(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 August 2012 (09.08.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/106101 A3

(51) **International Patent Classification**:
H01L 29/872 (2006.01) *H01L 21/328* (2006.01)

(21) **International Application Number**:
PCT/US2012/021483

(22) **International Filing Date**:
17 January 2012 (17.01.2012)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
13/019,716 2 February 2011 (02.02.2011) US

(71) **Applicant** *(for all designated States except US)*: **INTERNATIONAL BUSINESS MACHINES CORPORATION** [US/US]; New Orchard Road, Armonk, NY 10504 (US).

(72) **Inventors; and**

(75) **Inventors/Applicants** *(for US only)*: **RASSEL, Robert, M.** [US/US]; 1000 River Street, Essex Junction, VT 05452 (US). **STIDHAM, Mark, E.** [US/US]; 4645 S. Harrell Road, Bloomington, IN 47401 (US).

(74) **Agent**: **CANALE, Anthony, J.**; International Business Machines Corporation, Intellectual Property Law 972e, 1000 River Street, Essex Junction, VT 05152 (US).

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

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

[Continued on next page]

(54) **Title**: A SCHOTTKY BARRIER DIODE, A METHOD OF FORMING THE DIODE AND A DESIGN STRUCTURE FOR THE DIODE

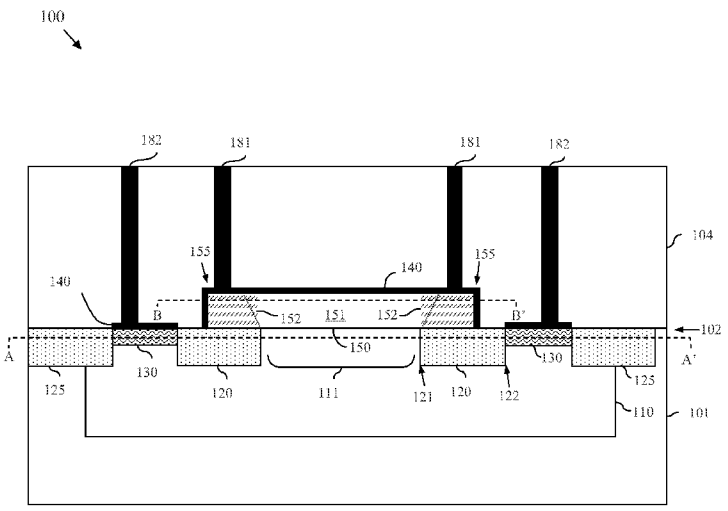

Figure 1

(57) **Abstract**: Disclosed are embodiments of a Schottky barrier diode (100). This Schottky barrier diode can be formed in a semiconductor substrate (101) having a doped region (110) with a first conductivity type. A trench isolation structure (120) can laterally surround a section (111) of the doped region at the top surface (102) of the substrate. A semiconductor layer (150) can be positioned on the top surface of the substrate. This semiconductor layer can have a Schottky barrier portion (151) over the defined section (111) of the doped region and a guardring portion (152) over the trench isolation structure laterally surrounding the Schottky barrier portion. The Schottky barrier portion can have the first conductivity type and the guarding portion can have a second conductivity type different from the first conductivity type. A metal silicide layer (140) can overlie the semiconductor layer. Also disclosed are embodiments of a method of forming this Schottky barrier diode and of a design structure for the Schottky barrier diode.

WO 2012/106101 A3

(88) Date of publication of the international search report:
26 October 2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/021483

A. CLASSIFICATION OF SUBJECT MATTER

H01L 29/872(2006.01)i, H01L 21/328(2006.01)i

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)

H01L 29/872; H01L 29/00; H01L 21/8222; H01L 21/04; H01L 29/56; H01L 29/792; H01L 21/329; H01L 29/48

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: schottky barrier diode, trench isolation, guard ring.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6096618 A (DUNN; JAMES S. et al.) 01 August 2000 See claims 1-29 and figures 1-7.	1-25
A	US 2006-0244050 A1 (JINSUKE SUDOU) 02 November 2006 See claims 1-8 and figures 1-12.	1-25
A	US 6576974 B1 (CHANG; CHYH-YIH et al.) 10 June 2003 See column 5, line 31 - column 7, line 54, and figures 7,9,11.	1-25
A	US 5109256 A (DE LONG; BANCHERD) 28 April 1992 See column 2, line 10 - column 5, line 14, and figure 1.	1-25
A	US 2010-0279483 A1 (COLLINS DAVID S. et al.) 04 November 2010 See paragraghs [0007],[0021],[0022], and figures 2,4,12.	1-25

☐ 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 but 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 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	Date of mailing of the international search report
29 AUGUST 2012 (29.08.2012)	**30 AUGUST 2012 (30.08.2012)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
LEE, SUNG JOON
Telephone No. 82-42-481-8501

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/021483

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6096618 A	01.08.2000	None	
US 2006-0244050 A1	02.11.2006	CN 100576570 C	30.12.2009
		CN 1855551 A	01.11.2006
		JP 2006-310555 A	09.11.2006
		KR 10-0733751 B1	29.06.2007
		KR 10-2006-0113531 A	02.11.2006
		TW I315099A	21.09.2009
		TW I315099B	21.09.2009
		TW 200707728 A	16.02.2007
US 6576974 B1	10.06.2003	CN 1476090 A0	18.02.2004
		CN 1476090 B	12.05.2010
		TW 578242 B	01.03.2004
US 5109256 A	28.04.1992	JP 04-359566 A	11.12.1992
		JP 3232111 B2	26.11.2001
		KR 10-0200059 B1	01.07.1999
		US 5225359 A	06.07.1993
US 2010-0279483 A1	04.11.2010	US 2007-0278614 A1	06.12.2007
		US 7821097 B2	26.10.2010