

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
3 November 2005 (03.11.2005)

PCT

(10) International Publication Number
WO 2005/104236 A3

(51) International Patent Classification:

G02F 1/017 (2006.01) H01L 21/20 (2006.01)
H01L 21/18 (2006.01) H01L 21/302 (2006.01)

Theodore, D. [US/US]; 26 Rocky Brook Road, Dover, MA 02030 (US). CABALU, Jasper, S. [PH/US]; 23 Brighton Avenue, #6, Allston, MA 02134 (US).

(21) International Application Number:

PCT/US2005/012849

(74) Agents: GAGNEBIN, Charles, L., III et al.; Weingarten, Schurgin, Gagnebin & Lebovici, LLP, Ten Post Office Square, Boston, MA 02109 (US).

(22) International Filing Date: 15 April 2005 (15.04.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/562,489 15 April 2004 (15.04.2004) US
60/615,047 1 October 2004 (01.10.2004) US
60/645,704 21 January 2005 (21.01.2005) US

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(71) Applicant (for all designated States except US):
TRUSTEES OF BOSTON UNIVERSITY [US/US];
One Sherborn Street, Boston, MA 02215 (US).

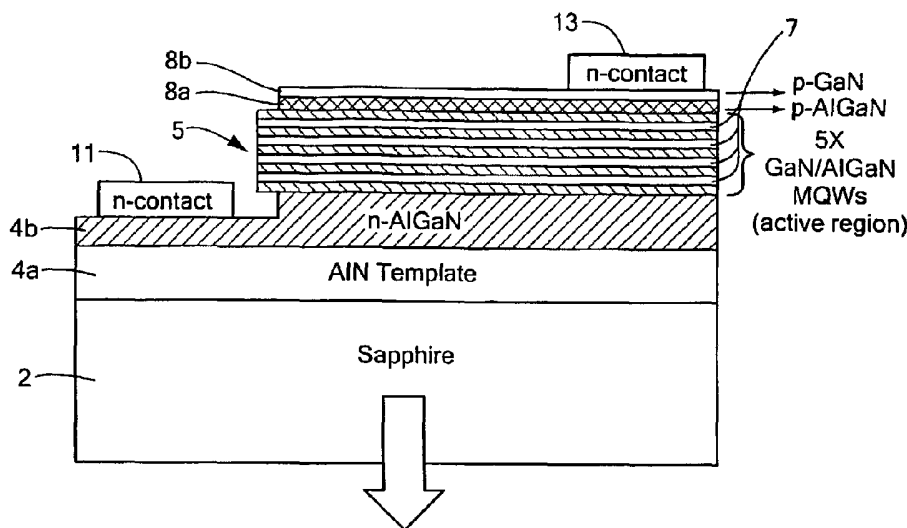
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,

(72) Inventors; and

(75) Inventors/Applicants (for US only): MOUSTAKAS,

[Continued on next page]

(54) Title: OPTICAL DEVICES FEATURING TEXTURED SEMICONDUCTOR LAYERS



(57) Abstract: A semiconductor sensor, solar cell or emitter or a precursor therefore having a substrate and textured semiconductor layer deposited onto the substrate. The layer can be textured as grown on the substrate or textured by replicating a textured substrate surface. The substrate or first layer is then a template for growing and texturing other semiconductor layers from the device. The textured layers are replicated to the surface from the substrate to enhance light extraction or light absorption. Multiple quantum wells, comprising several barrier and quantum well layers, are deposited as alternating textured layers. The texturing in the region of the quantum well layers greatly enhances internal quantum efficiency if the semiconductor is polar and the quantum wells are grown along the polar direction. This is the case in nitride semiconductors grown along the polar [0001] or [000-1] directions.

WO 2005/104236 A3



FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:

7 December 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US05/12849

A. CLASSIFICATION OF SUBJECT MATTER

IPC: G02F 1/017(2006.01);H01L 21/18(2006.01),21/20(2006.01),21/302(2006.01)

USPC: 257/14;438/71

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 257/14,E33.025,E33.033,E33.034; 438/22,71

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2003/0057444 A1 (Niki et al.) 27 March 2003 (27.03.2003), paragraphs 2, 47, 50-53 and 104 Fig. 7D, 8C and 9 paragraph 7	1-10, 12-39 and 41-52 ----- 11
X	US 6,534,336 B1 (Iwane et al.) 18 March 2003 (18.03.2003) column 1, lines 9-16 column 4, lines 60-64 column 7, lines 5-8 column 12, line 63 to column 13 line 9 Fig. 2E and 10D	15-21,23- 32,36,38,39,41-43,46- 49
Y	US 2002/0046693 A1 (Kiyoku et al.) 25 April 2002 (25.04.2002) paragraphs 61, 62 and 304	40

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

23 August 2006 (23.08.2006)

Date of mailing of the international search report

10 OCT 2006

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (571) 273-3201

Authorized officer

Minsun Harvey *Lylia Deuel For*

Telephone No. (571)272-1835