

EXHIBIT 4

(12) **United States Patent**
Sasabayashi et al.

(10) **Patent No.:** **US 8,044,907 B2**
(45) **Date of Patent:** **Oct. 25, 2011**

(54) **LIQUID CRYSTAL DISPLAY AND METHOD OF MANUFACTURING THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/961,009**

(22) Filed: **Dec. 6, 2010**

(65) **Prior Publication Data**

US 2011/0075060 A1 Mar. 31, 2011

Related U.S. Application Data

(62) Division of application No. 12/827,030, filed on Jun. 30, 2010, which is a division of application No. 11/299,799, filed on Dec. 12, 2005, now Pat. No. 7,859,500, which is a division of application No. 10/796,783, filed on Mar. 9, 2004, now Pat. No. 7,262,824.

(30) **Foreign Application Priority Data**

Mar. 18, 2003 (JP)	2003-073553
Mar. 31, 2003 (JP)	2003-095319
Mar. 31, 2003 (JP)	2003-096779
Feb. 24, 2004 (JP)	2004-048296

(51) **Int. Cl.**
G09G 3/36 (2006.01)
(52) **U.S. Cl.** **345/92**; 345/87; 345/89; 345/90; 345/204; 349/42; 349/144
(58) **Field of Classification Search** 345/87–100, 345/204, 211–213, 690; 349/42, 43, 144
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,840,460 A * 6/1989 Bernot et al. 349/144
(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 884 626 12/1998
(Continued)

Primary Examiner — Quan-Zhen Wang

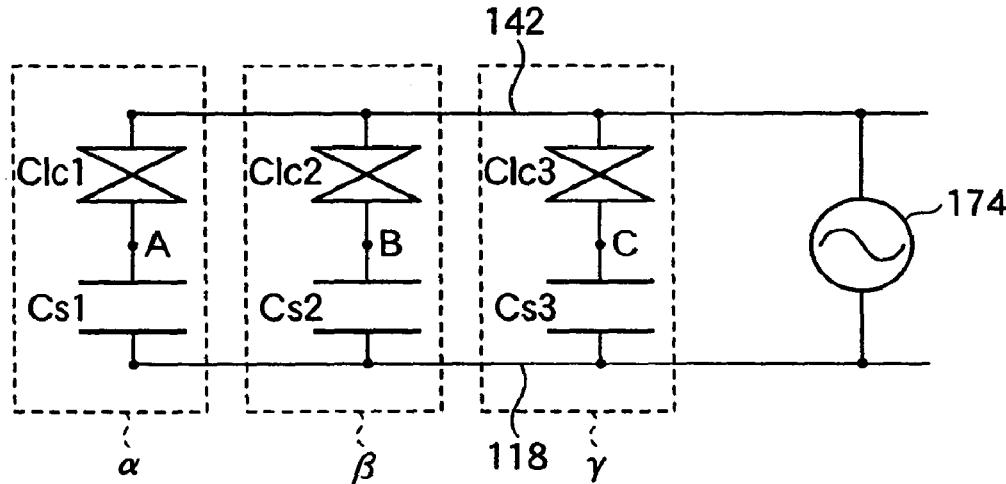
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(57) **ABSTRACT**

A liquid crystal display including two substrates, gate bus lines, liquid crystal molecules, and a polymer that determines directions in which the liquid crystal molecules tilt. A plurality of divisional areas are arranged on one of the substrates. The pixels are aligned in a column between drain bus lines. A pixel electrode is formed at each of the divisional areas. A first thin film transistor drives a first divisional area, and a second thin film transistor drives a second divisional area of the same column. The first and second thin film transistors are electrically connected to the same gate bus line. Either the pixel electrodes formed at each of the divisional areas are electrically insulated from each other, or they are connected to each other through a high resistance. A first threshold voltage within the first divisional area is different from a second threshold voltage of the second divisional area.

8 Claims, 57 Drawing Sheets



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U.S. PATENT DOCUMENTS

5,204,659 A *	4/1993	Sarma	345/89	7,511,789 B2	3/2009	Inoue et al.
5,319,480 A *	6/1994	McCartney	349/85	2001/0020992 A1	9/2001	Takeda et al.
5,321,535 A	6/1994	Ukai et al.		2001/0030726 A1	10/2001	Yoshida et al.
5,477,351 A	12/1995	Takahara et al.		2002/0050966 A1 *	5/2002	Asao et al. 345/87
5,519,519 A	5/1996	Nakajima et al.		2003/0048401 A1	3/2003	Hanaoka et al.
5,559,615 A	9/1996	Takei et al.		2003/0058374 A1	3/2003	Takeda et al.
5,897,187 A	4/1999	Aoki et al.		2003/0095229 A1	5/2003	Inoue et al.
5,923,311 A *	7/1999	Edwards	345/92	2003/0160750 A1	8/2003	Ueda et al.
5,969,781 A	10/1999	Matsuyama et al.		2006/0097972 A1 *	5/2006	Takeuchi et al. 345/90
6,081,315 A	6/2000	Matsuyama et al.				
6,306,469 B1	10/2001	Serbutoviez et al.				
RE37,591 E	3/2002	Shimada et al.		JP 11-242225	9/1999	
6,507,381 B1	1/2003	Katsuya et al.		JP 11-326927	11/1999	
6,633,356 B1	10/2003	Kataoka et al.		JP 2000-356773	12/2000	
6,710,827 B2	3/2004	Kubo et al.		JP 2002-229518	8/2002	
6,781,665 B2	8/2004	Nakanishi et al.		JP 2002-357830	12/2002	
6,856,373 B2	2/2005	Sekido et al.		JP 2003-177408	6/2003	
7,262,824 B2	8/2007	Sasabayashi et al.		JP 2003-255305	9/2003	
7,286,200 B2	10/2007	Inoue et al.		JP 2003-287755	10/2003	
7,289,178 B2	10/2007	Sasabayashi et al.		KR 2000-0028957	5/2000	

FOREIGN PATENT DOCUMENTS

JP	11-242225	9/1999
JP	11-326927	11/1999
JP	2000-356773	12/2000
JP	2002-229518	8/2002
JP	2002-357830	12/2002
JP	2003-177408	6/2003
JP	2003-255305	9/2003
JP	2003-287755	10/2003
KR	2000-0028957	5/2000

* cited by examiner

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FIG.1A

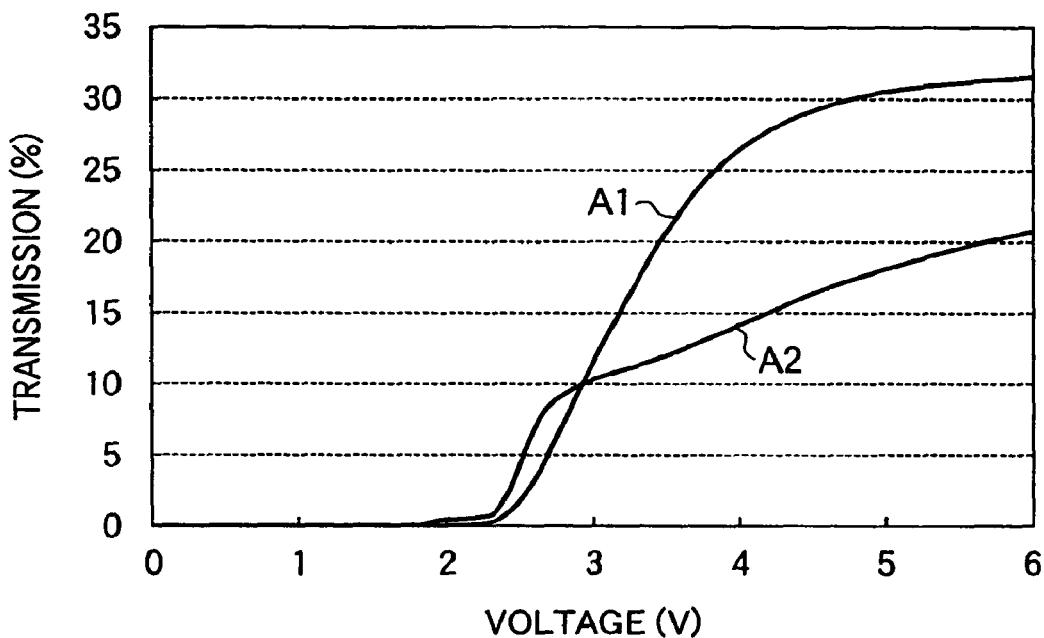
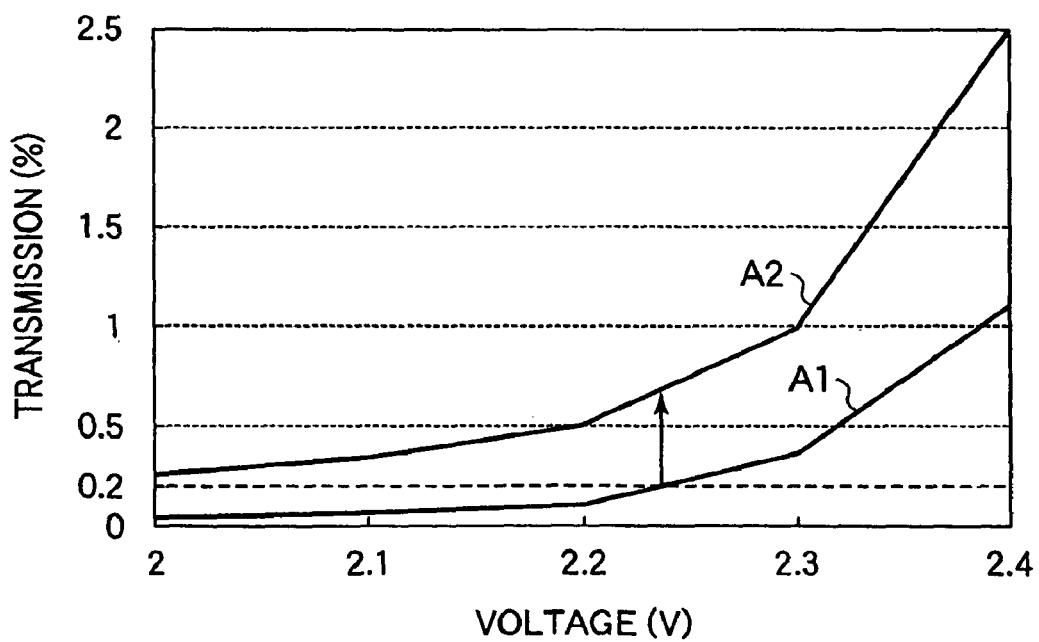


FIG.1B



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FIG.2

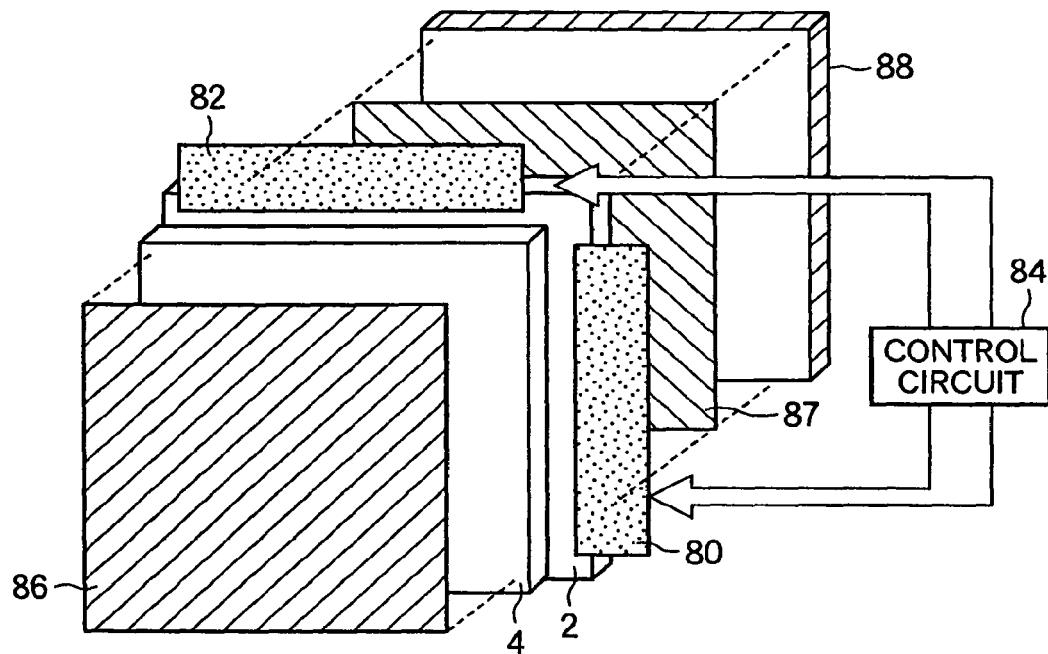
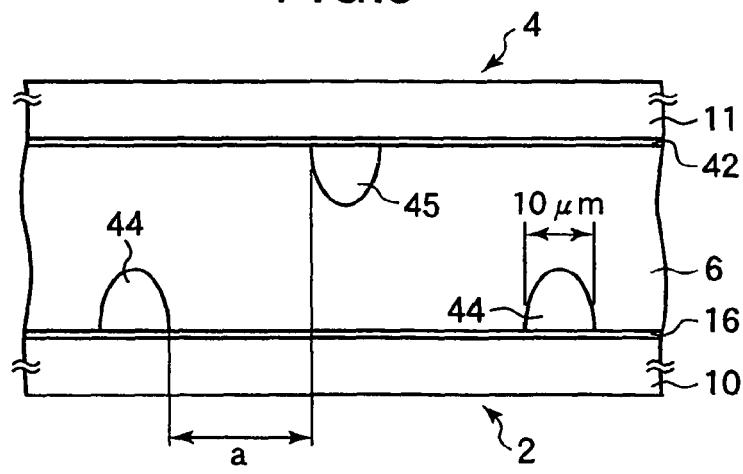


FIG.3



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