes to the drain regions 409 in the insulating film 405, a conductive layer 412, electrically connecting the drain regions 409 and the conductive colored layers 406 through 408, is formed. This conductive layer 412 is of metal or similar material. After forming the conductive layer 412, the conductive colored layers 406 through 408 which serve both as the color filter and as pixel electrodes are formed, to complete the active matrix substrate 410. The alignment film 422, opposing substrate 417, opposing electrode 418, alignment film 421, and liquid crystals 419 are formed similarly to the above-described first embodiment, to obtain the liquid crystal display device 400.

**[0053]** By this embodiment, good contact can be ensured between the conductive colored layers 406 through 408 serving as the pixel electrodes, and the drain region 409, which enables reduction of contact resistance and so on. As a result, the effective voltage applied to the liquid crystals can be increased, and the display characteristics can be improved. Here, as the material of the conductive layer 412, it is preferable that a material be used which can adequately reduce the contact resistance with the drain region and the contact resistance with the conductive colored layers.

### 2-1. First Modification

**[0054]** This embodiment is not limited to the above; the conductive layer 412 may be formed at the time of formation of the source lines 404, of the same material as the source lines 404. That is, when forming a pattern for the source lines 404, a pattern is also formed for a conductive layer 412 of the same material as the source lines 404. Then, the conductive colored layers 406

through 408 are formed. Through this method of forming a conductive layer 412 of the same material as the source lines 404, there is no longer a need to add new photolithography and etching processes to form the conductive layer, so that the number of processes can be reduced and the manufacturing yield can be raised.

**[0055]** In this embodiment, the conductive layer 412 of metal or the like is drawn out from the contact holes, and the size of the area of contact with the conductive colored layer 406 is determined such that the contact resistance with the conductive ink is sufficiently low. However, when the conductive layer 412 comprises a non-translucent material, if this contact area is made too large the aperture ratio is decreased; hence the size of the contact area must be determined according to the required contact resistance and aperture ratio.

### 2-2. Second Modification

**[0056]** The conductive layer 412 may be formed only on the periphery of contact holes, as in Fig. 5; however, the conductive layer 412 may also be formed on the periphery of the conductive colored layers 406 serving as pixel electrodes. By this means, the parasitic resistance between the drain region 409 and the pixel electrode can be reduced, and degradation of image quality can be prevented.

**[0057]** When forming the conductive layer 412 on the periphery of the conductive colored layers 406, the conductive layer 412 can also be used as a portion of the black matrix. In this case, the gate lines 403 and source lines 404 become other portions of the black matrix.

### 2-3. Third Modification

**[0058]** Further, the conductive layer 412 may be formed from ITO over the entire lower surfaces of the conductive colored layers 406 through 408. As a result, even if the resistivity of the conductive colored layers 406 through 408 is high, the actual resistance is only the resistance resulting from the thickness of the conductive colored layers, so that reduction of the effective voltage applied to the liquid crystals can be effectively prevented.

### 2-4. Fourth Modification

**[0059]** Further, if the conductive layer 412 is formed over the entire lower surfaces of the conductive colored layers 406 through 408, and the conductive layer 412 is formed from a metal or other non-translucent material, then a reflective-type active matrix liquid crystal display device can be configured. When fabricating a reflective-type active matrix liquid crystal display device, it is preferable that the material of the conductive layer 412 have as high a reflectivity as possible.

**[0060]** In conventional reflective-type liquid crystal display devices, the color filter is formed on the opposing substrate. However, in a reflective-type liquid crystal dis-

play device, reflected light is the only light source, so that a higher embodiment ratio is desired. In this embodiment, the aperture ratio can be increased by incorporating the color filter in the thin film transistor substrate 401. And, by making the color filter conductive, the problem of voltage division arising from intervention of the color filter between the pixel electrodes and Liquid crystals can be prevented.

**[0061]** It is preferable that the liquid crystals 419 enclosed to configure a reflective-type liquid crystal display device be polymer-disperse liquid crystals (PDLCs). As opposed to TN liquid crystals, PDLCs enable control of light transmission through the scattering strength, and have the advantage of not requiring a polarizer. By eliminating the need for a polarizer, the aperture ratio can be raised, and the device manufacturing cost can be reduced. PDLCs can be realized by dispersing liquid crystal molecules in polymers to approximately micron order, or by incorporating liquid crystals in a polymer network.

### 3. Third Embodiment

**[0062]** In the third embodiment, the TFTs which are the active elements are used in a form differing from that described above. The difference with the first and second embodiments is that the positional relationship of the TFT gate electrode and the source and drain electrodes is vertically inverted.

**[0063]** Fig. 6 is a cross-sectional view of processes to manufacture the active matrix substrate and liquid crystal display device of the third embodiment. As shown in Fig. 6(a), the TFT 602 is fabricated by forming a gate electrode 603, gate insulating film 605, amorphous silicon film 631, etching protective film 632, Ohmic layer 633, source electrode 604 and drain electrode 611 on the thin film transistor substrate 601.

**[0064]** Next, an insulating film 620 is formed on the source electrode 604, as shown in Fig. 6(b). This insulating film also serves as the black matrix, and in addition acts as a bank to prevent applied ink from overflowing into other pixels.

**[0065]** Then, red, green and blue conductive inks are selectively discharged by the ink jet method into each pixel, and are dried and hardened, as shown in Fig. 6(c). By this means, the conductive colored layers 606, 607, 608, which serve as both pixel electrodes and as the color filter, are formed, to complete the active matrix substrate 610.

**[0066]** Finally, the alignment film 622 is applied and subjected to rubbing processing, as shown in Fig. 6(d). On the inside of the opposing substrate 617, an opposing electrode 618 comprising a transparent conductive film and an alignment film 621 are provided. Liquid crystals 619 are enclosed between the thin film transistor substrate 601 and the opposing substrate 617 to obtain a liquid crystal display device 600.

**[0067]** In this embodiment, the drain electrodes 611 are positioned on the upper surface of the TFTs 602, so

that no contact holes for connection to pixel electrodes are needed, with the advantage that manufacturing processes are simplified.

**[0068]** The TFT structure is not limited to those described in the above embodiments; various other structures can be adopted, including inverted-type and normal-type amorphous silicon thin film transistor structures, and planar-type and normal-type polysilicon (polycrystalline silicon) thin film transistor structures.

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### 3-1. Fifth Modification

**[0069]** Fig. 7 shows a modification of the third embodiment. Portions which are similar to those in Fig. 6 are assigned the same symbols, and explanations are omitted. In this modification, a reflective-type liquid crystal display device is obtained by providing an electrode 641, with light-reflecting properties, so as to be electrically connected with the drain electrodes 611 of the third embodiment.

**[0070]** First, as shown in Fig. 7(a), the TFT 602 is formed comprising a source electrode 604 and drain electrode 611, similarly to Fig. 6(a).

**[0071]** Next, as shown in Fig. 7(b), the insulating film 640 is formed. When fabricating a reflective-type liquid crystal display device, a configuration is also possible in which this insulating film 640 is not provided. However, it is preferable that the efficiency of use of reflected light in a reflective-type liquid crystal display device be increased. That is, it is preferable that the area of the portion acting as pixel electrodes be broadened. Hence the insulating film 640 is formed in order that the portion above the neighboring transistor or above the electrode constituting the wiring (in Fig. 7, the source electrode 604) also act as the pixel electrode.

**[0072]** Because this embodiment concerns a reflective-type liquid crystal display device, the insulating film 640 need not be translucent.

**[0073]** After forming the insulating film 640, contact holes are opened in the insulating film 640 leading to the drain electrodes 611, and a conductive layer 641 for electrical connection to the drain electrodes 611 is formed.

**[0074]** In order to obtain a reflective-type liquid crystal display device, this conductive layer 641 is formed from a material such as aluminum (Al) with as high an optical reflectivity as possible. Also, though not shown in the figure, a diffused reflective surface, having fine protrusions and depressions, is formed in the surface of the conductive layer 641 in order that the display quality of the reflective liquid crystal display device be more satisfactory.

**[0075]** Similar to the example of Fig. 6, an insulating film 620 is formed. However, in contrast with the example of Fig. 6, there is no need to cover the entire source electrode 604. This insulating film 620 also serves as the black matrix, and in addition acts as a bank to prevent overflow of the applied ink into other pixels.

**[0076]** As shown in Fig. 7(c), red, green and blue con-

ductive inks are selectively discharged by the ink jet method into each pixel, and are dried and hardened. By this means, conductive colored layers 606, 607, 608, which function both as pixel electrodes and as the color filter, are formed, to complete the reflective-type active matrix substrate 610'.

[0077] Finally, as shown in Fig. 7(d), the alignment film 622 is formed and is subjected to rubbing processing. On the inside of the opposing substrate 617, an opposing electrode 618 comprising a transparent electrode film, and an alignment film 621 are provided. Liquid crystals 619 are enclosed between the thin film transistor substrate 601 and the opposing substrate 617 to obtain the reflective-type liquid crystal display device 600'.

### 3-2. Sixth Modification

[0078] Fig. 8 shows another modification of the third embodiment. Components similar to those in Fig. 6 and Fig. 7 are assigned the same symbols, and explanations are omitted. In this modification, a semi-transmissive active matrix-type liquid crystal display device is configured by forming the conductive layer 641 of the fifth modification from metal or another non-translucent material, and by forming this layer in a shape so as to impart partial translucence, as conductive layer 651.

[0079] As shown in Fig. 8(a), similarly to Fig. 6(a) and Fig. 7(a), TFTs 602 comprising a source electrode 604 and drain electrode 611 are formed.

[0080] Then, as shown in Fig. 8(b), the insulating film 650 is formed. This modification concerns a semi-transmissive liquid crystal display device which utilizes both reflected light and transmitted light for display; hence the insulating film 650 is formed from material having optical transmissivity. A configuration in which the insulating film 650 is not formed can also be adopted. However, for reasons similar to the reasons why it is preferable to form the insulating film 640 in the fifth modification, in this modification also it is preferable that the insulating film 650 be formed.

[0081] After forming the insulating film 650, contact holes leading to the drain electrodes 611 are opened in the insulating film 650, and the conductive layer 651 for electrical connection to the drain electrodes 611 is formed.

[0082] In order to obtain a semi-transmissive liquid crystal display which also utilizes reflected light for display, this conductive layer 651 is formed from aluminum (Al) or some other material with as high an optical reflectivity as possible. Though not shown, in this modification also a diffused reflective surface, having fine protrusions and depressions, is formed in the surface of the conductive layer 651 in order that the display quality when utilizing reflected light for display be more satisfactory.

[0083] A difference from the fifth modification is the fact that slits 652 are formed in the conductive layer 651, in order that light is partially transmitted. These slits 652 are formed in the process of patterning the conductive

layer 651.

[0084] The shape which imparts translucence to the conductive layer 651 is not limited to slits, and may be any shape, so long as there is partial removal of the conductive layer 651. Also, the area of partial removal of the conductive layer 651 is determined according to the value to be set for the transmittance for light passing through pixel regions (light from the backlight).

[0085] Next, the insulating film 620 is formed, similarly to the example of Fig. 7. This insulating film 620 also serves as the black matrix, and in addition acts as a bank to prevent applied ink from overflowing into other pixels.

[0086] Then, as shown in Fig. 8(c), red, green, and blue conductive inks are selectively discharged by an ink jet method into each pixel, and are dried and hardened. By this means, conductive colored layers 606, 607, 608, which function both as pixel electrodes and as the color filter, are formed, to complete the semi-transmissive active matrix substrate 610".

[0087] Finally, as shown in Fig. 8(d), the alignment film 622 is formed and is subjected to rubbing processing. Also, an opposing electrode 618 comprising a transparent conductive film, and an alignment film 621, are provided on the inside of the opposing substrate 617. Liquid crystals 619 are enclosed between the thin film transistor substrate 601 and the opposing substrate 617.

[0088] A backlight 660 which irradiates light from the side of the thin film transistor substrate 601 is provided, to obtain the semi-transmissive liquid crystal display device 600".

### 4. Fourth Embodiment

[0089] In a fourth embodiment, TFDs are used as the active elements.

[0090] Fig. 9 through Fig. 12 are figures showing an example of a manufacturing process of the fourth embodiment; in each figure, (a) is a plane view, and (b) is a cross-sectional view along line A-A'. First, the thin film diode substrate 801 is formed from, for example, glass, plastic, ceramic, semiconductor wafer, or other insulating material. This thin film diode substrate 801 must be transparent in the case of a transmissive-type liquid crystal display device, but need not be transparent in the case of a reflective-type liquid crystal display device.

[0091] As shown in Fig. 9, the signal lines 814 and first conductive film 851 of the TFDs 802 are formed in a prescribed pattern on the thin film diode substrate 801. Specifically, tantalum or a tantalum-based alloy is deposited by sputtering or by electron beam evaporation, and is formed in a prescribed pattern by reactive ion etching, chemical dry etching or a similar method.

[0092] The signal line 814 is used as a scanning signal line; a plurality of signal lines 814 are provided in parallel, in a prescribed pattern, on the thin film diode substrate 801, and extend to the position at which the driver IC of a scanning signal driving circuit, not shown, is located.

[0093] The first conductive film 851 is provided on the

thin film diode substrate 801, extending from the signal lines 814, and formed in connection with the signal lines 814.

**[0094]** Prior to this patterning, a tantalum oxide protective oxide film may if necessary be formed on the entire surface of the thin film diode substrate 801 prior to patterning. This protective oxide film can be formed by thermal oxidation of a tantalum film deposited by sputtering, by sputtering of a target consisting of tantalum oxide, or by some other method.

**[0095]** Next, the thin film diode substrate 801 is placed in an electrolytic solution of citric acid or the like, anodic oxidation of the signal lines 814 and the first conductive film 815 is performed, and by forming a tantalum oxide film on these surfaces, an insulating film 852 is formed on the surface of the first conductive film 851.

**[0096]** Next, chromium (Cr) is sputtered onto the entire surface of the thin film diode substrate 801 to form a chromium film, which is then etched to pattern a second conductive film 853 in a prescribed pattern. By forming this second conductive film 853, the TFDs 802, which are two-terminal nonlinear elements, are formed. As a result, the first conductive film 851 and the second conductive film 853 enclose the insulating film 852 and are capacitively coupled. Signals from the driver IC are transmitted from the signal line 814 to the first conductive film 851, and are input to the TFDs 802.

**[0097]** The conductive layer 812 is formed in a prescribed pattern on this thin film diode substrate 12, extending over nearly the entire area of each pixel. The conductive layer 812 consists of ITO when, for example, a transmissive-type liquid crystal display device is to be fabricated. When a reflective-type liquid crystal display device is to be fabricated, the conductive layer 812 consists of aluminum (Al), and a diffused reflective surface, having fine protrusions and depressions, is formed in the surface.

**[0098]** The conductive layer 812 overlaps with the second conductive film 853 at positions of TFDs 802, and is connected with the TFDs 802. Signals from the signal lines 814 are input to the conductive layer 812 via the TFDs 802.

**[0099]** Next, as shown in Fig. 10, an insulating film 820 covering the signal lines 814 is formed. As shown in Fig. 10(a), this insulating film 820 is formed in the boundary portions between pixels so as to function as the black matrix and as a bank, in addition to the signal lines 814.

**[0100]** As shown in Fig. 11, conductive inks are then discharged by the ink jet method into each pixel, dried and hardened to form the conductive colored layers 806 through 808, completing the active matrix substrate 810.

**[0101]** An alignment film 822 is then formed on the active matrix substrate 810 and subjected to rubbing processing, as shown in Fig. 12. Scan lines 818 are provided on the transparent opposing substrate 817, on top of which an alignment film 821 is formed and subjected to rubbing processing; the active matrix substrate 810 and opposing substrate 817 are placed facing each other,

and liquid crystals 819 are enclosed between them to form the liquid crystal display device 800.

**[0102]** A polarizer, not shown, is provided on the outside of the opposing substrate 817. In the case of a transmissive-type active matrix substrate, a backlight is added, to obtain a liquid crystal display device.

#### 4-1. Seventh Modification

**[0103]** Fig. 13 through Fig. 15 show an example of a process to manufacture an active matrix substrate and liquid crystal display device in a modification of the fourth embodiment; in each figure, (a) is a plane view, and (b) is a cross-sectional view along line A-A'. Components similar to those in Fig. 9 through Fig. 12 are assigned the same symbols, and explanations are omitted. In this modification, a semi-transmissive active matrix liquid crystal display device is configured by forming the conductive layer 812 of the fourth embodiment from metal or some other non-translucent material, and forming the layer in a shape which imparts partial translucence, as the conductive layer 870.

**[0104]** As shown in Fig. 13, in order to fabricate the active matrix substrate of this modification, a second conductive film 853 comprised by the TFDs is formed, similarly to Fig. 9.

**[0105]** Next, an optically transmissive insulating film 860 is formed, as shown in Fig. 14. A configuration is also possible in which this insulating film 860 is not provided. However, in a semi-transmissive as well as a reflective-type liquid crystal display device, it is desirable that the efficiency of usage of reflected light be increased. That is, it is preferable that the area of the portions used as pixel electrodes be broadened. Hence the insulating film 860 is formed in order that the upper parts of electrodes comprised by neighboring TFDs or wiring (in Fig. 14, the second conductive film 853) also act as pixel electrodes.

**[0106]** After the insulating film 860 is formed, contact holes for connection to the second conductive film 853 are opened in the insulating film 860, and a conductive layer 870 is formed for electrical connection to the second conductive film 853.

**[0107]** In order to obtain a semi-transmissive liquid crystal display device which also utilizes reflected light for display, this conductive layer 870 should be formed from aluminum (Al) or other material with as high an optical reflectivity as possible. Also, though not shown in the figure, a diffused reflective surface, having fine protrusions and depressions, is formed in the surface of the conductive layer 870 in order that the display quality be more satisfactory when utilizing reflected light for display.

**[0108]** Also, slits 872 are formed in the conductive layer 870, in order that light is partially transmitted. These slits 872 are formed in the process of patterning the conductive layer 870.

**[0109]** The shape which imparts translucence to the conductive layer 870 is not limited to slits, and may be

any shape, so long as there is partial removal of the conductive layer 870. Also, the area of partial removal of the conductive layer 870 is determined according to the value to be set for the transmittance for light passing through pixel regions (light from the backlight).

[0110] Next, as shown in Fig. 15, an insulating film 880 is formed in a shape running along the outside of the conductive layer 870. This insulating film 880 is formed in the boundary portions between pixels so as to function as the black matrix and as a bank.

[0111] Conductive inks are then discharged by the ink jet method into each pixel, dried and hardened to form the conductive colored layers 806 through 808, completing the active matrix substrate 810' comprised by a semi-transmissive liquid crystal display device.

[0112] Next, an alignment film 822 is formed on the active matrix substrate 810' and subjected to rubbing processing, similarly to Fig. 12. Scan lines 818 are provided on the transparent opposing substrate 817, on top of which an alignment film 821 is formed and subjected to rubbing processing; the active matrix substrate 810' and opposing substrate 817 are placed facing each other, and liquid crystals 819 are enclosed between them to form the liquid crystal display device 800'.

[0113] A polarizer, not shown, is provided on the outside of the opposing substrate 817. Because this modification concerns a semi-transmissive liquid crystal display device, a backlight 890 is added.

[0114] Although not shown, if slits are not formed in the conductive layer 870, a reflective-type liquid crystal display device can be obtained.

## 5. Electronic Equipment

[0115] Fig. 16 is a perspective view of a notebook-type personal computer, which is electronic equipment manufactured by the manufacturing method of the first embodiment of this invention. This personal computer 500 employs the above color liquid crystal display device as the display unit, so that there are the advantages of an expanded range of materials for selection, and higher production yields.

[0116] As shown in the figure, the liquid crystal display device 300 is housed in a case 510, configured such that the display area of the liquid crystal display device 300 is exposed from an aperture 511 formed in the case 510. The personal computer 500 comprises a keyboard 530 as an input unit.

[0117] This personal computer 500 comprises, in addition to the liquid crystal display device 300, a display signal generation unit, which comprises a display information output source, display information processing circuit, clock generation circuit and other circuits, as well as a power supply circuit to supply power to these circuits. A display image is formed by supplying display signals, generated by the display signal generation unit based on information input from the input unit 530, for example, to the liquid crystal display device 300.

[0118] The electronic equipment incorporating an electro-optical device of this embodiment is not limited to a personal computer, but may include various other electronic equipment, including portable telephone sets, PDAs (personal digital assistants), pagers, POS terminals, IC cards, mini-disc players, liquid crystal projectors, engineering workstations (EWS), word processors, television sets, videotape recorders with viewfinders or direct-view monitors, electronic calculators, car navigation equipment, devices comprising touch panels, clocks, and game equipment.

[0119] By this invention, a method of manufacture of an active matrix substrate and a method of manufacture of a liquid crystal display device using this substrate can be provided, in which complexity can be avoided in the manufacturing process, the range for selection of materials can be expanded, and which affords high manufacturing yields.

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## Claims

1. A method of manufacture of an active matrix substrate (210), in which active elements (202) are formed in a matrix, comprising  
depositing an insulating film (220) to a prescribed height over portions of said active elements (202) so that said insulating film (220) surrounds pixel areas over which said insulating film (220) is not deposited; and  
depositing a conductive colored layer (206-208) acting both as a pixel electrode layer and as a color filter layer over said pixel areas to a predetermined height, so as to form pixel electrodes to be electrically connected to said active elements (202); wherein  
said step of depositing a conductive colored layer (206-208) includes using an ink jet method to discharge ink in which color material and conductive material are intermixed onto said pixel areas.
2. The method of manufacture of an active matrix substrate (210) according to claim 1, wherein said insulating film (220) constitutes a black matrix and is deposited at positions covering the electrodes (203, 204) of each of said active elements (202) other than a single electrode (209) which is electrically connected to said conductive colored layers (206-208).
3. The method of manufacture of an active matrix substrate (210) according to claim 1, wherein a reflective-type active matrix substrate (410) is manufactured by executing said process to discharge said ink after forming a reflective layer (412) with optical reflectivity in the positions in which said conductive colored layer (406-408) is formed.
4. The method of manufacture of an active matrix substrate (210) according to claim 3, wherein a semi-

transmissive active matrix substrate (610) is manufactured by forming, on said reflective layer (651), a gap (652) to transmit light in the layer thickness direction.

5. The method of manufacture of an active matrix substrate (410) according to claim 3 or claim 4, wherein a first insulating layer (405) is formed at positions covering the electrodes (403, 404) of each of said active elements (202) other than a single electrode (409) which is electrically connected to said conductive colored layer (206-208);  
10 said reflective layer (412), electrically connecting said conductive colored layer (206-208) to said single electrode (409) of each active element, and said insulating film (220) constituting a black matrix, are formed on said first insulating layer (405); and said process to discharge said ink is then executed.

6. The method of manufacture of an active matrix substrate (410) according to claim 5, wherein  
15 said first insulating layer (405) is formed in positions covering the entire surface of said active elements (202), and  
said reflective layer (412) is electrically connected to said single electrode (409) of each active element (202) via contact holes formed in said first insulating layer (405) at positions corresponding to said single electrodes (409).

7. The method of manufacture of an active matrix substrate (210) according to any of claim 1 through claim  
20 6, wherein the pixel electrodes (206-208) formed by discharge of said ink have at least three colors.

8. The method of manufacture of an active matrix substrate (210) according to any of claim 1 through claim  
25 7, wherein said active elements (202) are thin film transistors (TFTs).

9. The method of manufacture of an active matrix substrate (210) according to any of claim 1 through claim  
30 7, wherein said active elements (202) are thin film diodes (TFDs).

10. A method of manufacture of a liquid crystal display device (200), wherein liquid crystals (219) are enclosed between an active matrix substrate (210) manufactured by the method of any of claim 1 through claim 9, and an opposing substrate (217) positioned in opposition to said active matrix substrate (210).

11. A method of manufacture of electronic equipment, wherein a liquid crystal display device (200) manufactured by the method of claim 10 is employed as the display means.

5. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210), in welchem aktive Elemente (202) in einer Matrix ausgebildet sind, umfassend:

Auftragen eines Isolierfilms (220) bis zu einer vorgegebenen Höhe über Abschnitte der aktiven Elemente (202), derart dass der Isolierfilm (220) Pixelbereiche umgibt, über welche der Isolierfilm (220) nicht aufgetragen ist; und Auftragen einer leitenden Farbschicht (206-208), die sowohl als eine Pixelelektroden-schicht als auch als eine Farbfilterschicht agiert, über die Pixelbereiche bis zu einer vorbestimmten Höhe, um Pixelelektroden zu bilden, die mit den aktiven Elementen (202) elektrisch zu verbinden sind; wobei  
Der Schritt des Auftragens einer leitenden Farbschicht (206-208) das Verwenden eines Tintenstrahlverfahrens umfasst, um Tinte, in welcher Farbmateriale und leitendes Material vermischt sind, auf die Pixelbereiche zu entladen.

2. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210) nach Anspruch 1, wobei der Isolierfilm (220) eine schwarze Matrix bildet und an Positionen aufgetragen wird, welche die Elektroden (203, 204) jedes der aktiven Elemente (202) außer einer einzelnen Elektrode (209), welche mit den leitenden Farbschichten (206-208) elektrisch verbunden ist, bedekken.

3. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210) nach Anspruch 1, wobei ein Aktivmatrixsubstrat (410) der Reflexionsart durch Ausführen des Prozesses, um die Tinte zu entladen, nach dem Bilden einer reflektierenden Schicht (412) mit optischem Reflexionsvermögen in den Positionen hergestellt wird, in welchen die leitende Farbschicht (406-408) ausgebildet ist.

4. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210) nach Anspruch 3, wobei ein halbdurchlässiges Aktivmatrixsubstrat (610) durch Bilden auf der reflektierenden Schicht (651) eines Spalts (652), um Licht in der Schichtdickenrichtung durchzulassen, hergestellt wird.

5. Verfahren zur Herstellung eines Aktivmatrixsubstrats (410) nach Anspruch 3 oder 4, wobei eine erste Isolierschicht (405) an Positionen gebildet wird, welche die Elektroden (403, 404) jedes der aktiven Elemente (202) außer einer einzelnen Elektrode (409), welche mit der leitenden Farbschicht (206-208) elektrisch verbunden ist, bedecken; die reflektierende Schicht (412), welche die leitende Farbschicht (206-208) mit der einzelnen Elektrode

(409) jedes aktiven Elements elektrisch verbindet, und der Isolierfilm (220), welcher eine schwarze Matrix bildet, auf der ersten Isolierschicht (405) gebildet werden; und  
der Prozess, um die Tinte zu entladen, anschließend ausgeführt wird.

6. Verfahren zur Herstellung eines Aktivmatrixsubstrats (410) nach Anspruch 5, wobei die erste Isolierschicht (405) in Positionen gebildet wird, welche die gesamte Oberfläche der aktiven Elemente (202) bedecken, und die reflektierende Schicht (412) mit der einzelnen Elektrode (409) jedes aktiven Elements (202) über Kontaktlöcher, die in der ersten Isolierschicht (405) an Positionen ausgebildet sind, welche den einzelnen Elektroden (409) entsprechen, elektrisch verbunden ist.
7. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210) nach einem der Ansprüche 1 bis 6, wobei die Pixelelektroden (206-208), welche durch Entladen der Tinte gebildet werden, wenigstens drei Farben aufweisen.
8. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210) nach einem der Ansprüche 1 bis 7, wobei die aktiven Elemente (202) Dünndfilmtransistoren (TFTs) sind.
9. Verfahren zur Herstellung eines Aktivmatrixsubstrats (210) nach einem der Ansprüche 1 bis 7, wobei die aktiven Elemente (202) Dünndfilmdioden (TFDs) sind.
10. Verfahren zur Herstellung einer Flüssigkristallanzeigeeinrichtung (200), wobei Flüssigkristalle (219) zwischen einem Aktivmatrixsubstrat (210), welches durch das Verfahren nach einem der Ansprüche 1 bis 9 hergestellt ist, und einem gegenüberliegenden Substrat (217), das in Gegenüberstellung zum Aktivmatrixsubstrat (210) positioniert ist, eingeschlossen werden.
11. Verfahren zur Herstellung von elektronischen Geräten, wobei eine Flüssigkristallanzeigeeinrichtung (200), welche durch das Verfahren von Anspruch 10 hergestellt ist, als das Anzeigemittel eingesetzt wird.

#### Revendications

1. Procédé de fabrication d'un substrat à matrice active (210), dans lequel des éléments actifs (202) sont formés dans une matrice, comprenant le dépôt d'un film isolant (220) en un poids prescrit sur des parties desdits éléments actifs (202) de manière à ce que ledit film isolant (220) entoure les zo-

nes de pixels sur lesquelles ledit film isolant (220) n'est pas déposé ; et  
le dépôt d'une couche colorée conductrice (206-208) faisant office à la fois de couche d'électrode de pixels et de couche de filtre couleur sur lesdites zones de pixels en un poids prédéterminé de manière à former des électrodes de pixels à connecter électriquement auxdits éléments actifs (202) ; dans lequel ladite étape de dépôt d'une couche colorée conductrice (206-208) englobe l'utilisation d'un procédé de jet d'encre pour décharger de l'encre dans laquelle sont mélées de la couleur et de la matière conductrice sur lesdites zones de pixels.

15. 2. Procédé de fabrication d'un substrat à matrice active (210) selon la revendication 1, dans lequel ledit film isolant (220) constitue une matrice noire et est déposé à des endroits couvrant les électrodes (203, 204) de chacun desdits éléments actifs (202) autres qu'une unique électrode (209) qui est connectée électriquement auxdites couches colorées conductrices (206-208).
20. 3. Procédé de fabrication d'un substrat à matrice active (210) selon la revendication 1, dans lequel un substrat à matrice active de type réflectif (410) est fabriqué en exécutant ledit processus pour décharger ladite encre après la formation d'une couche réflective (412) à réflectivité optique aux endroits où ladite couche colorée conductrice (406-408) est formée.
25. 4. Procédé de fabrication d'un substrat à matrice active (210) selon la revendication 3, dans lequel un substrat à matrice actif semi-transmissif (610) est fabriqué en formant, sur ladite couche réflective (651), un intervalle (652) pour transmettre de la lumière dans le sens de l'épaisseur de la couche.
30. 5. Procédé de fabrication d'un substrat à matrice active (410) selon la revendication 3 ou 4, dans lequel une première couche isolante (405) est formée aux endroits couvrant les électrodes (403, 404) de chacun desdits éléments actifs (202) autres qu'une unique électrode (409) qui est électriquement connectée à ladite couche colorée conductrice (206-208) ; ladite couche réflective (412) connectant électriquement ladite couche colorée conductrice (206-208) à ladite unique électrode (409) de chaque élément actif et ledit film isolant (220) constituant une matrice noire sont formées sur ladite première couche isolante (405) ; et  
ledit processus de décharge de ladite encre est ensuite exécuté.
35. 6. Procédé de fabrication d'un substrat à matrice active (410) selon la revendication 5, dans lequel ladite première couche isolante (405) est formée à des endroits couvrant la totalité de la surface desdits

éléments actifs (202) ; et  
ladite couche réflective (412) est connectée électri-  
quement à ladite unique électrode (409) de chaque  
élément actif (202) via des trous de contact pratiqués  
dans ladite première couche isolante (405) à des      5  
endroits correspondant auxdites électrodes uniques  
(409).

7. Procédé de fabrication d'un substrat à matrice active (210) selon l'une quelconque des revendications 1      10  
à 6, dans lequel les électrodes de pixels (206-208)  
formées par décharge de ladite encre ont au moins  
trois couleurs.
8. Procédé de fabrication d'un substrat à matrice active (210) selon l'une quelconque des revendications 1      15  
à 7, dans lequel lesdits éléments actifs (202) sont  
des transistors à film mince (TFT).
9. Procédé de fabrication d'un substrat à matrice active (210) selon l'une quelconque des revendications 1      20  
à 7, dans lequel lesdits éléments actifs (202) sont  
des diodes à film mince (TFD).
10. Procédé de fabrication d'un dispositif d'affichage à      25  
cristaux liquides (200), dans lequel les cristaux liqui-  
des (219) sont inclus entre un substrat à matrice ac-  
tive (210) fabriqués suivant le procédé de l'une quel-  
conque des revendications 1 à 9 et un substrat op-  
posé (217) positionné à l'opposé dudit substrat à ma-      30  
trice active (210).
11. Procédé de fabrication d'un équipement électroni-  
que, dans lequel un dispositif d'affichage à cristaux      35  
liquides (200) fabriqué suivant le procédé de la re-  
vendication 10 est employé comme moyen d'afficha-  
ge.

40

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50

55

Fig. 1

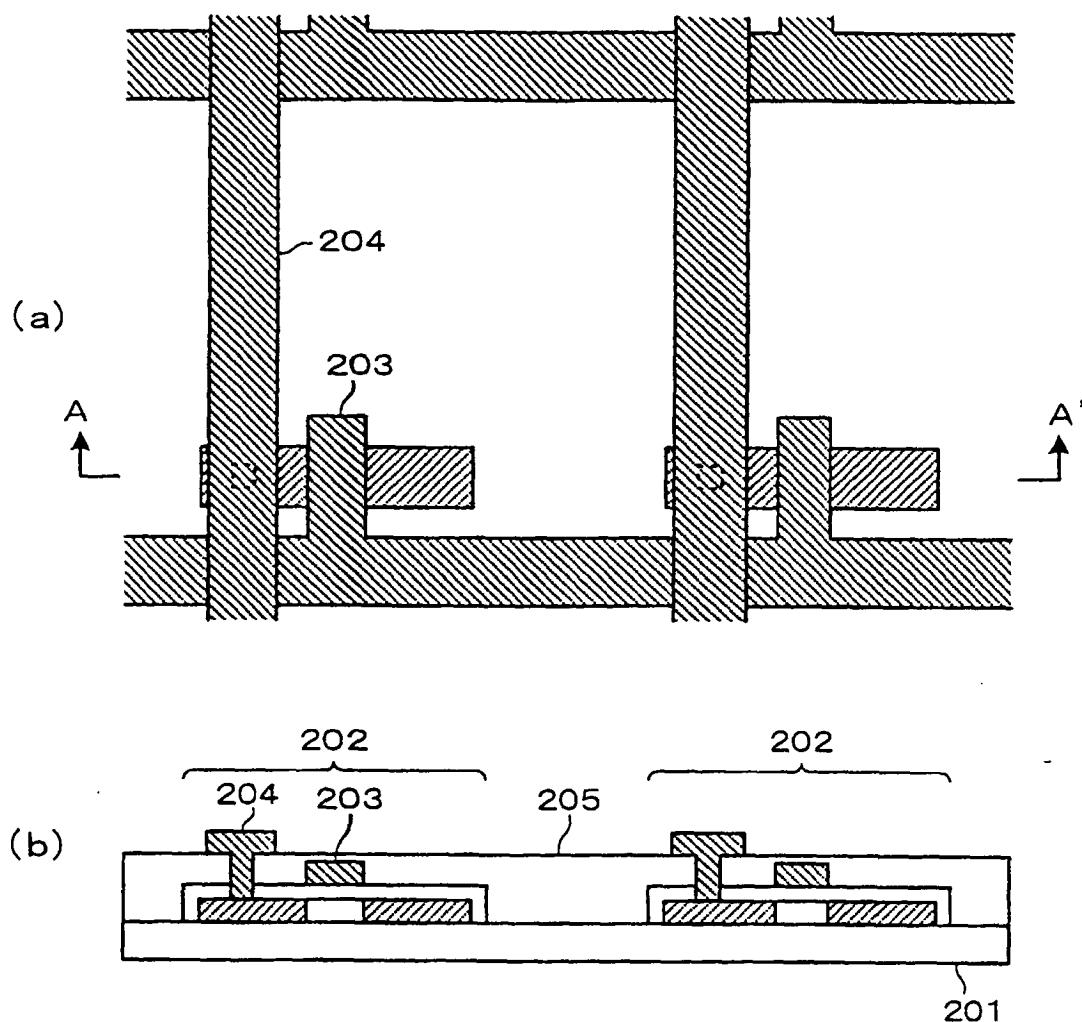


Fig. 2

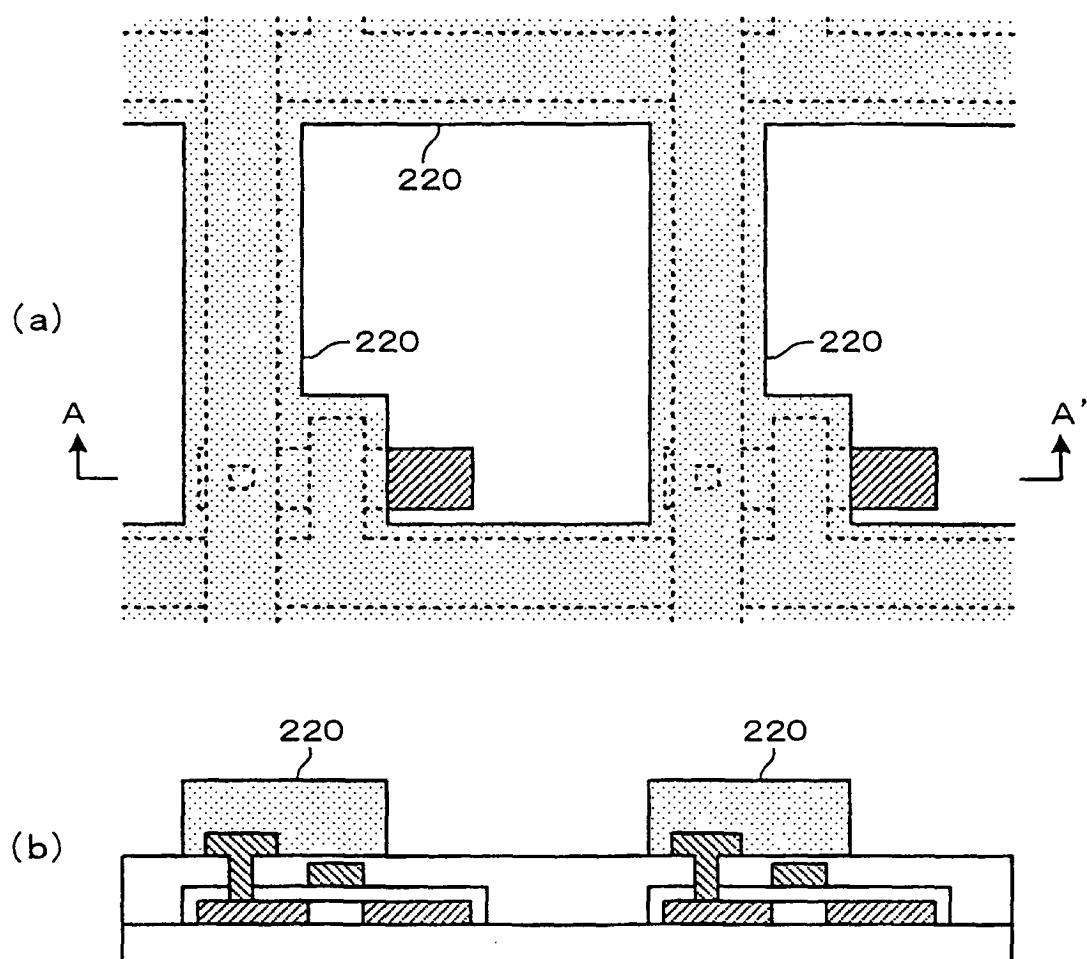


Fig. 3

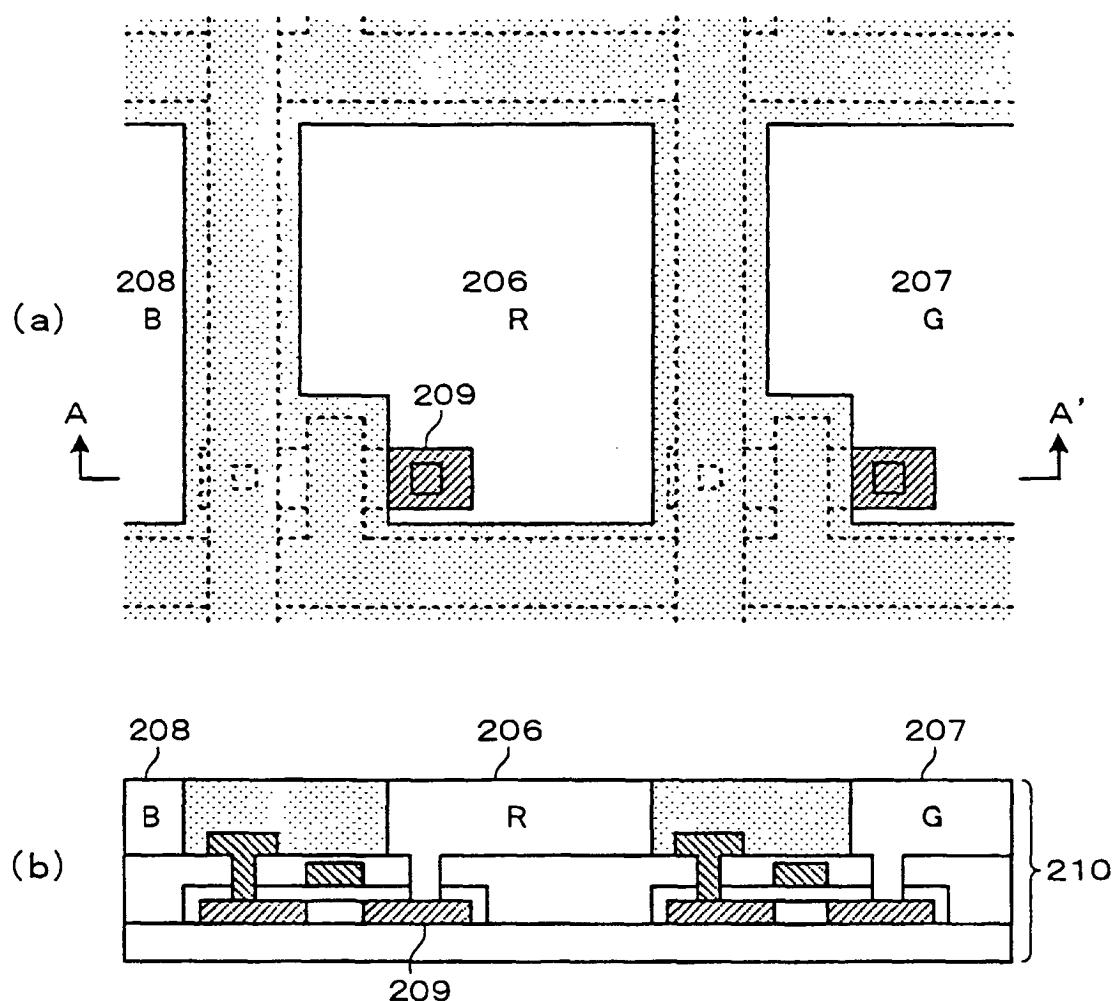


Fig. 4

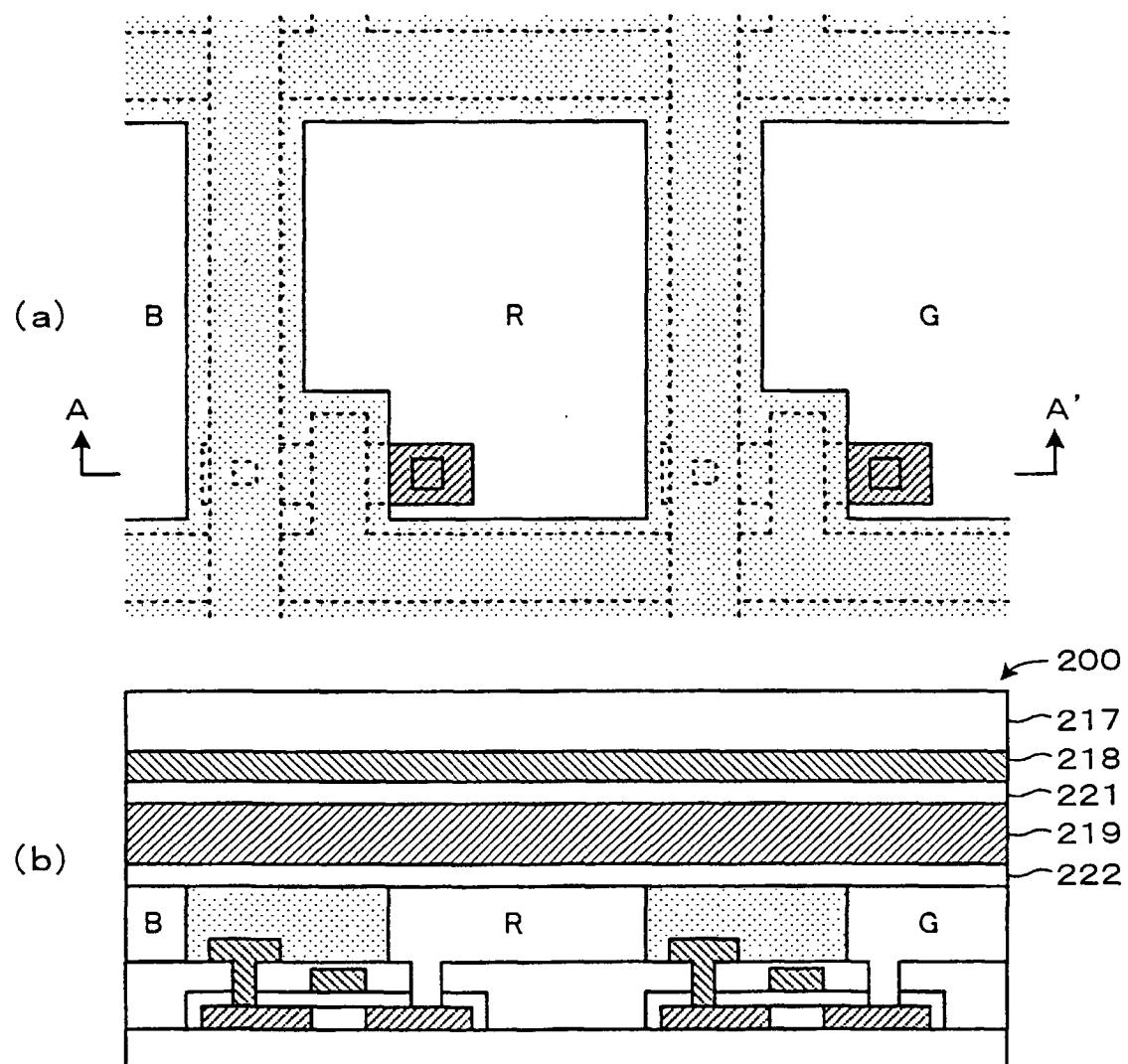


Fig. 5

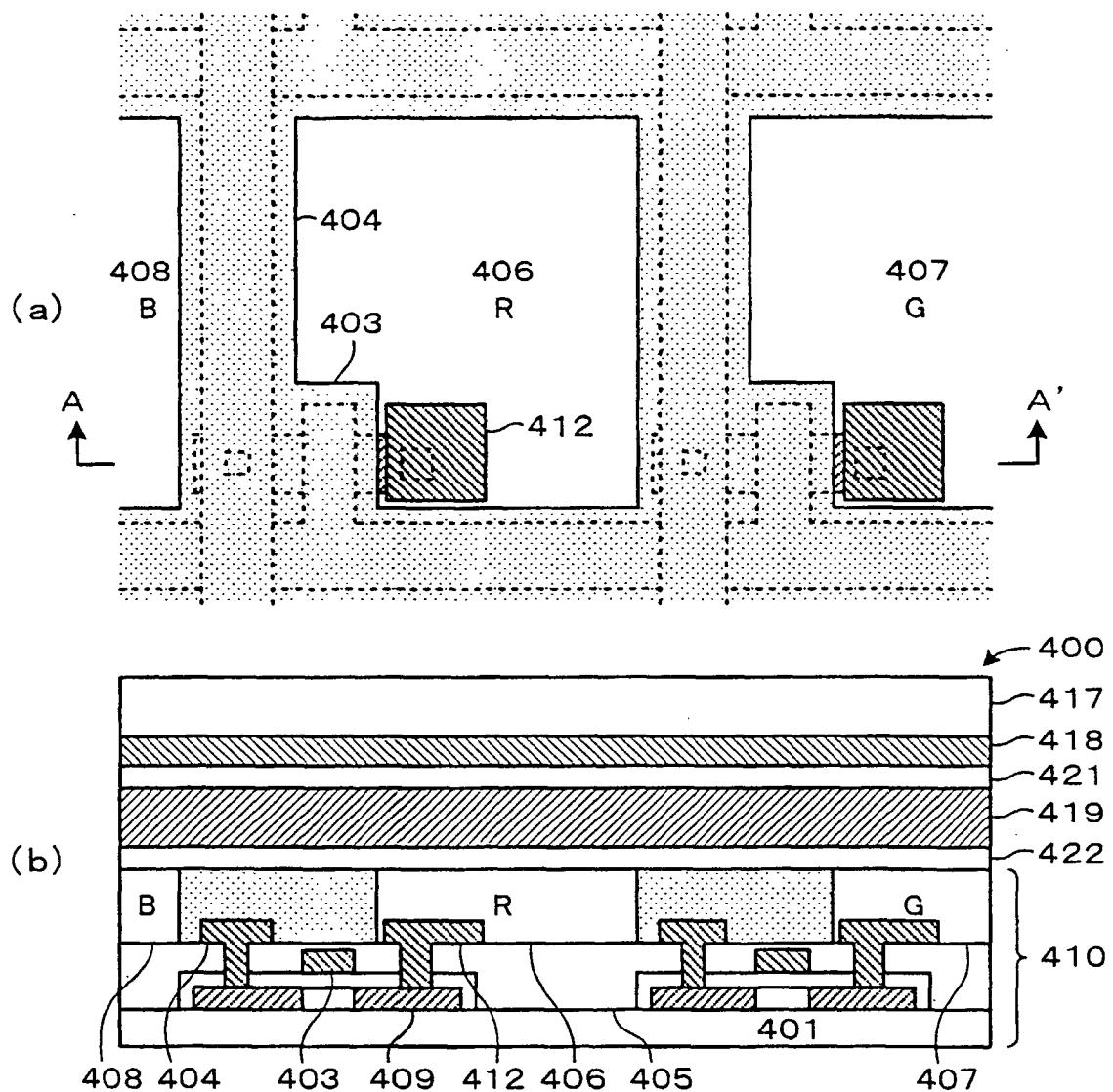


Fig. 6

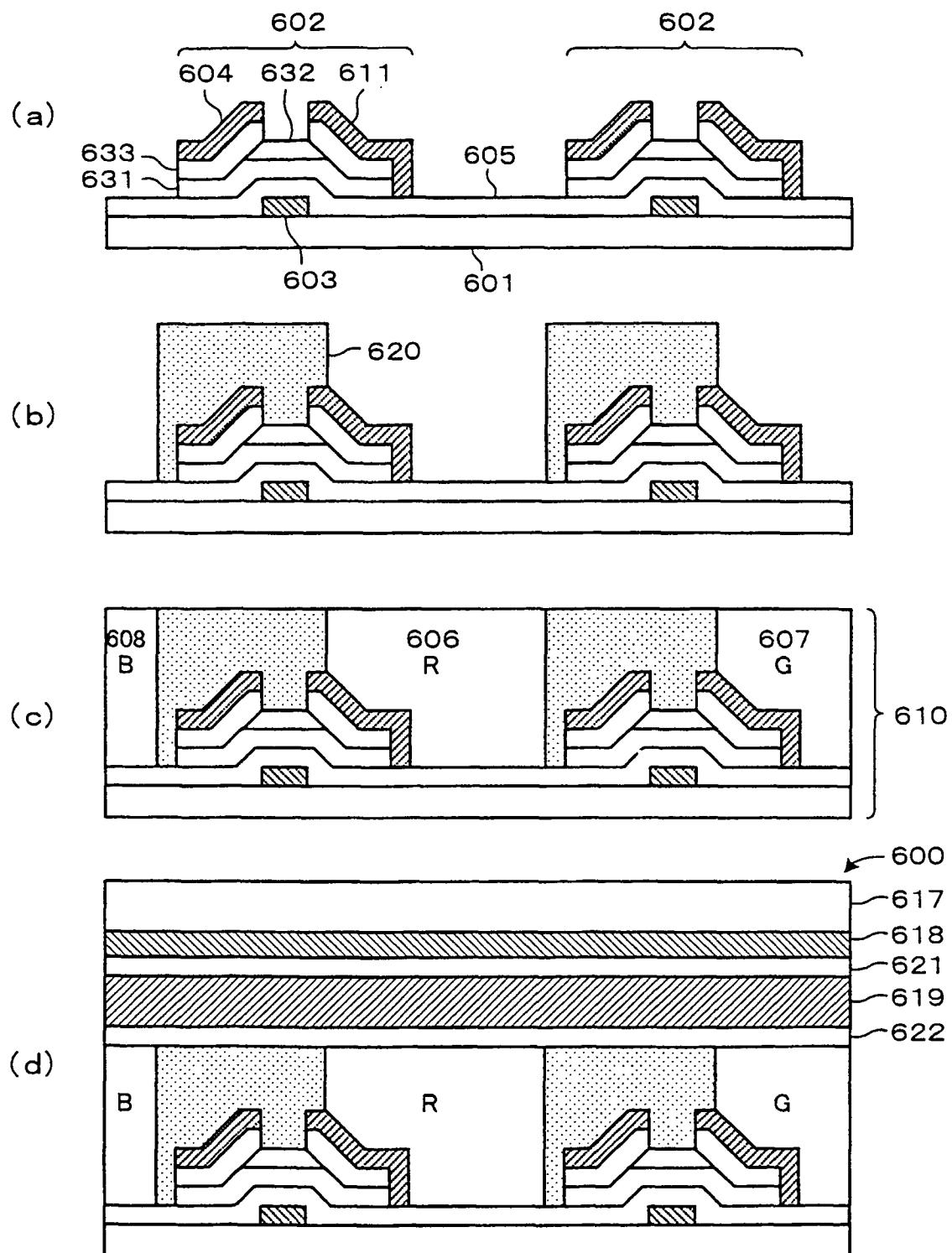


Fig. 7

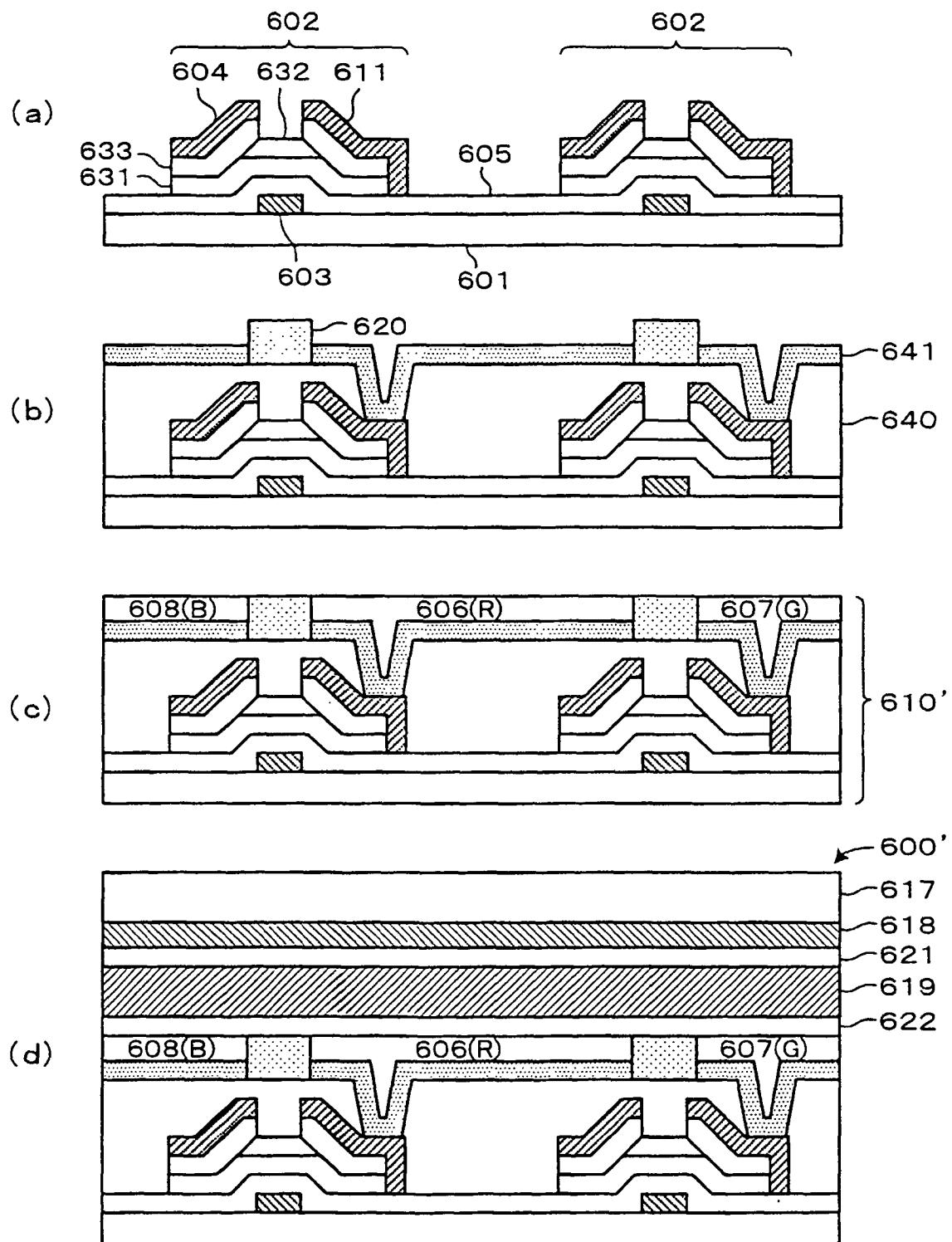


Fig. 8

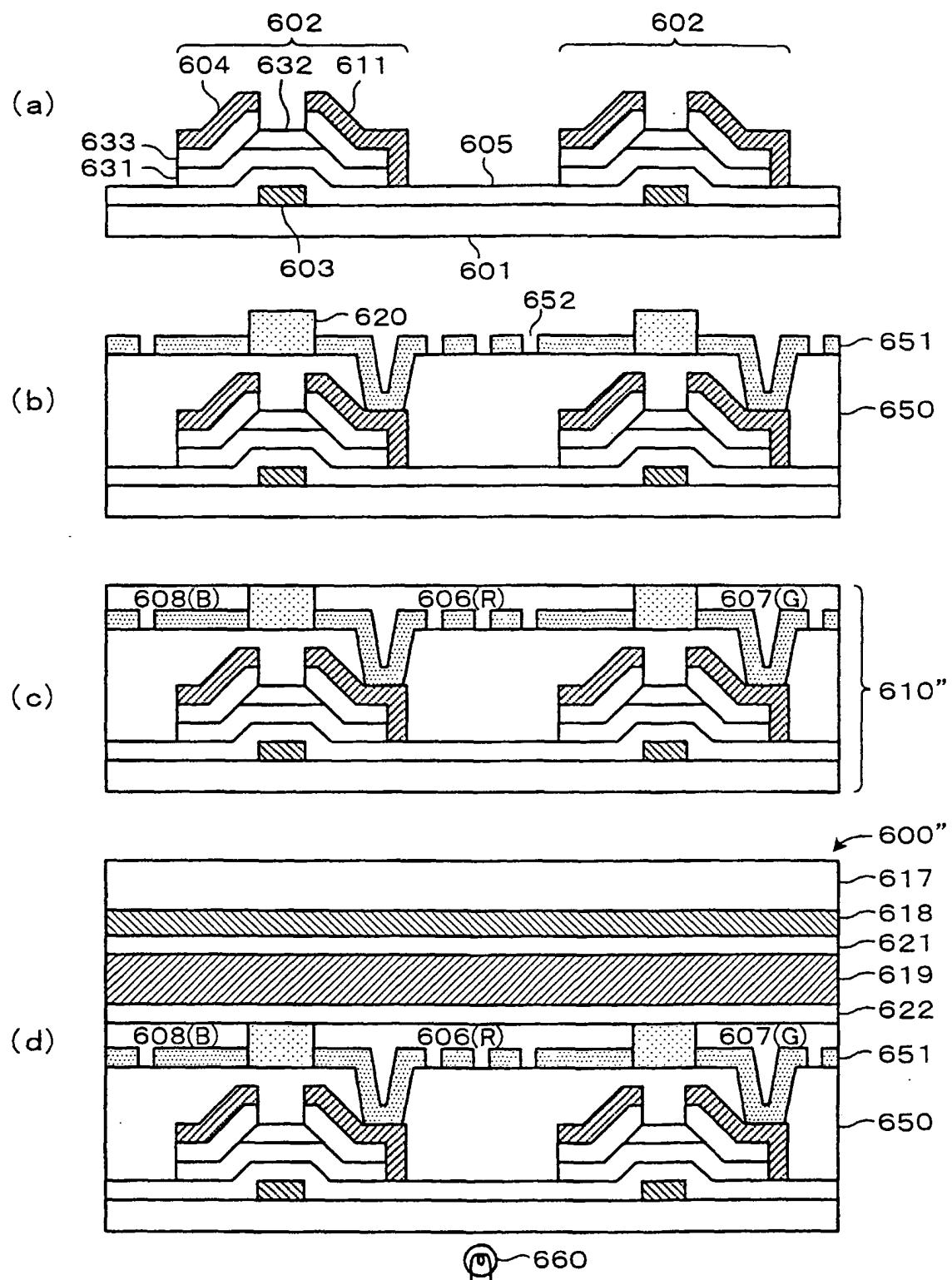


Fig. 9

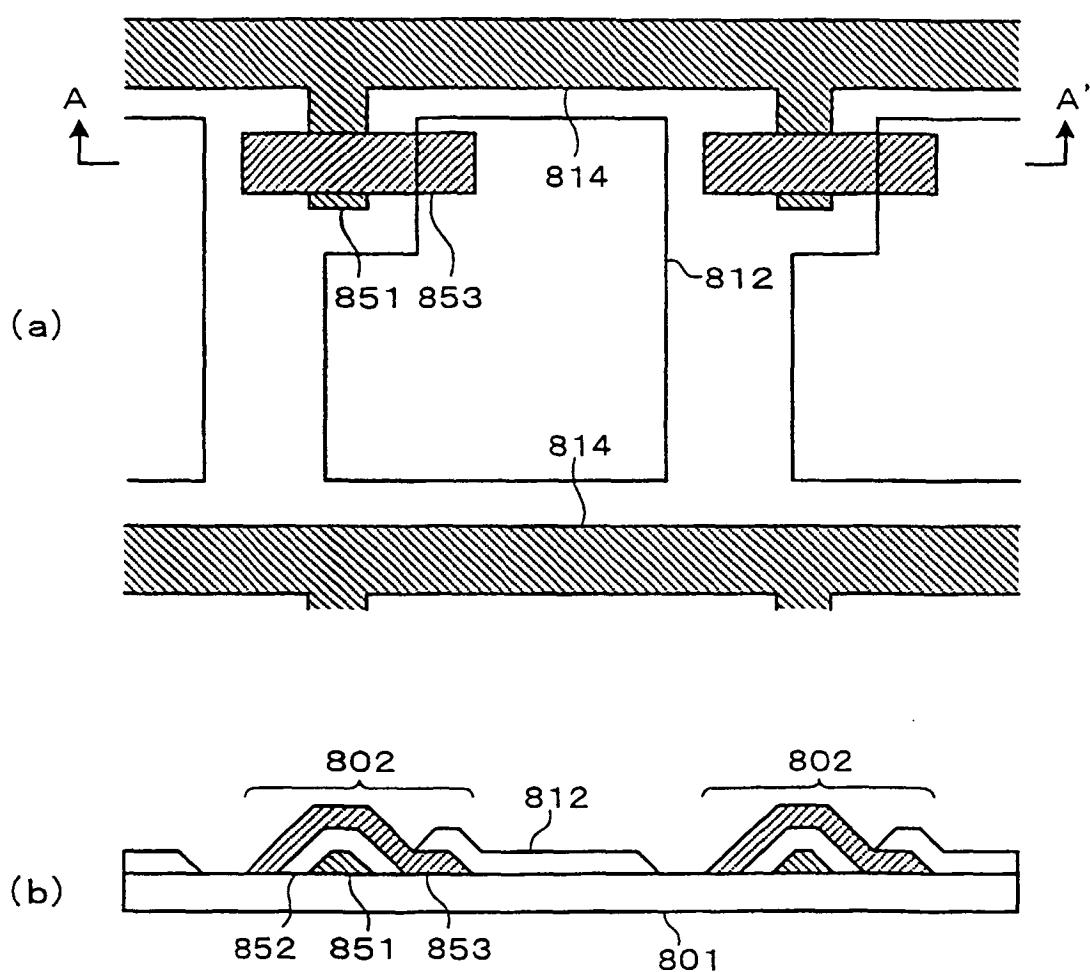


Fig. 10

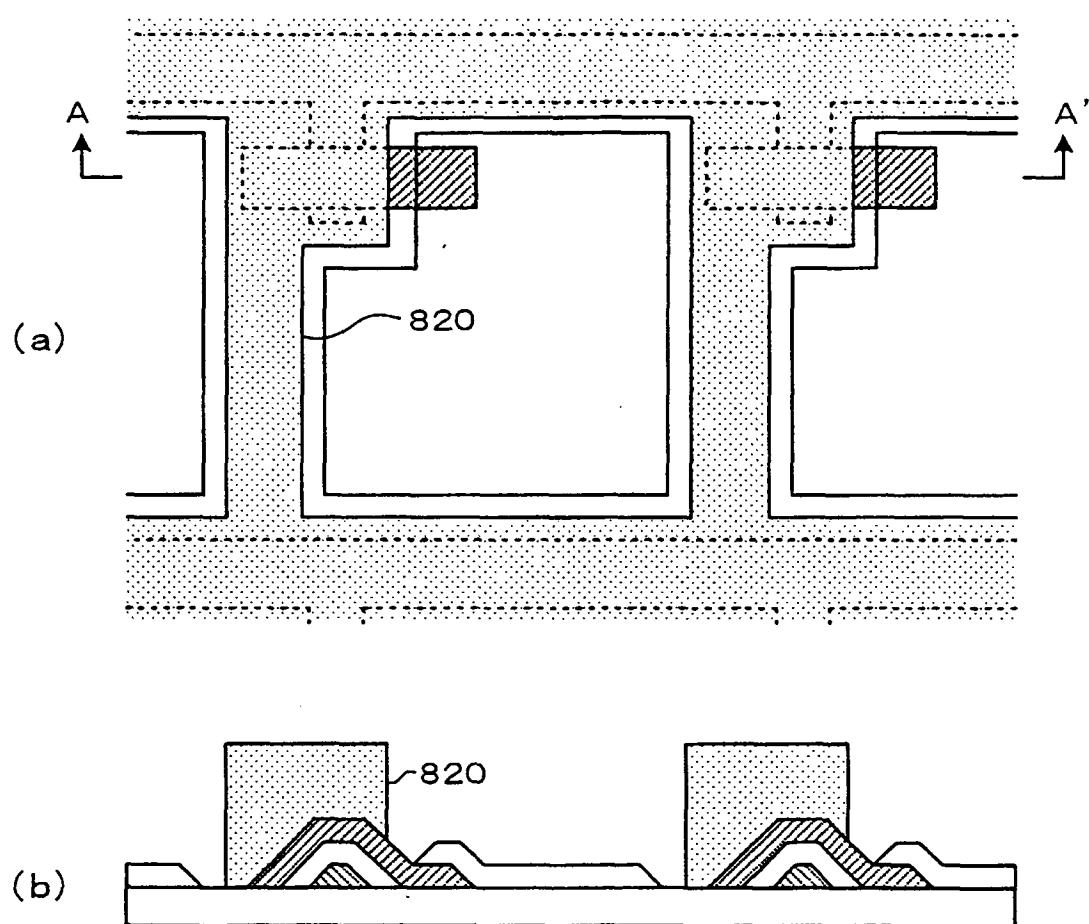


Fig. 11

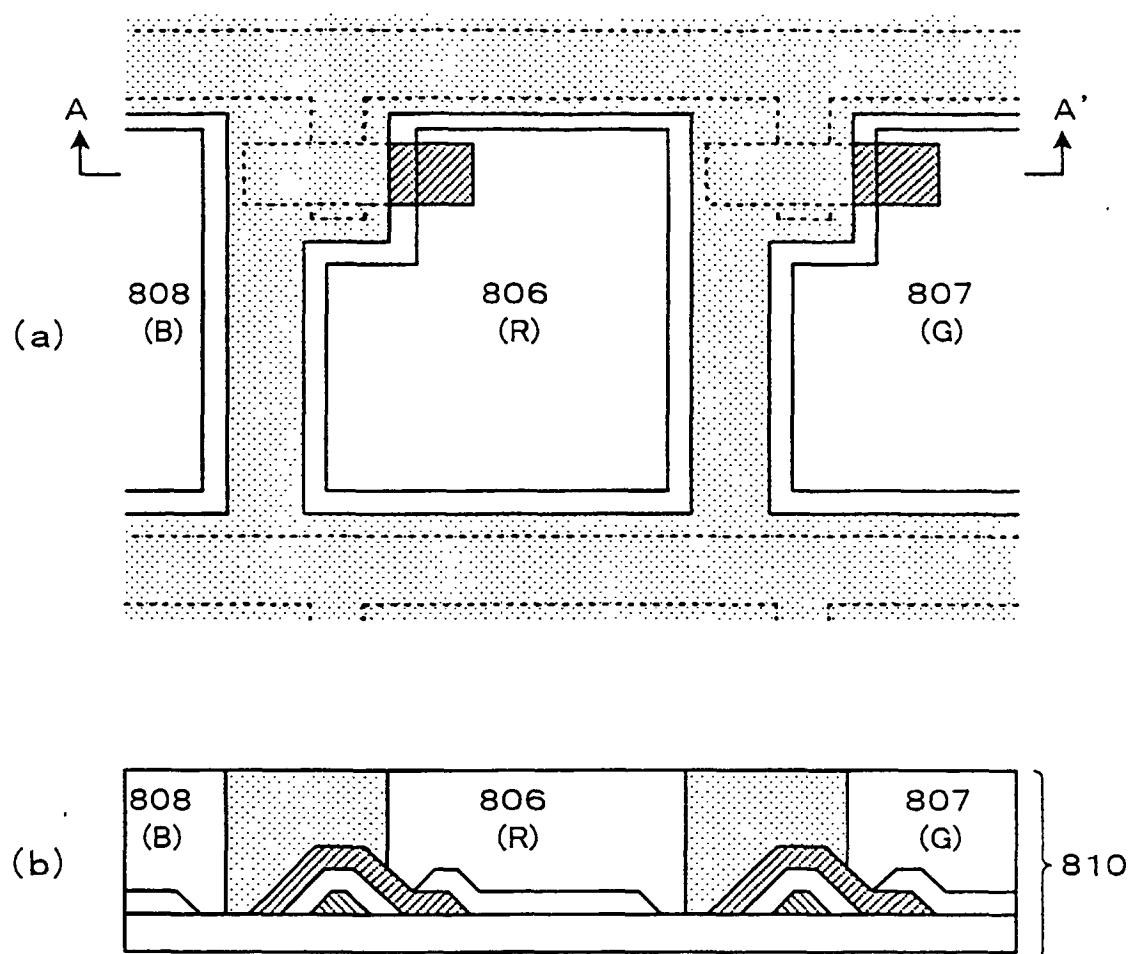


Fig. 12

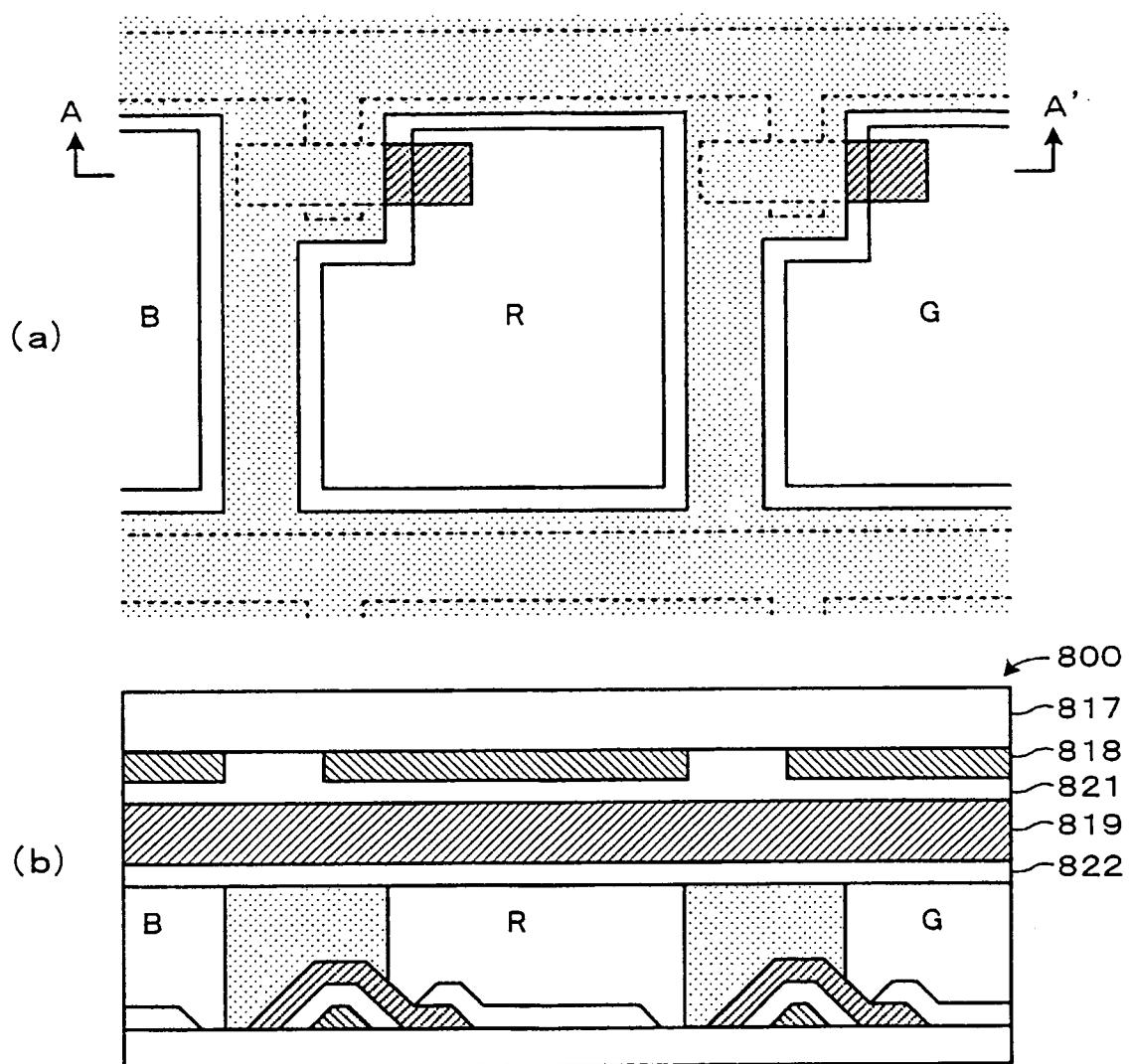


Fig. 13

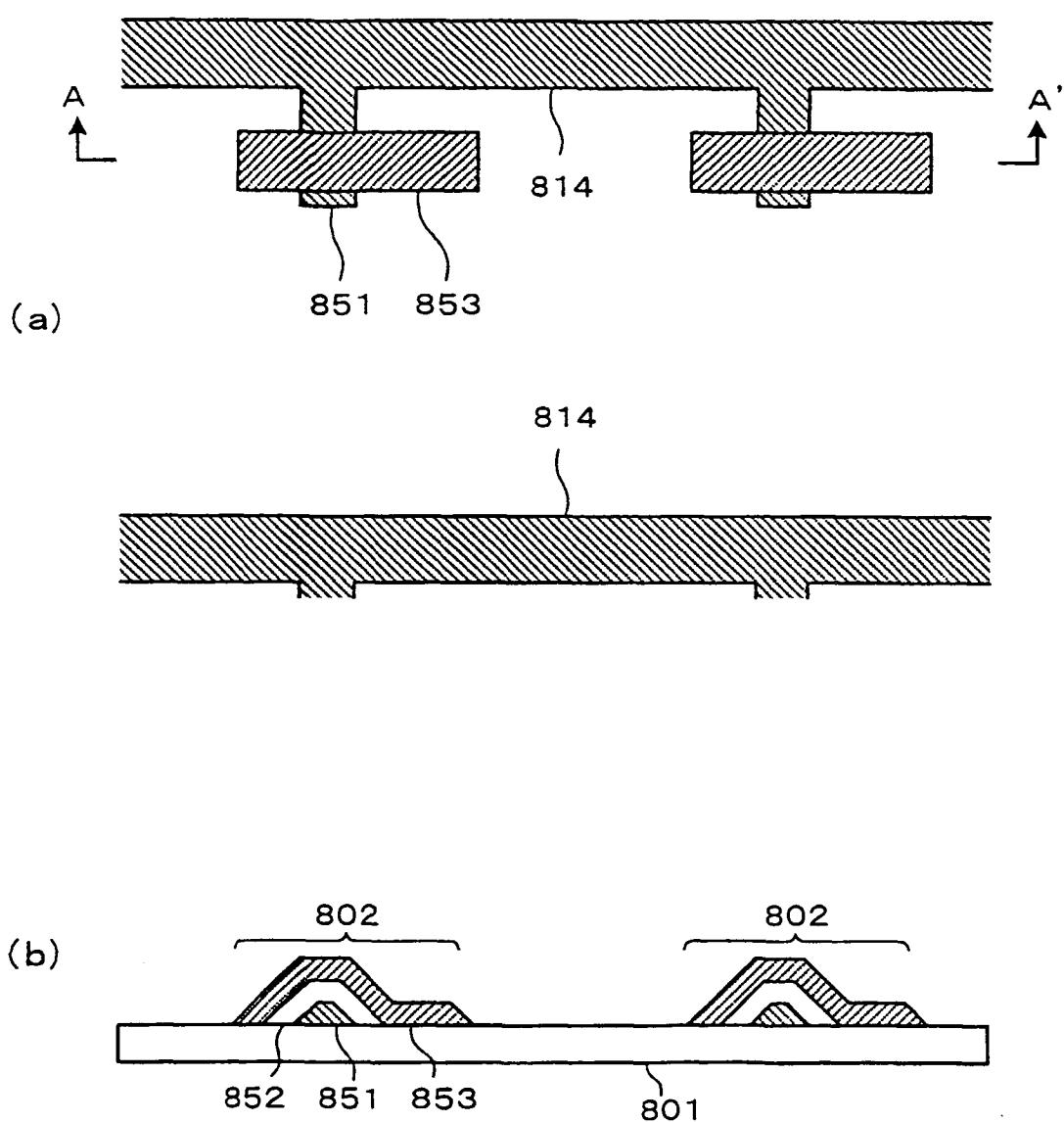


Fig. 14

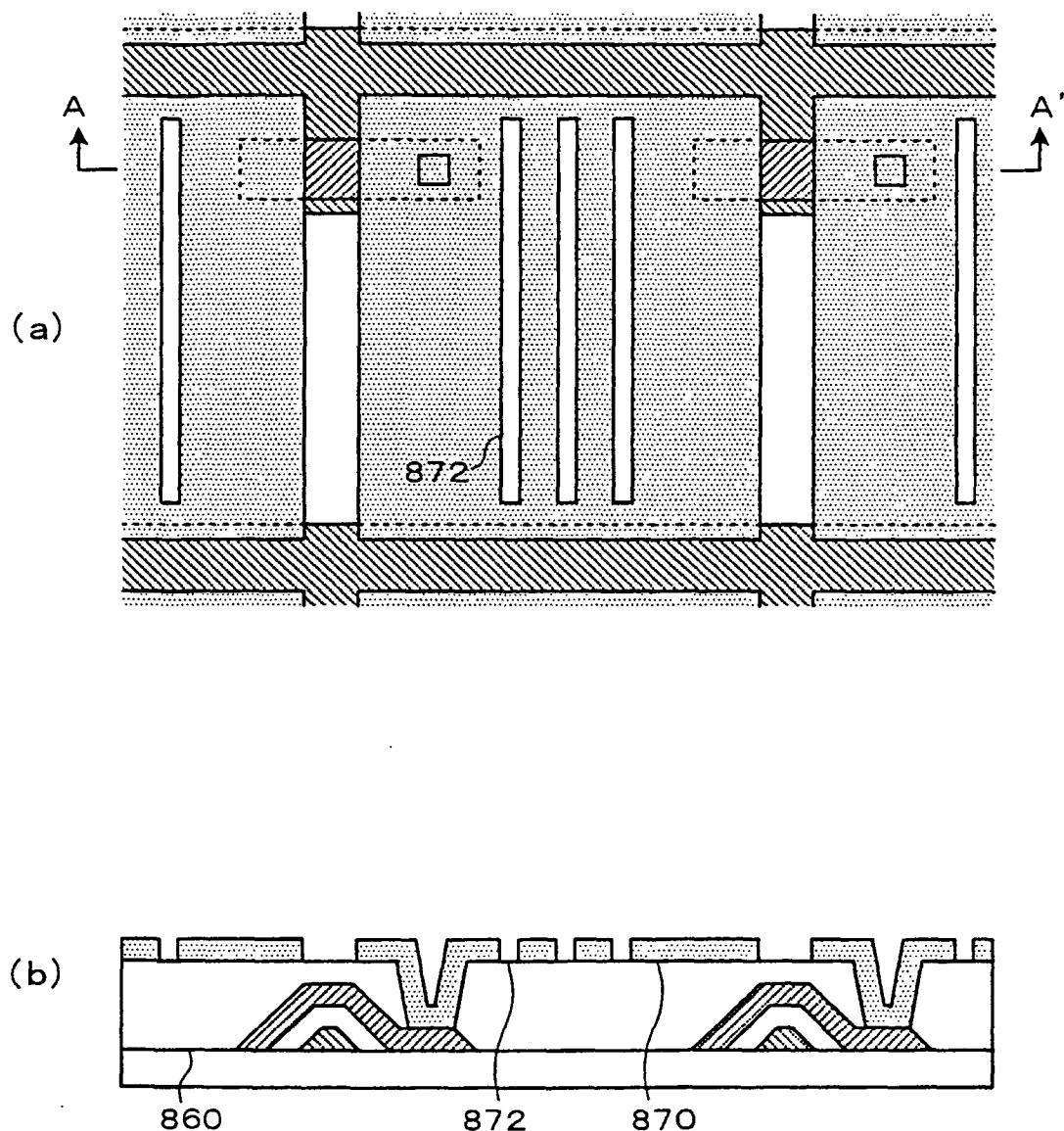


Fig. 15

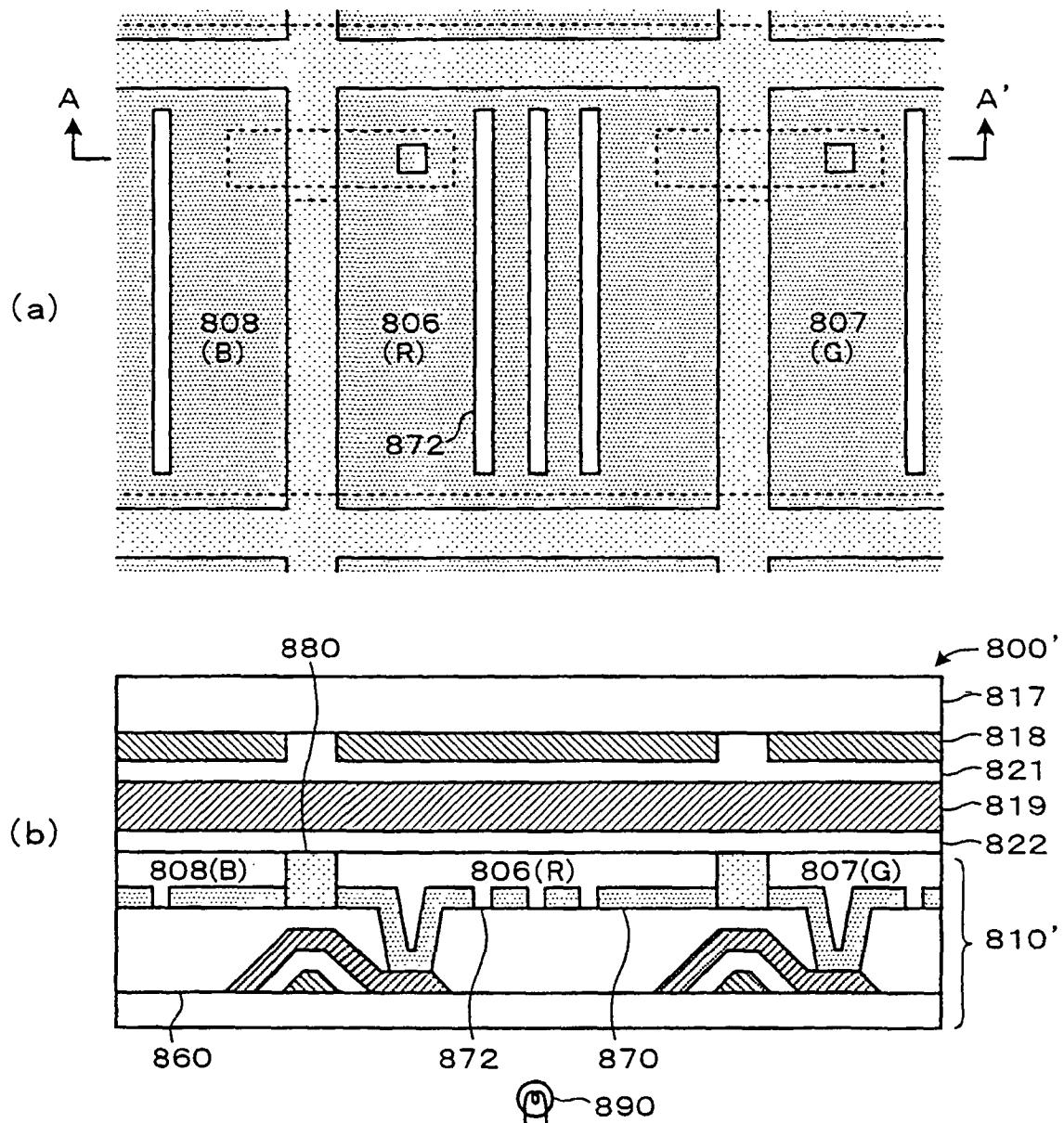
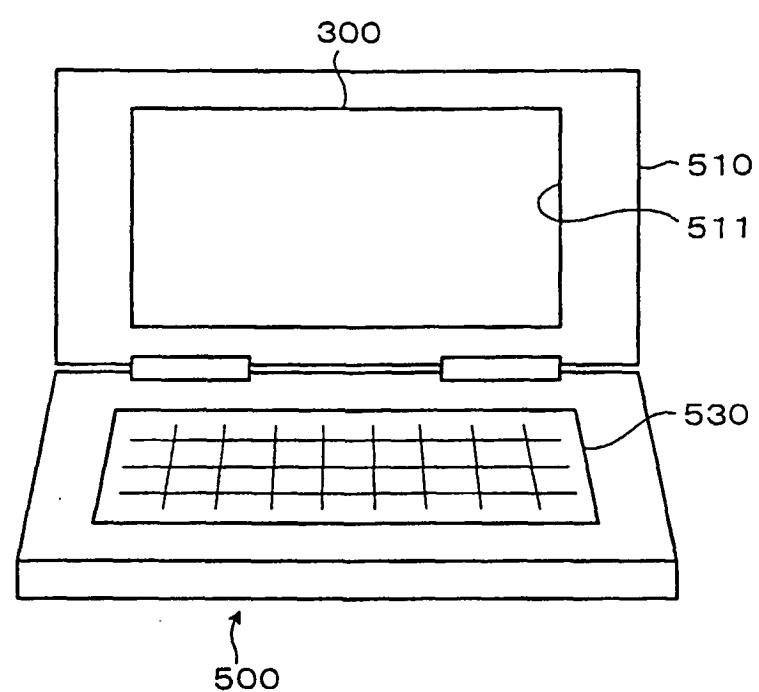


Fig. 16



专利名称(译)	制造有源矩阵基板的方法和液晶显示装置		
公开(公告)号	EP1331511B1	公开(公告)日	2006-06-07
申请号	EP2001976713	申请日	2001-10-17
[标]申请(专利权)人(译)	精工爱普生株式会社		
申请(专利权)人(译)	SEIKO EPSON CORPORATION		
当前申请(专利权)人(译)	SEIKO EPSON CORPORATION		
发明人	KIGUCHI, HIROSHI, C/O SEIKO EPSON CORP. KATAGAMI, SATORU, C/O SEIKO EPSON CORP KAWASE, TOMOMI, C/O SEIKO EPSON CORP. ARUGA, HISASHI, C/O SEIKO EPSON CORP. SHIMIZU, MASAHIRO, C/O SEIKO EPSON CORP.		
IPC分类号	G02F1/1343 G02F1/1368 G02F1/1335 B41J2/01 G02B5/20 G02F1/1362 G09F9/30 G09F9/35		
CPC分类号	G02F1/133514 G02F1/133516 G02F1/133553 G02F1/133555 G02F1/134336 G02F1/13439 G02F1/136209 G02F2001/136222		
代理机构(译)	斯特 , CLIFFORD MARK		
优先权	2000316957 2000-10-17 JP 2001318207 2001-10-16 JP		
其他公开文献	EP1331511A1 EP1331511A4		
外部链接	<a href="#">Espacenet</a>		

## 摘要(译)

一种有源矩阵基板的制造方法，其能够防止制造工艺的复杂性，扩大材料选择的范围并且允许高的制造产量，以及使用这种有源矩阵基板的液晶显示器的制造方法。用作像素电极和滤色器的导电着色层（606至608）通过喷墨方法将着色材料和导电材料的混合墨水排出到要电连接的像素电极的形成区域的过程而形成。到活动元素（602）。

Fig. 1

