

EXHIBIT 4



US008044907B2

(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**

(75) Inventors: **Takashi Sasabayashi**, Kawasaki (JP); **Arihiro Takeda**, Sagamihara (JP); **Hiroyasu Inoue**, Kawasaki (JP); **Kazuya Ueda**, Kawasaki (JP); **Yoshio Koike**, Kawasaki (JP); **Hideaki Tsuda**, Kawasaki (JP); **Yasutoshi Tasaka**, Kawasaki (JP); **Hidefumi Yoshida**, Kawasaki (JP); **Kunihiro Tashiro**, Kawasaki (JP); **Tsuyoshi Kamada**, Kawasaki (JP); **Kimiaki Nakamura**, Kawasaki (JP)

(73) Assignee: **Sharp Kabushiki Kaisha**, Osaka (JP)

(*) 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.

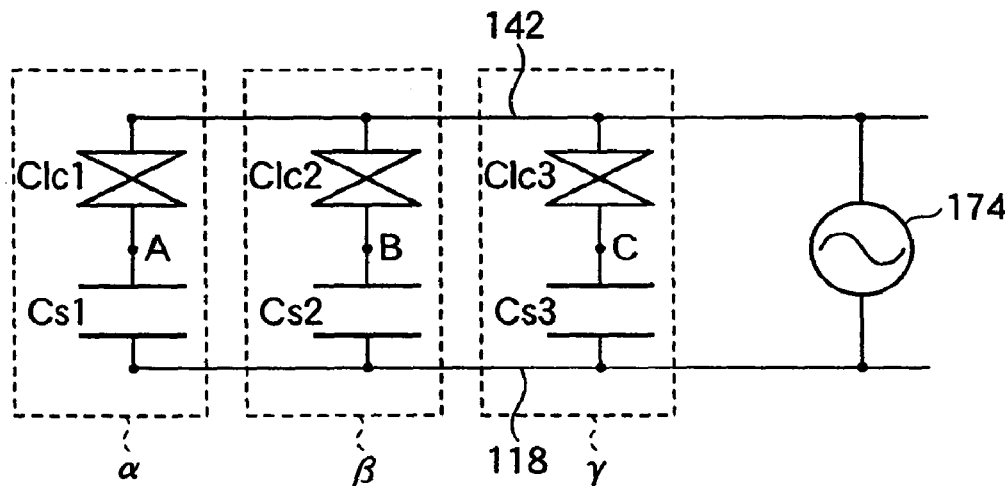
(56) **References Cited**
 U.S. PATENT DOCUMENTS
 4,840,460 A * 6/1989 Bernot et al. 349/144
 (Continued)

FOREIGN PATENT DOCUMENTS
 EP 0 884 626 12/1998
 (Continued)

Primary Examiner — Quan-Zhen Wang
Assistant Examiner — Jennifer T Nguyen
 (74) *Attorney, Agent, or Firm* — Greer, Burns & Crain, Ltd.

(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



US 8,044,907 B2

Page 2

U.S. PATENT DOCUMENTS

5,204,659 A * 4/1993 Sarma 345/89
 5,319,480 A * 6/1994 McCartney 349/85
 5,321,535 A 6/1994 Ukai et al.
 5,477,351 A 12/1995 Takahara et al.
 5,519,519 A 5/1996 Nakajima et al.
 5,559,615 A 9/1996 Takei et al.
 5,897,187 A 4/1999 Aoki et al.
 5,923,311 A * 7/1999 Edwards 345/92
 5,969,781 A 10/1999 Matsuyama et al.
 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.
 6,507,381 B1 1/2003 Katsuya et al.
 6,633,356 B1 10/2003 Kataoka et al.
 6,710,827 B2 3/2004 Kubo et al.
 6,781,665 B2 8/2004 Nakanishi et al.
 6,856,373 B2 2/2005 Sekido et al.
 7,262,824 B2 8/2007 Sasabayashi et al.
 7,286,200 B2 10/2007 Inoue et al.
 7,289,178 B2 10/2007 Sasabayashi et al.

7,511,789 B2 3/2009 Inoue et al.
 2001/0020992 A1 9/2001 Takeda et al.
 2001/0030726 A1 10/2001 Yoshida et al.
 2002/0050966 A1 * 5/2002 Asao et al. 345/87
 2003/0048401 A1 3/2003 Hanaoka et al.
 2003/0058374 A1 3/2003 Takeda et al.
 2003/0095229 A1 5/2003 Inoue et al.
 2003/0160750 A1 8/2003 Ueda et al.
 2006/0097972 A1 * 5/2006 Takeuchi et al. 345/90

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

FIG.1A

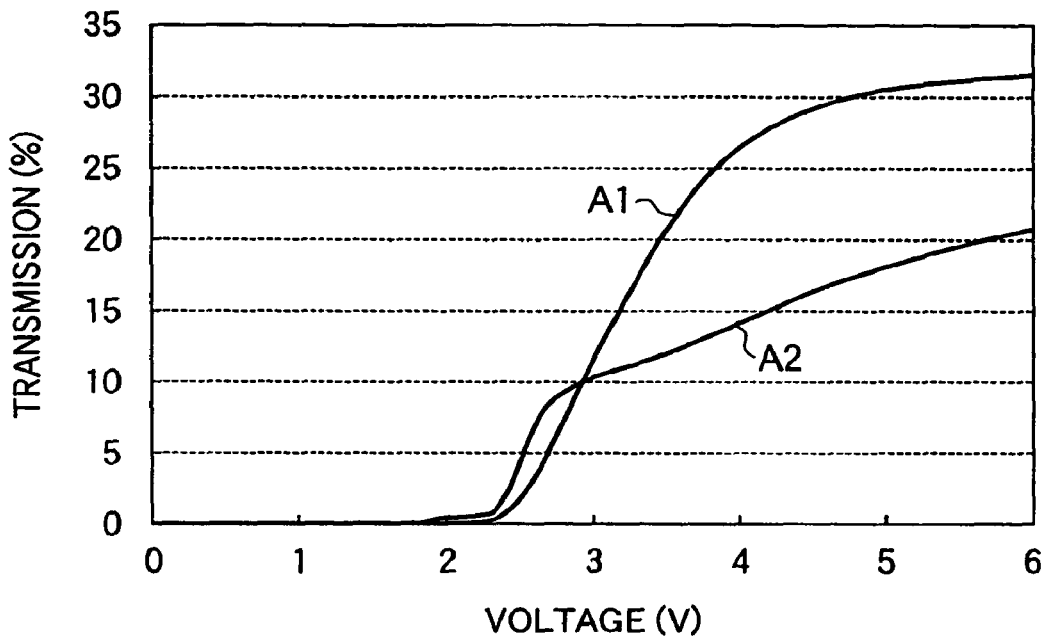


FIG.1B

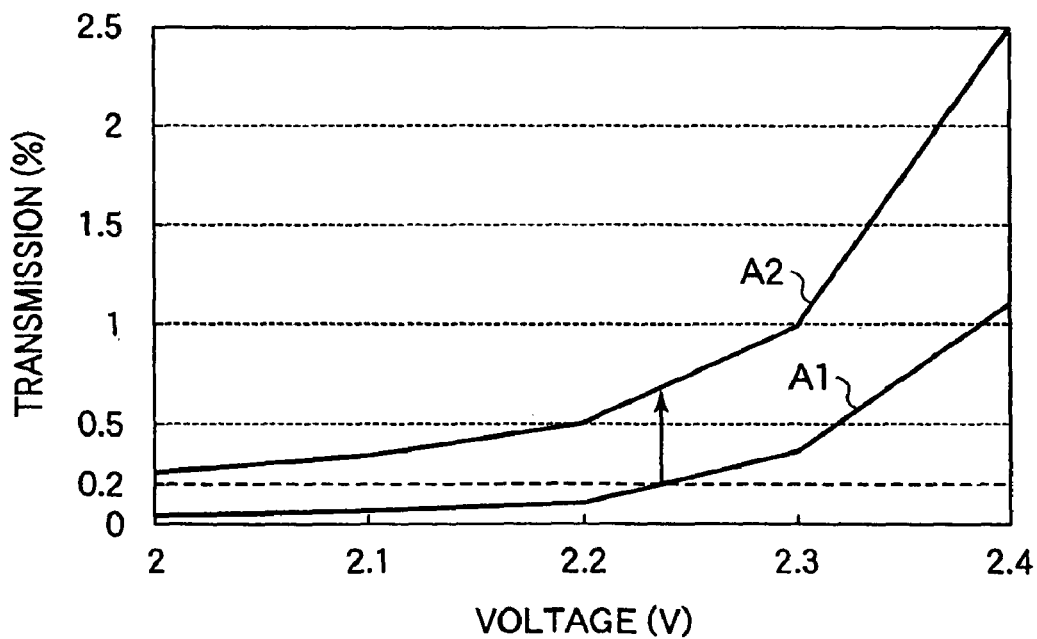


FIG.2

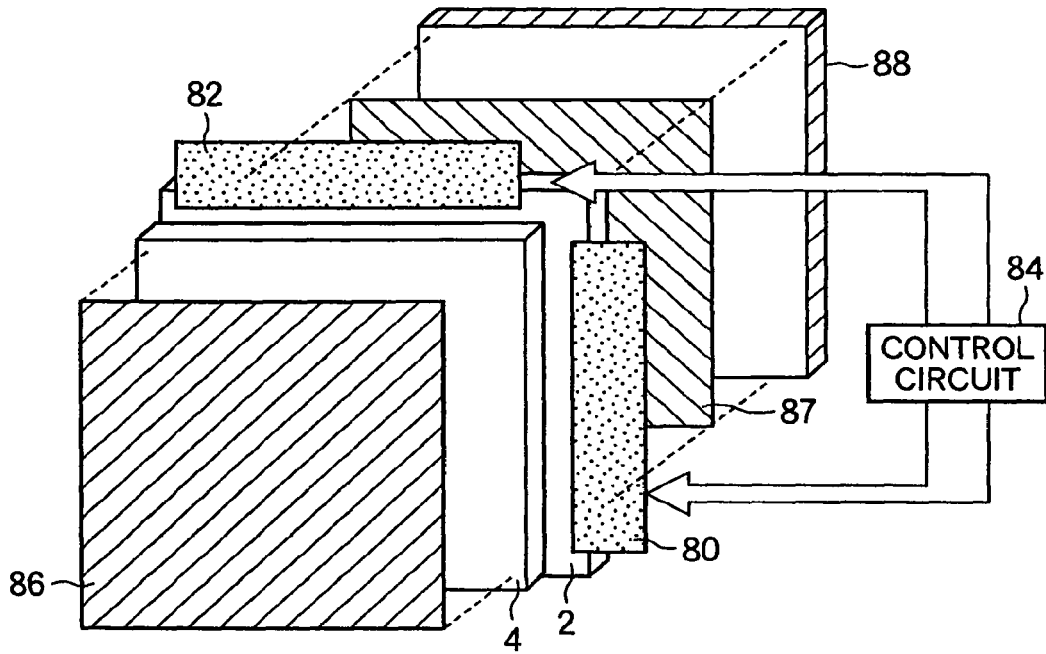
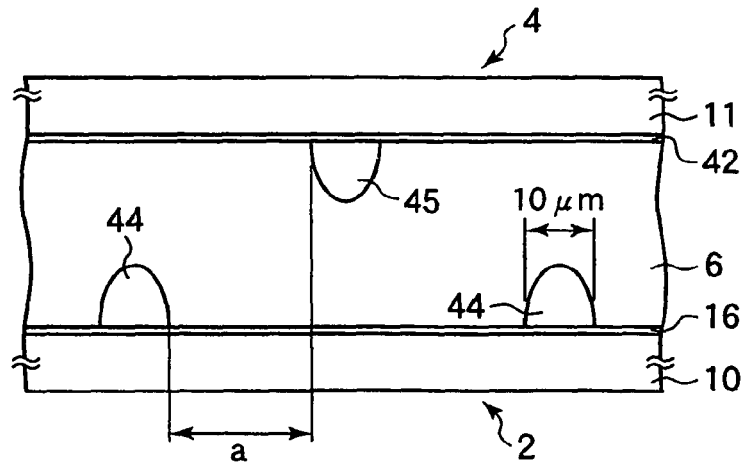


FIG.3



Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.