US009411187B2

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

(10) **Patent No.: US 9,411,187 B2**
(45) **Date of Patent: Aug. 9, 2016**

(54) **DISPLAY DEVICE AND MANUFACTURING METHOD THEREOF**

(71) Applicant: **Samsung Display Co., Ltd.**, Yongin (KR)

(72) Inventors: **Hyoung Sub Lee**, Yongin-si (KR); **Seung-Yeon Chae**, Hwaseong-si (KR); **Joo Young Yoon**, Suwon-si (KR); **Chung Sock Choi**, Seoul (KR)

(73) Assignee: **Samsung Display Co., Ltd.**, Yongin-si (KR)

(*) 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.: **14/663,552**

(22) Filed: **Mar. 20, 2015**

(65) **Prior Publication Data**

US 2016/0109746 A1 Apr. 21, 2016

(30) **Foreign Application Priority Data**

Oct. 21, 2014 (KR) 10-2014-0142529

(51) **Int. Cl.**

G02F 1/1339	(2006.01)
G02F 1/1333	(2006.01)
G02F 1/1368	(2006.01)
G02F 1/1341	(2006.01)
G02F 1/1337	(2006.01)
G02F 1/1334	(2006.01)

(52) **U.S. Cl.**

CPC ***G02F 1/133345*** (2013.01); ***G02F 1/1334*** (2013.01); ***G02F 1/1337*** (2013.01); ***G02F 1/1341*** (2013.01); ***G02F 1/1368*** (2013.01); ***G02F 1/13394*** (2013.01); ***G02F 1/133377*** (2013.01)

(58) **Field of Classification Search**

CPC G02F 1/1344; G02F 1/13394

See application file for complete search history.

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

KR	10-2007-0050451	5/2007
KR	10-2009-0015991	2/2009
KR	10-2013-0141097	12/2013

OTHER PUBLICATIONS

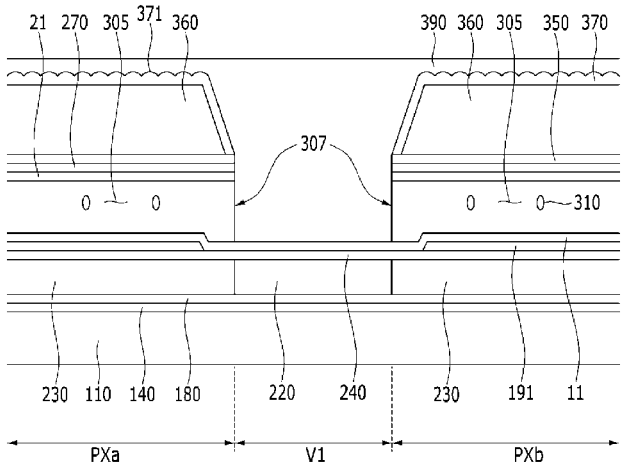
Zhengmao Yin "Light transmission enhancement from hybrid ZnO micro-mesh and nanorod arrays with application to GaN-based light-emitting diodes" Optics Express, pp. 28531-28542, vol. 21, No. 23, 2013.

Ji Hye Kang "Comparison of various surface textured layer in InGaN LEDs for high light extraction efficiency" Optics Express 19(4), 3637-3647, 2011.

Primary Examiner — Phu Vu

(74) *Attorney, Agent, or Firm* — H.C. Park & Associates, PLC

(57) **ABSTRACT**

A display device includes a substrate including pixel areas, a thin-film transistor disposed on the substrate, a first insulating layer disposed on the thin-film transistor, a pixel electrode disposed on the first insulating layer and connected to the thin-film transistor, a liquid crystal layer filling a microcavity disposed on the pixel electrode, a common electrode spaced apart from the pixel electrode by the microcavity, a roof layer disposed on the common electrode, an injection hole disposed in the common electrode and the roof layer, the injection hole partially exposing the microcavity, a third insulating layer disposed on the roof layer, and an overcoat disposed on the third insulating layer and sealing the microcavity by covering the injection hole, wherein a first convex embossing pattern is formed on an upper surface of the third insulating layer.

20 Claims, 14 Drawing Sheets