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(54) PHOTO MASK FOR FABRICATING A THIN FILM TRANSISTOR LIQUID CRYSTAL DISPLAY

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(57) **ABSTRACT**

The present invention discloses a photo mask employing in a TFT—LCD fabrication using 4-mask process. The disclosed photo mask comprises a transparent substrate and a shielding pattern formed thereon, wherein the shielding pattern includes a pair of first shielding patterns of a box type disposed with separation to cover source and drain formation regions, a pair of second shielding patterns of a bar type disposed between the first shielding patterns and third shielding patterns of a bar type disposed on lower and upper portions of the first and the second shielding patterns to make a clear division between a light transmittance region and a light shielding region on the edge of a channel region.

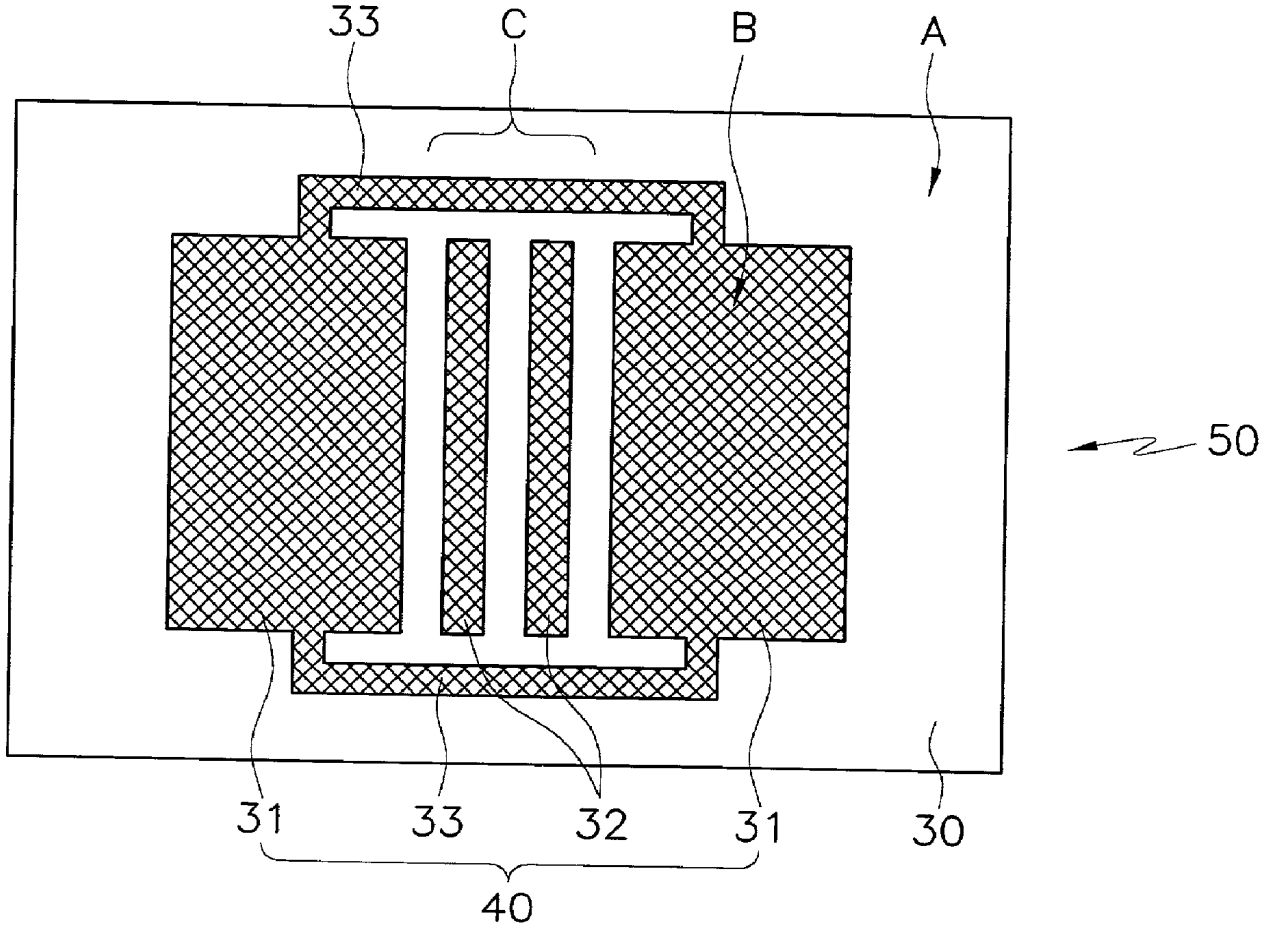

FIG. 1A
(PRIOR ART)

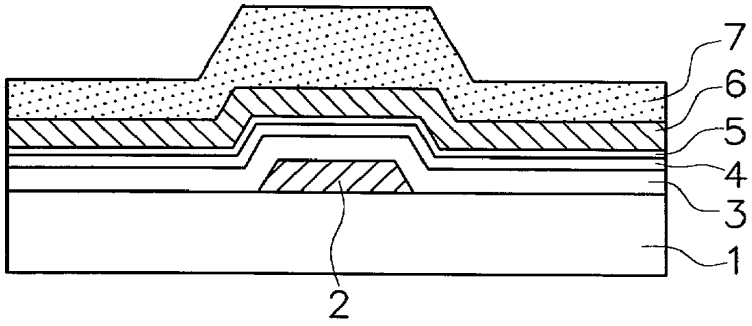

FIG. 1B
(PRIOR ART)

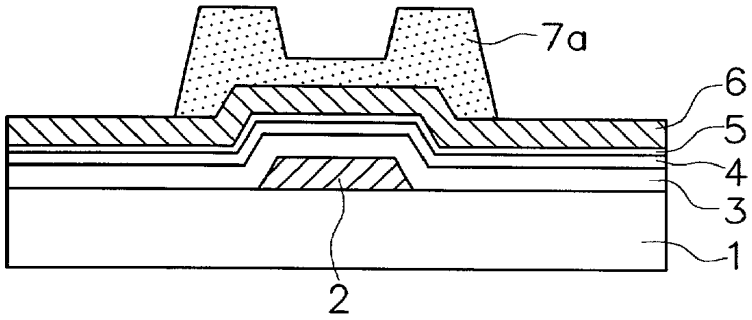

FIG. 1C
(PRIOR ART)

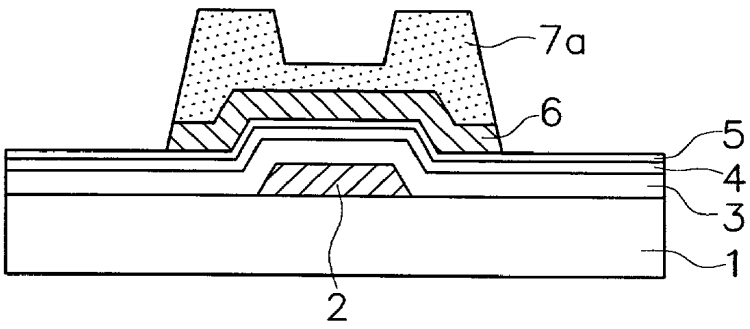

FIG. 1D
(PRIOR ART)

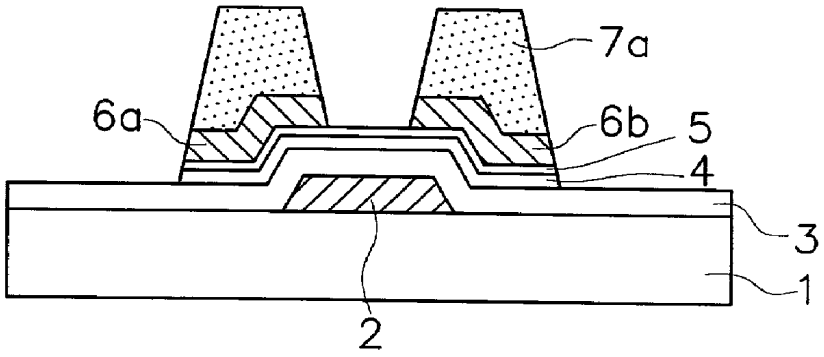

FIG. 1E
(PRIOR ART)

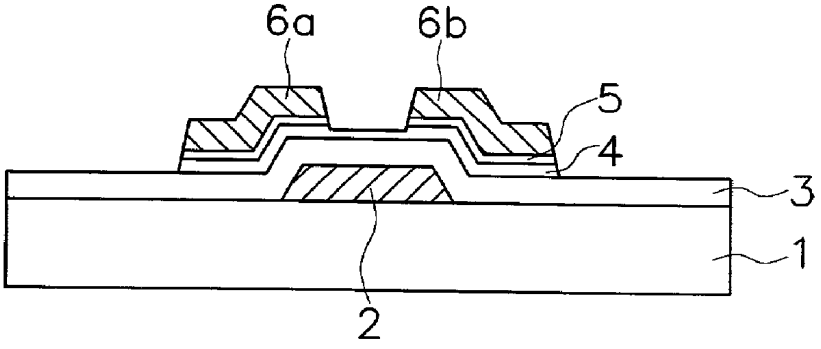

FIG.2A
(PRIOR ART)

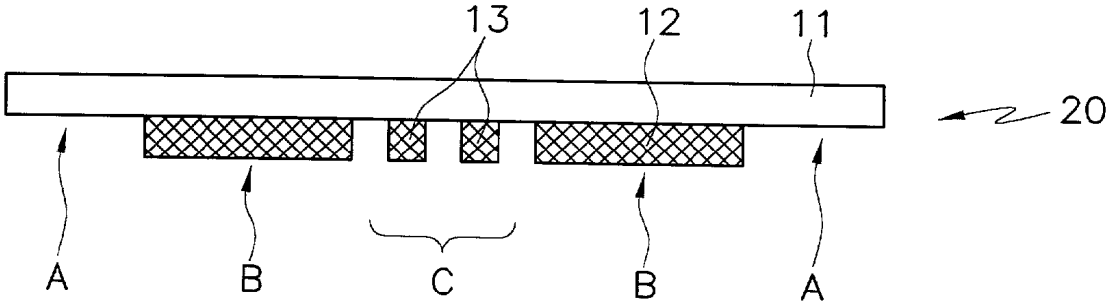

FIG.2B
(PRIOR ART)

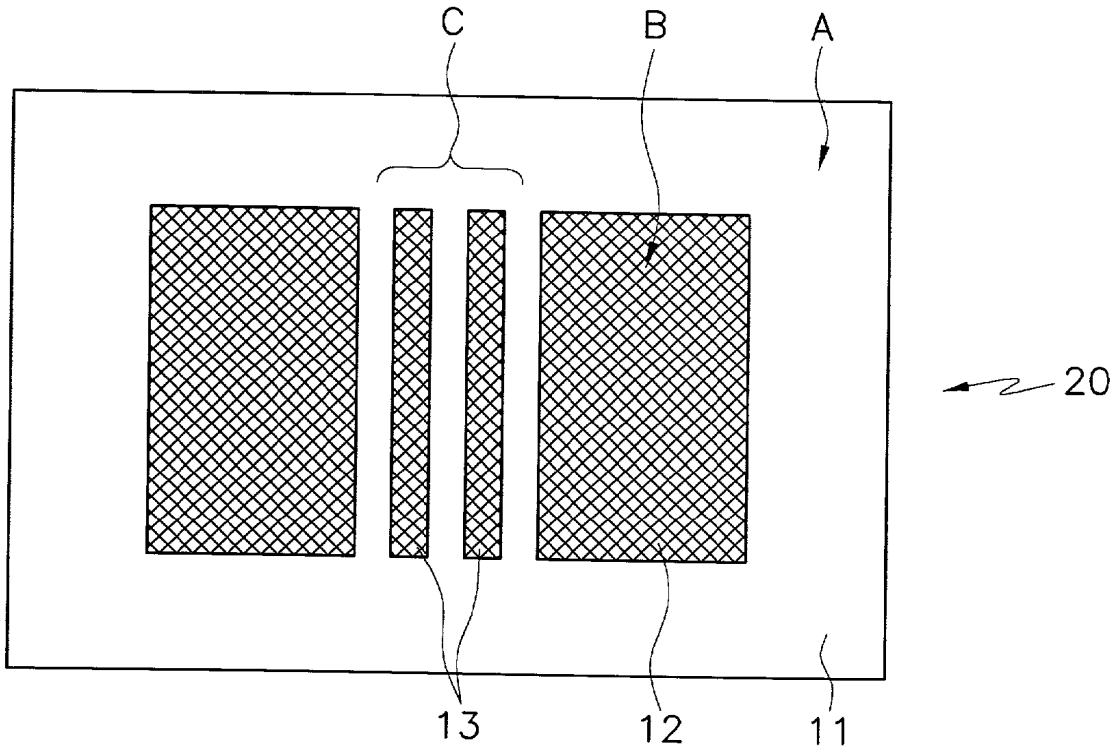

FIG.3

(PRIOR ART)

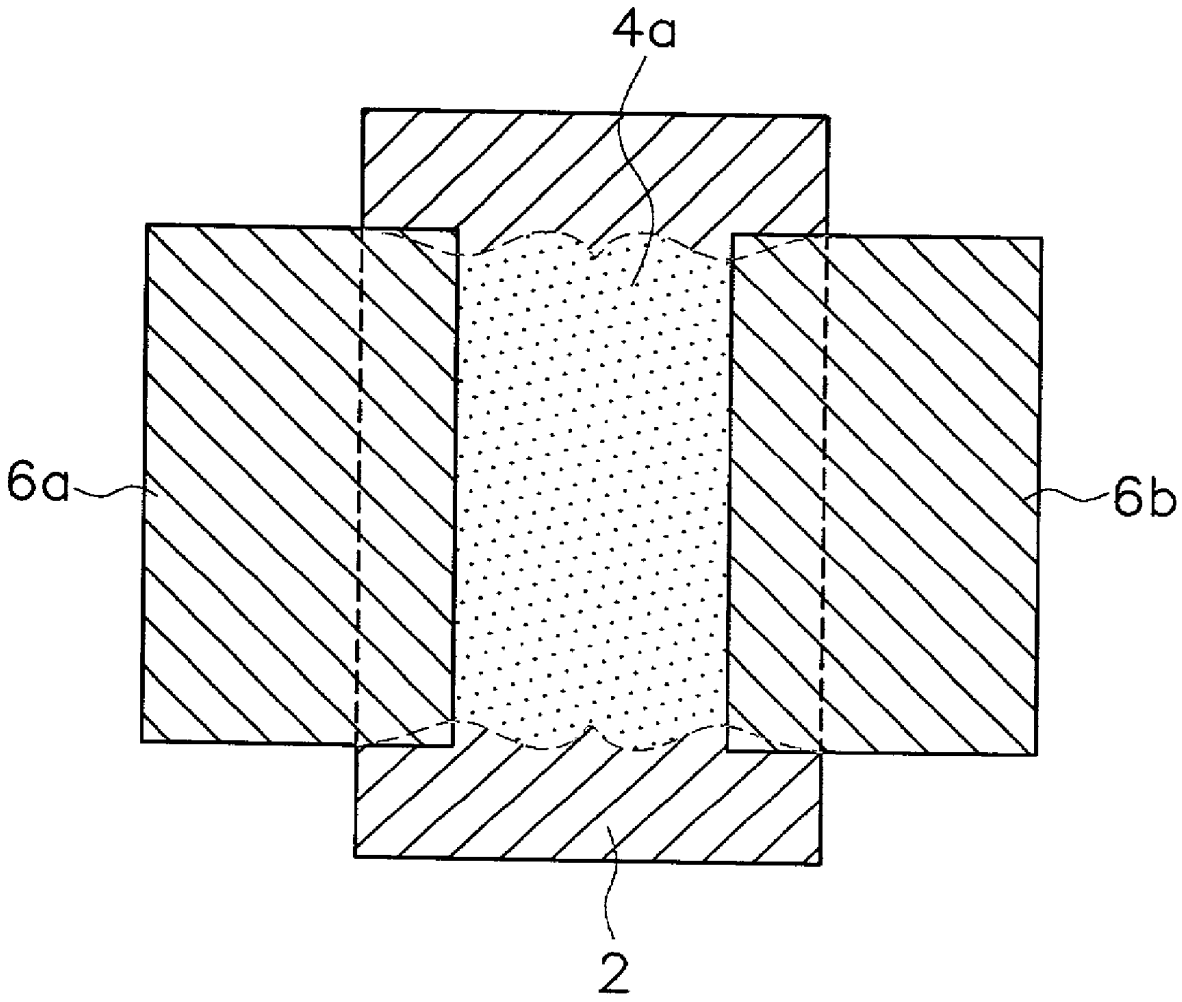

FIG.4

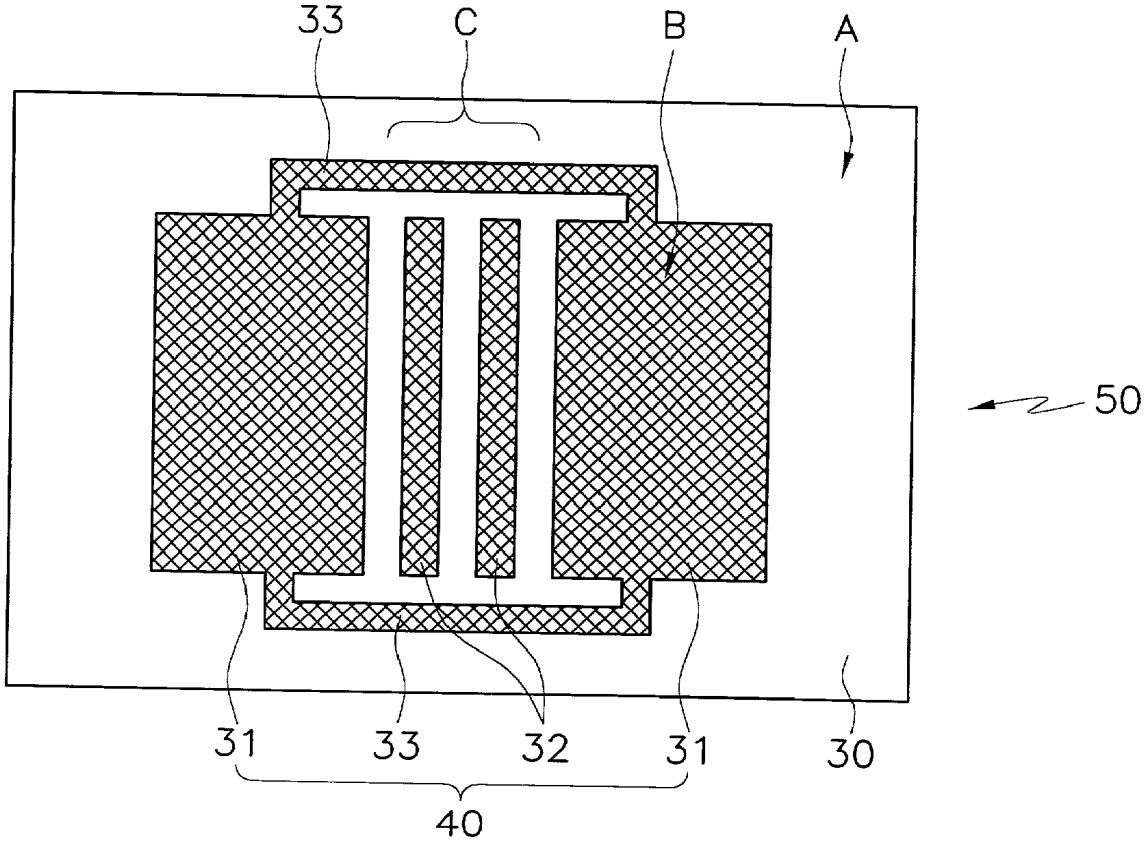

FIG.5

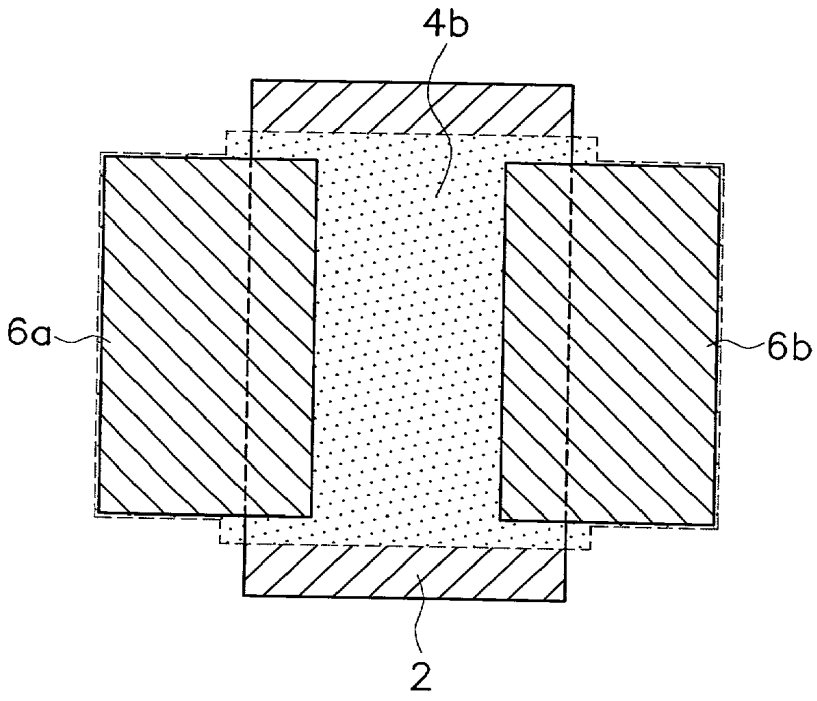

FIG.6A

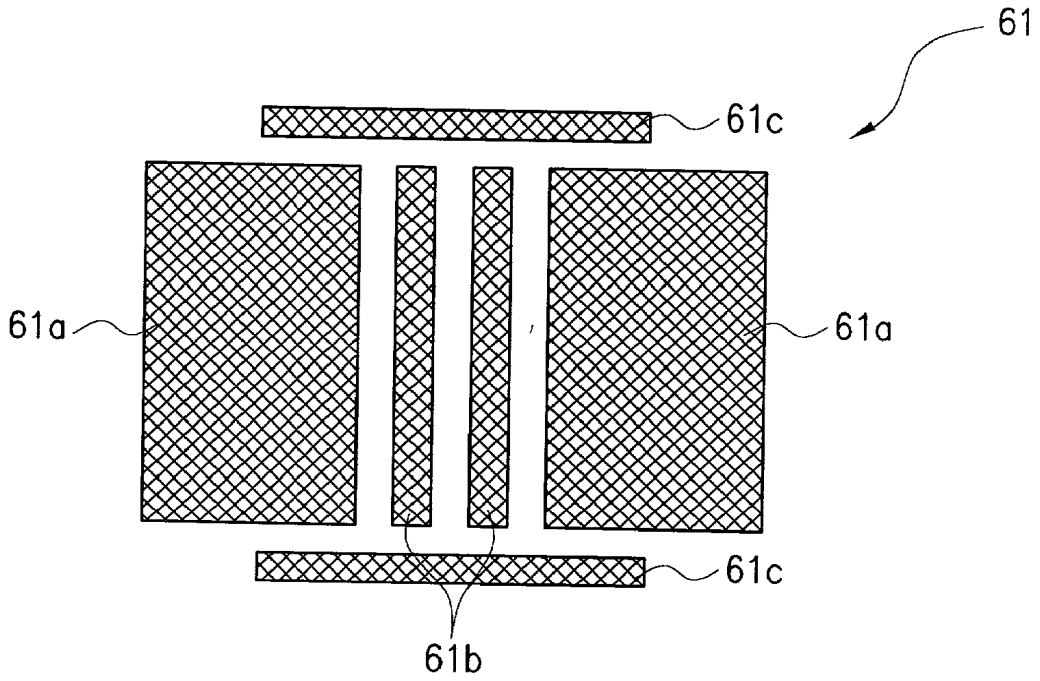

FIG.6B

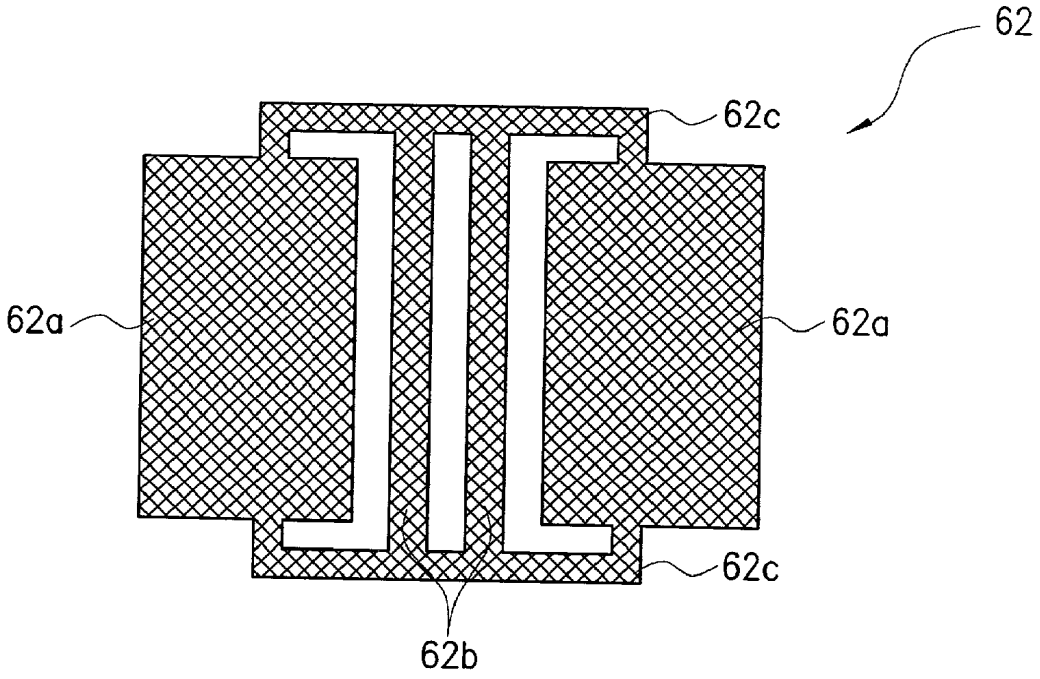

FIG.6C

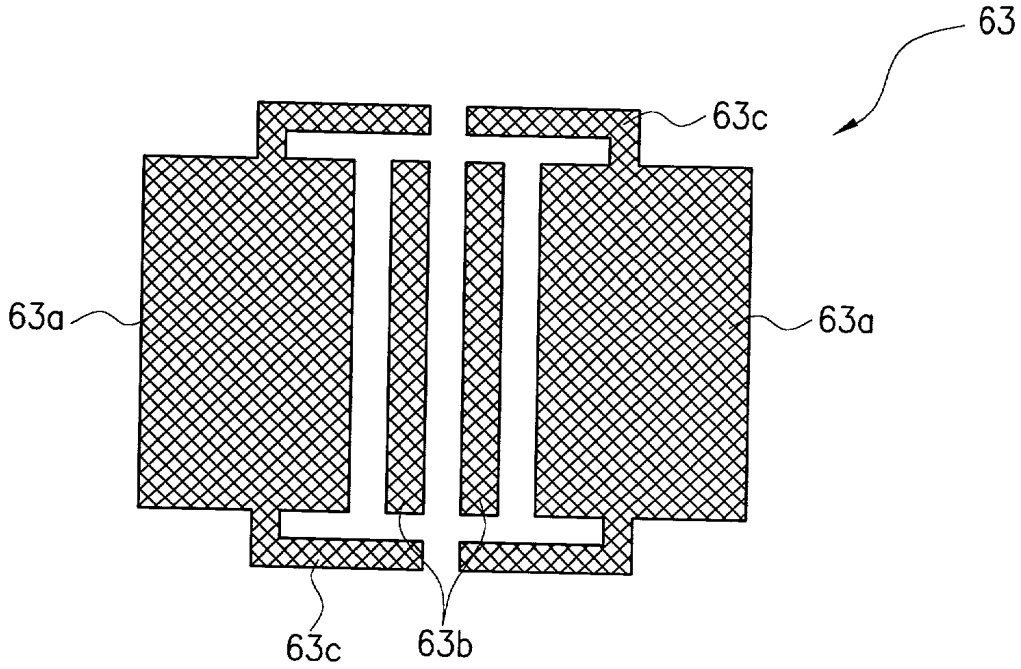

FIG.6D

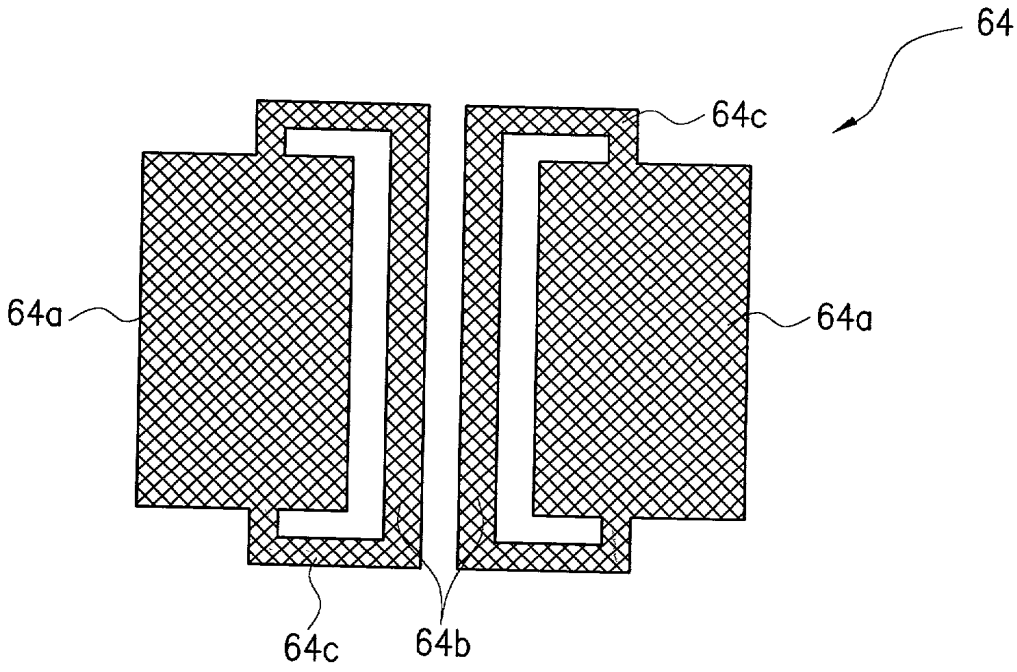

FIG.6E

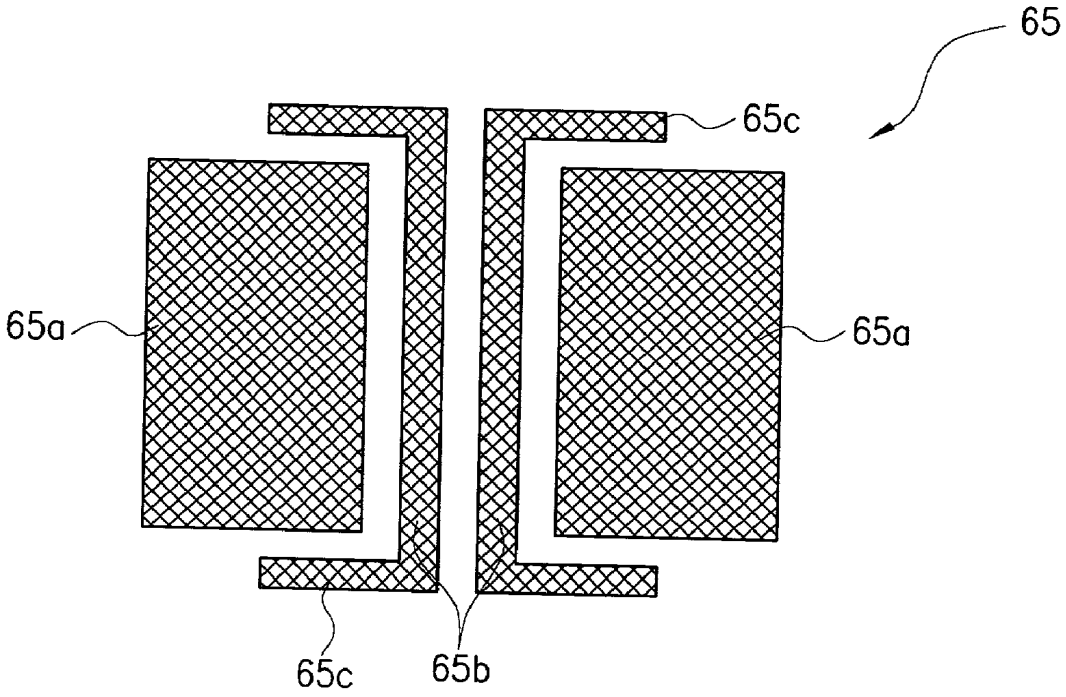

FIG.7A

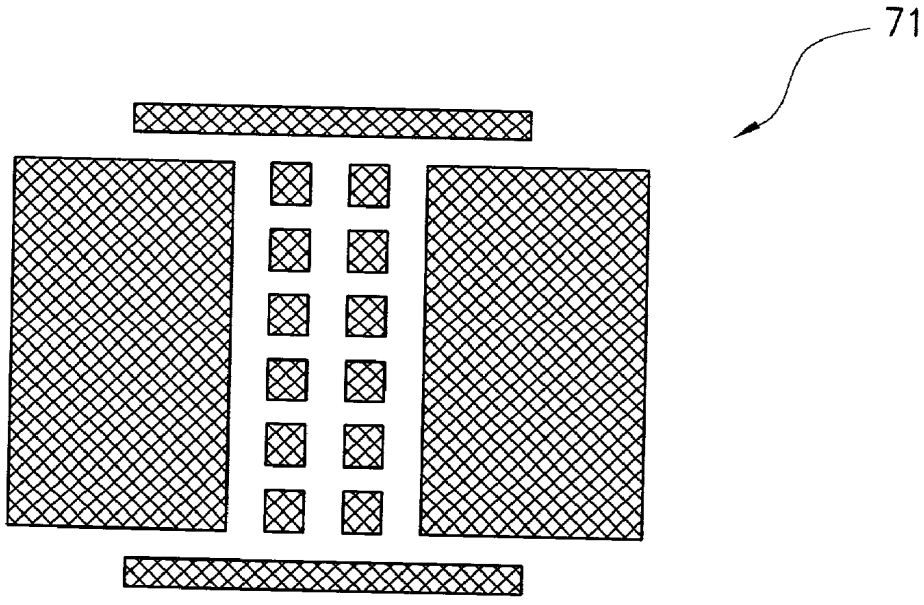

FIG.7B

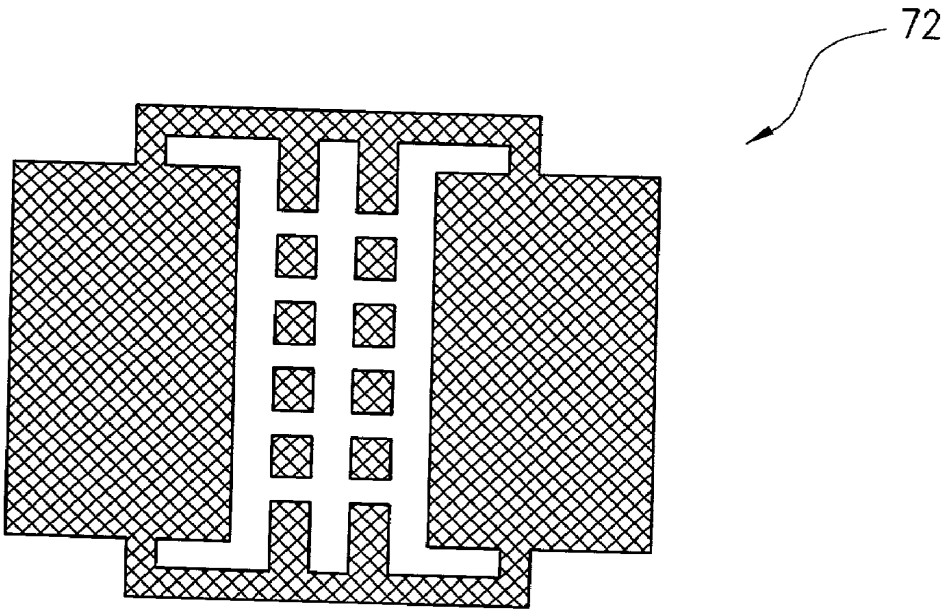

FIG.7C

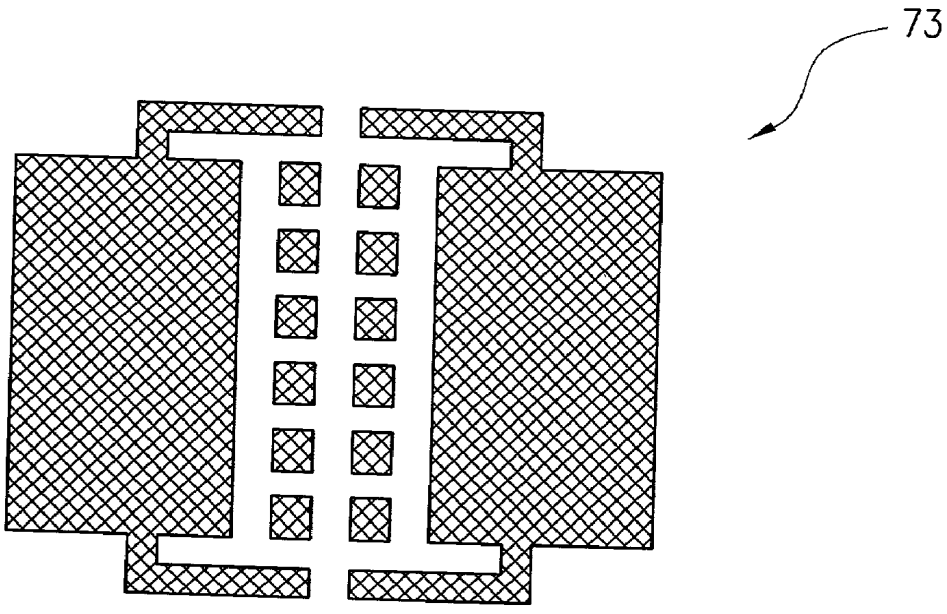

FIG.7D

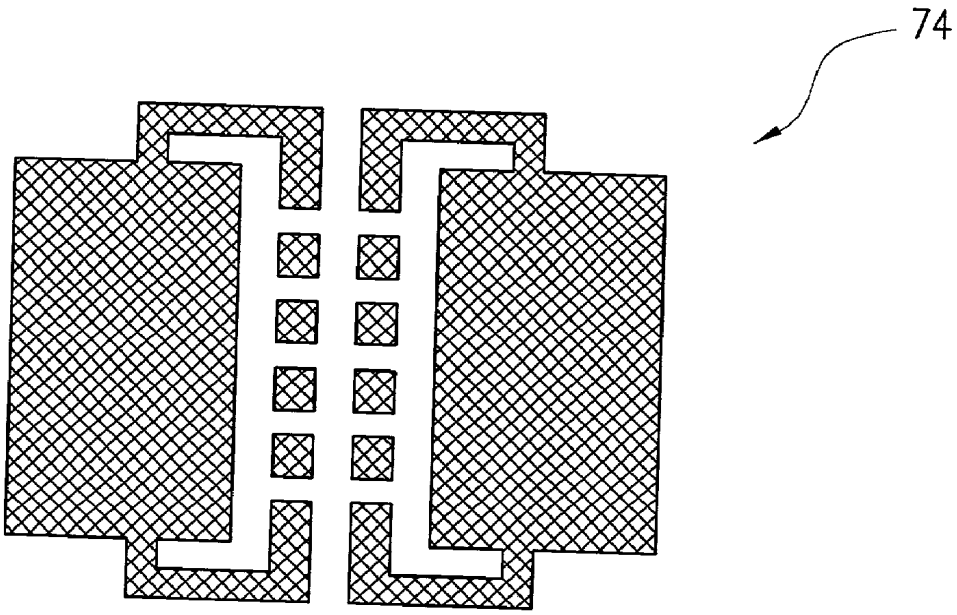

FIG.7E

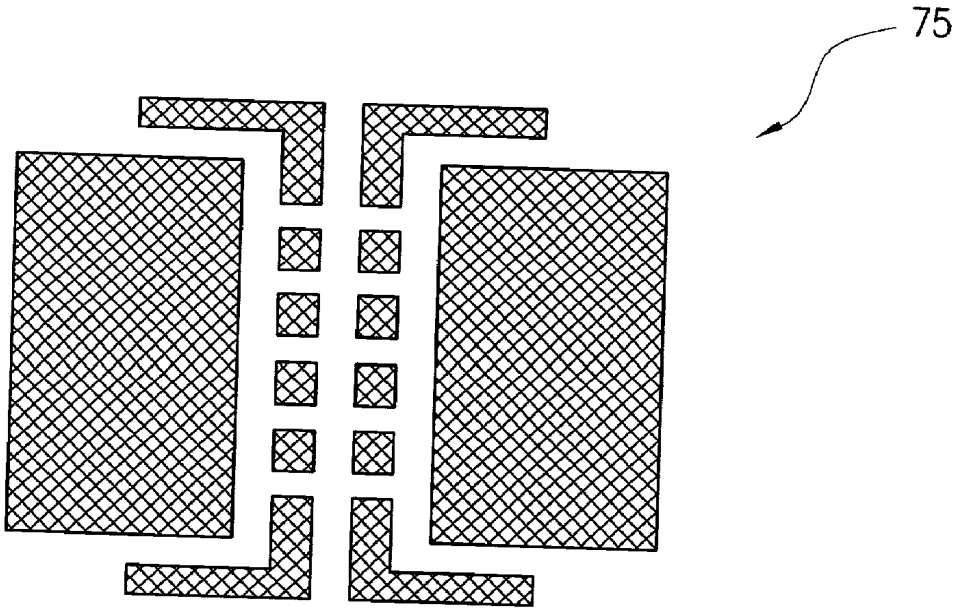

PHOTO MASK FOR FABRICATING A THIN FILM TRANSISTOR LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a thin film transistor liquid crystal display, and more particularly a photo mask for fabricating a thin film transistor liquid crystal display using 4-mask process.

[0003] 2. Description of the Related Art

[0004] Thin Film Transistor Liquid Crystal Display (hereinafter referred as TFT—LCD) has advantages of light weight, thin thickness and low power consumption. Therefore, it has been substituted for Cathode-ray tube (CRT) in a terminal of information system and video unit, etc. and recently, it is widely used in a notebook PC and a computer monitor market.

[0005] This TFT—LCD comprises a TFT array substrate which has a structure that TFT is disposed on each pixel arranged in a matrix shape, a color filter substrate which has a structure that red, green and blue color filters are arranged corresponding to each pixel, and a liquid crystal layer interposed between the substrates.

[0006] In fabrication of the TFT—LCD, it is very important to reduce the number of fabrication processes, particularly, the number of TFT array substrate fabrication processes. This is because reduction of fabrication processes lowers production cost, thereby increasing the TFT—LCD supply with a low price.

[0007] In order to reduce fabrication processes, it is necessary to reduce the number of photolithography processes and it is realized by reducing the number of photo mask used in the processes. Recently, photo masks of 5 to 7 sheets are used for fabricating TFT—LCD, and photo masks of 4 sheets may be used in some cases.

[0008] **FIGS. 1A** to 1E are cross-sectional views for showing a conventional method of fabricating a TFT array substrate using photo masks of **4** sheets. TFT formation parts are illustrated in the drawings.

[0009] Referring to **FIG. 1A, a** gate metal layer is deposited on a glass substrate (**1**), and then a gate line (not shown) including a gate electrode (**2**) is formed by patterning with a mask process using a first photo mask. A gate insulating layer (**3**), an a—Si layer (**4**), a n+ a—Si layer (**5**), a source/drain metal layer (**6**) and a sensitive layer (**7**) are sequentially formed on the glass substrate including the gate electrode.

[0010] Referring to **FIG. 1**B, the sensitive layer (**7**) is exposed using a second photo mask and the exposed sensitive layer is then developed, thereby forming a sensitive layer pattern (**7***a*) to cover a channel unit and source/drain formation regions. The sensitive layer pattern (**7***a*) is formed by half tone exposure and the center thereof, that is, a part to cover a TFT channel formation region, is thinner than parts to cover source/drain formation regions.

[0011] According to the half tone exposure, each region is exposed to different exposure degree, so that a photoresist pattern has uneven thickness. In this process, the exposure degree may be controlled by designing a photo mask.

[0012] **FIGS. 2A and 2B** are cross sectional view and plane view illustrating a photo mask for half tone exposure process. As shown in FIGS., a photo mask (**20**) for half tone exposure comprises a light transmission substrate (**11**) and a shielding pattern (**12**). And, in addition to a light transmission region (A) and a light shielding region (B), a semi-permeable region (C) is included, which transmits light to a lower degree than that of the light transmittance region (A).

[0013] Resolution of stepper as an exposure device is 3 μm, therefore, when fine patterns with resolution lower than that of the exposure device are formed on the transparent substrate (**11**), exposure degree is lowered in the fine patterns formation region, thereby the sensitive layer pattern corresponding to this region has a thinner thickness when compared to other regions.

[0014] Referring to **FIG. 1**C, source/drain metal layers are etched using the sensitive layer pattern (**7***a*) as an etching mask to form a data line.

[0015] Referring to **FIG. 1**D, n+ a—Si layer (**5**) and a—Si layer (**4**) are etched using the sensitive layer pattern (**7***a*) as an etching mask to define an active region, and subsequently, source/drain (**6***a*,**6***b*) are formed by etching source/drain metal layer disposed on the channel region. That is, while the n+ a—Si layer and the a—Si layer are etched, center of the sensitive layer pattern (**7***a*) is etched together with the layers due to relatively thin thickness and source/drain metal layers of the exposed channel region are also etched to form the source/drain (**6***a*, **6***b*).

[0016] Referring to **FIG. 1E, a** n+ a—Si layer on the exposed channel region is etched and then, the sensitive layer pattern is removed, thereby completing a TFT (**10**).

[0017] Although it is not shown in drawings, a protective layer is formed using a third photo mask and a pixel electrode is formed using a fourth photo mask. A TFT array substrate is completed through well-known following processes including formation processes of the protective layer and the pixel electrode.

[0018] However, a conventional method of fabricating a TFT array substrate has following problems.

[0019] As shown in **FIG. 3**, in half tone exposure, both edges of a channel unit (**4***a*) are flexed by interference of light since a division is not clear between a light transmittance region and a light shielding region at the edge of channel region. When edges of the channel unit (**4***a*) are flexed, a path of On-current is flexed at the flexed edges of channel unit (**4***a*), thereby causing a screen quality of TFT—LCD to be deteriorated.

SUMMARY OF THE INVENTION

[0020] Therefore, an object of the present invention is to provide a photo mask for fabricating TFT—LCD which can prevent flexion at both edges of channel region in half tone exposure.

[0021] In order to achieve the above object, a photo mask for fabricating TFT—LCD according to the present invention comprising a transparent substrate and a shielding pattern formed thereon, wherein the shielding pattern includes: a pair of first shielding patterns of a box type disposed with separation to cover a source and a drain formation regions; a pair of second shielding patterns of a

bar type disposed between the first shielding patterns; and a third shielding pattern of a bar type disposed on upper and lower portions of the first and second shielding patterns to divide a light transmittance region and light shielding region at the edges of a channel region.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The above objects, and other features and advantages of the present invention will become more apparent after a reading of the following detailed description when taken in conjunction with the referenced drawings.

[0023] **FIGS. 1A** to **1**E are cross-sectional views for showing a conventional method of fabricating a TFT array substrate using **4** photo masks.

[0024] **FIGS. 2A and 2B** are a plane view and a cross sectional view illustrating a conventional photo mask for half tone exposure process.

[0025] **FIG. 3** is a plane view of main parts for showing a conventional problem.

[0026] **FIG. 4** is a plane view illustrating a photo mask for fabricating TFT LCD according to a preferred embodiment of the present invention.

[0027] **FIG. 5** is a plane view of a channel region of TFT using the photo mask in **FIG. 4**.

[0028] **FIGS. 6A** to **6**E are plane views illustrating photo masks for fabricating TFT LCD according to other embodiments of the present invention.

[0029] **FIGS. 7A** to **7**E are plane views illustrating photo masks for fabricating TFT LCD according to other embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0030] **FIG. 4** is a plane view illustrating a photo mask for fabricating a TFT LCD according to the present invention.

[0031] As illustrated, a photo mask (**50**) of the present invention comprises a transparent substrate (**30**) and a light shielding pattern (**40**) formed on the transparent substrate (**30**). The light shielding pattern (**40**) includes a pair of first shielding patterns (**31**) of a box type disposed with separation to cover source/drain formation regions, a pair of second shielding patterns (**32**) of a bar type disposed between the first shielding patterns (**31**), and third shielding patterns (**33**) of a bar type disposed on upper and lower portions of the first shielding patterns (**31**). Herein, the third shielding pattern (**33**) has a width less than 1 μm and both edges thereof are connected to sides of the first shielding patterns (**31**), not to the second shielding patterns (**32**).

[0032] In this photo mask (**50**), the shielding pattern (**40**) services as a shielding region (B) and the region between the first shielding patterns (**31**) including the second shielding patterns (**32**) operates as a semi-permeable region (C) . And, the region of the remaining transparent substrate (**30**) except the shielding pattern region (**40**) services as a light transmittance region (A).

[0033] **FIG. 5** is a plane view of channel region of TFT obtained using a photo mask of the present invention. As illustrated, flexion is not occurred at the edges of channel unit (**4***b*) by disposing a third shielding pattern on the photo mask in order to clearly divide the light transmittance region and light shielding region, thereby enlarging the channel region.

[0034] Therefore, path flexion of On-current is not caused at the edges of channel unit (**4***b*) and a channel width is sufficiently ensured, thereby preventing degradation of TFT—LCD.

[0035] **FIGS. 6A** to **6**E are plane views of photo masks for fabricating TFT—LCD according to other embodiments of the present invention. In the drawings, shielding patterns are illustrated and transparent substrates are omitted. There is no repeated explanation for the same parts as those in **FIG. 4**.

[0036] Referring to **FIG. 6A, a** shielding pattern (**61**) has a structure that third shielding patterns (**61***c*) are formed in a bar type, whose edges are not connected to either first shielding patterns (**61***a*) and second shielding patterns (**61***b*).

[0037] Referring to **FIG. 6B, a** shielding pattern (**62**) has a structure that third shielding patterns (**62***c*) are formed in a bar type, whose edges are connected to both first shielding patterns (**62***a*) and second shielding patterns (**62***b*).

[0038] Referring to **FIG. 6C, a** shielding pattern (**63**) has a structure that third shielding patterns (**63***c*) are connected to first shielding patterns (**63***a*) and separated from second shielding patterns (**63***b*).

[0039] Referring to **FIG. 6D, a** shielding pattern (**64**) has a structure that third shielding patterns (**64***c*) connect one side of first shielding patterns (**64***a*) and edges of second shielding patterns (**64***b*).

[0040] Referring to **FIG. 6E, a** shielding pattern has a structure that third shielding patterns (**65***c*) are connected to edges of second shielding patterns (**65***b*) and separated from first shielding patterns (**65***a*).

[0041] **FIGS. 7A** to **7**E are plane views illustrating photo masks for fabricating TFT—LCD according to other embodiments of the present invention.

[0042] In the drawings, shielding patterns (**71,72,73,74, 75**) have the same structures as those of shielding patterns (**61,62,63,64,65**) in **FIGS. 6A** to **6**E. except that the second shielding patterns are formed not in a bar type, but in a dot type. Therefore, there is no repeated explanation about **FIGS. 7A** to **7**E.

[0043] As described above, in the present invention, a shielding pattern is additionally provided on the edges of TFT channel unit in order to clearly divide a light transmittance region and a light shielding region, thereby ensuring a stable channel width and accordingly stabilizing On-current of TFT. As a result, it is possible to improve a screen quality of TFT—LCD.

[0044] Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. A photo mask for fabricating a TFT—LCD comprising:

a transparent substrate and a shielding pattern formed thereon,

wherein the shielding pattern includes a pair of first shielding patterns of a box-type disposed with separation in order to cover source/drain formation regions;

a pair of second shielding patterns of a bar type disposed between the first shielding patterns; and

third shielding patterns of a bar type disposed on lower and upper portions of the first and the second shielding patterns in order to clearly divide a light transmittance region and a light shielding region at the edge of a channel region.

2. The photo mask for fabricating a TFT—LCD according to claim 1, wherein the second shielding pattern has a structure that dot-shaped patterns are disposed in a bar type.

3. The photo mask for fabricating a TFT—LCD according to claim 1, wherein both edges of the third shielding pattern are connected to one side of the first shielding pattern and separated from the second shielding pattern.

4. The photo mask for fabricating a TFT—LCD according to claim 3, wherein the second shielding pattern has a structure that dot-shaped patterns are disposed in a bar type.

5. The photo mask for fabricating a TFT—LCD according to claim 1, wherein both edges of the third shielding pattern are connected to one side of the first shielding pattern and at the same time connected to the second shielding pattern.

6. The photo mask for fabricating a TFT—LCD according to claim 5, wherein the second shielding pattern has a structure that dot-shaped patterns are disposed in a bar type.

7. The photo mask for fabricating a TFT—LCD according to claim 3, wherein the third shielding pattern has a separated structure.

8. The photo mask for fabricating a TFT—LCD according to claim 7, wherein the second shielding pattern has a structure that dot-shaped patterns are disposed in a bar type.

9. The photo mask for fabricating a TFT—LCD according to claim 7, wherein a separated edge of the third shielding pattern is connected to an edge of the second shielding pattern.

10. The photo mask for fabricating a TFT—LCD according to claim 9, wherein the second shielding pattern has a structure that dot-shaped patterns are disposed in a bar type.

11. The photo mask for fabricating a TFT—LCD according to claim 1, wherein the third shielding pattern is connected to an edge of the second shielding pattern separated from the first shielding pattern.

12. The photo mask for fabricating a TFT—LCD according to claim 11, wherein the second shielding pattern has a structure that dot-shaped patterns are disposed in a bar type.

* * * * *

专利名称(译)	用于制造薄膜晶体管液晶显示器的光掩模		
公开(公告)号	US20010049064A1	公开(公告)日	2001-12-06
申请号	US09/870978	申请日	2001-05-31
[标]申请(专利权)人(译)	LEE DEUK SU JUN JUNG MOK		
申请(专利权)人(译)	LEE DEUK SU JUN JUNG MOK		
当前申请(专利权)人(译)	LEE DEUK SU JUN JUNG MOK		
[标]发明人	LEE DEUK SU JUN JUNG MOK		
发明人	LEE, DEUK SU JUN, JUNG MOK		
IPC分类号	G02F1/1335 G02F1/13 G02F1/1368 G03F1/54 G03F1/70 H01L21/3213 H01L21/336 H01L29/786 G03F9/00 G03C5/00		
CPC分类号	G03F1/14 H01L21/32139 G03F1/50		
优先权	1020000029775 2000-05-31 KR		
其他公开文献	US6653028		
外部链接	Espacenet USPTO		

摘要(译)

本发明公开了一种采用4掩模工艺的TFT-LCD制造中采用的光掩模。所公开的光掩模包括透明基板和形成在其上的屏蔽图案，其中屏蔽图案包括一对盒式的第一屏蔽图案，其设置有分离以覆盖源极和漏极形成区域，一对第二屏蔽图案的棒设置在第一屏蔽图案和设置在第一和第二屏蔽图案的下部和上部上的条形第三屏蔽图案之间的类型，以在通道边缘上的透光区域和遮光区域之间进行清晰的划分区域。