US007446827B2

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

(10) **Patent No.: US 7,446,827 B2**
(45) **Date of Patent: Nov. 4, 2008**

(54) **DIRECT-LIT LIQUID CRYSTAL DISPLAYS WITH LAMINATED DIFFUSER PLATES**

(75) Inventors: **Byungsoo Ko**, Seoul (KR); **Mark D. Gehlsen**, Eagan, MN (US); **Chingwen Chen**, Taoyuan (TW); **Robert M. Emmons**, St. Paul, MN (US); **James W. Laumer**, White Bear Lake, MN (US); **Ji-Hyung Kim**, Anyang (KR); **Ji-Hwa Lee**, Suwon (KR); **Kang-il Seo**, Suwon (KR); **Ryan T. Fabick**, St. Paul, MN (US); **Linda M. Rivard**, Stillwater, MN (US); **Kenneth A. Epstein**, St. Paul, MN (US); **Chideuk Kim**, Sungnam (KR); **Youngsoo Park**, Suwon (KR)

(73) Assignee: **3M Innovative Properties Company**, St. Paul, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 345 days.

(21) Appl. No.: **10/966,610**

(22) Filed: **Oct. 15, 2004**

(65) **Prior Publication Data**

US 2006/0082698 A1 Apr. 20, 2006

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

(52) **U.S. Cl.** **349/64**

(58) **Field of Classification Search** 349/64
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,655,263 A 4/1972 Hoffman et al.
4,415,509 A 11/1983 Toyooka et al.
5,112,722 A 5/1992 Tsujino et al.
5,269,977 A 12/1993 Nakahashi et al.
5,592,047 A 1/1997 Park et al.
5,914,560 A 6/1999 Winsor
6,153,289 A 11/2000 Murray
6,282,821 B1 9/2001 Freier et al.
6,288,172 B1 9/2001 Goetz et al.
6,341,879 B1 1/2002 Skinner et al.
6,343,865 B1 2/2002 Suzuki
6,359,670 B1 3/2002 Broer et al.

(Continued)

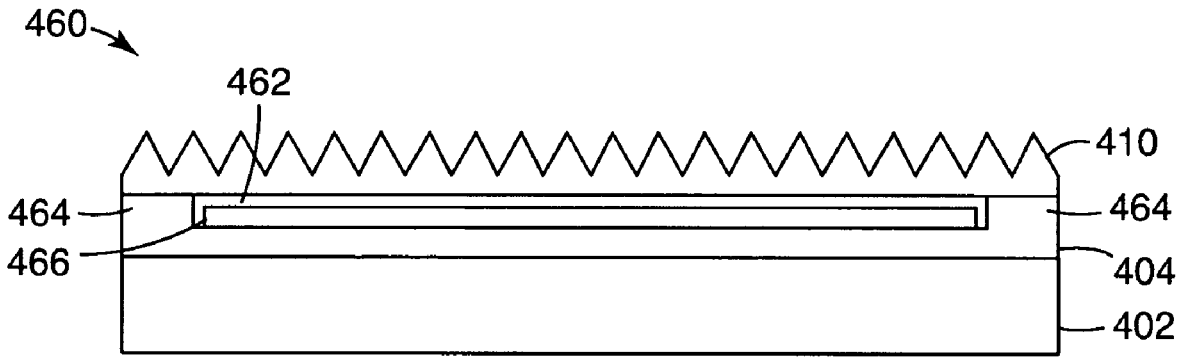
FOREIGN PATENT DOCUMENTS

EP 0881510 12/1998

(Continued)

Primary Examiner—James A Dudek
(74) *Attorney, Agent, or Firm*—Jay R. Pralle

(57) **ABSTRACT**

In a directly-illuminated liquid crystal display (LCD), for example an LCD monitor or an LCD-TV, a number of light management films, including a diffuser layer, lie between the light source and the LCD panel to provide bright, uniform illumination. The diffuser layer is attached to a substrate which is separate from the light source and the LCD panel, or may be attached to either the LCD panel or, when using a two dimensional light source, to the light source. The other light management layers may also be attached to the separate substrate or to the LCD panel or two-dimensional light source. High levels of illumination uniformity at the LCD may be achieved with a uniform (non-patterned) diffuser, even with relatively low levels of diffusion, when the diffuser is used with a brightness enhancing layer.

22 Claims, 17 Drawing Sheets