



- (51) **International Patent Classification:**  
H01L 27/115 (2006.01) H01L 21/8247 (2006.01)
- (21) **International Application Number:**  
PCT/US20 12/040232
- (22) **International Filing Date:**  
31 May 2012 (31.05.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
13/149,757 31 May 2011 (31.05.2011) US
- (71) **Applicant (for all designated States except US):** CROSS-BAR, INC. [US/US]; 3200 Patrick Henry Drive, Suite 110, Santa Clara, California 95054 (US).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** LU, Wei [CN/US]; 344 Sedgewood Lane, Ann Arbor, Michigan 48103 (US).  
JO, Sung Hyun [KR/US]; 730 East Evelyn Road, #125, Sunnyvale, California 94086 (US).
- (74) **Agent:** CHO, Steve Y.; 6100 219th Street SW, Suite 580, Mountlake Terrace, Washington 98043 (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, 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))

- (88) **Date of publication of the international search report:**  
25 April 2013

(54) **Title:** SWITCHING DEVICE HAVING A NON-LINEAR ELEMENT

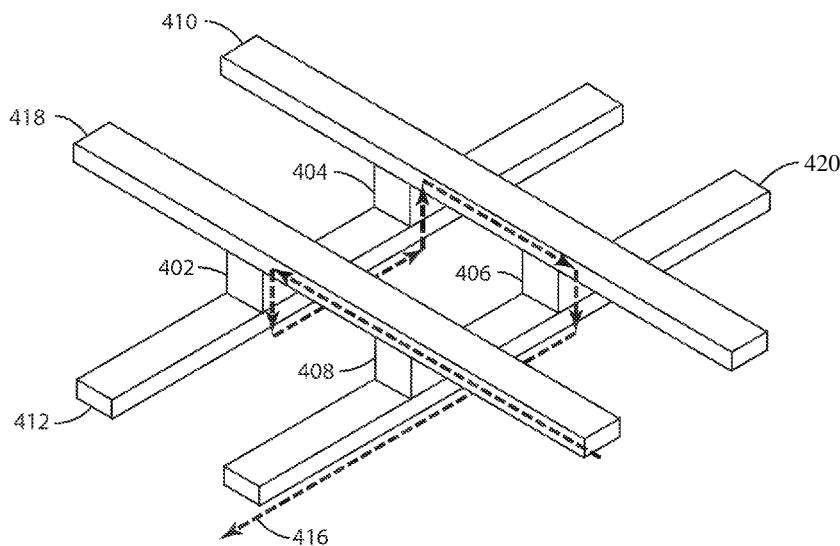


FIG. 4

(57) **Abstract:** A switching device includes a substrate; a first electrode formed over the substrate; a second electrode formed over the first electrode; a switching medium disposed between the first and second electrode; and a nonlinear element disposed between the first and second electrodes and electrically coupled in series to the first electrode and the switching medium. The nonlinear element is configured to change from a first resistance state to a second resistance state on application of a voltage greater than a threshold.



WO2012/166935 A3

**A. CLASSIFICATION OF SUBJECT MATTER****HOIL 27/115(2006.01)i, HOIL 21/8247(2006.01)1**

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)

HOIL 27/1 15; HOIL 29/861; HOIL 29/40; HOIL 45/00; HOIL 47/00; HOIL 21/16; HOIL 27/10; G1IC 11/00; G1IC 19/08

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) &amp; keywords: switch, memory, nonlinear, resistance, electrode

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011-005266 A1 (HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.) 13 January 2011	1-2, 6, 8-11
Y	See pages 4-10; claims 1-10; and figures 1A-4B.	3-5, 7
Y	US 7830698 B2 (XIYING CHEN et al.) 09 November 2010 See abstract; column 1, lines 8-34, column 2, lines 9-64, column 8, line 35 - column 11, line 53; and figures 1-2B, 7A-8K.	3-4, 7
Y	US 2004-0170040 A1 (DARRELL RINERSON et al.) 02 September 2004 See paragraphs [0033]-[0054], [0062]-[0066]; claims 1, 16, 18; and figures 1-3B, 7-9.	5
A	JP 2011-023645 A (SHARP CORP.) 03 February 2011 See abstract; paragraphs [0040]-[0063]; and figures 5, 9.	1-11
A	US 2011-0089391 A1 (ANDREI MIHNEA et al.) 21 April 2011 See paragraphs [0032]-[0049]; claim 1; and figures 1-3.	1-11
A	US 2010-0243983 A1 (TONY CHIANG et al.) 30 September 2010 See paragraphs [0021]-[0024]; claim 1; and figure 1.	1-11



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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

25 FEBRUARY 2013 (25.02.2013)

Date of mailing of the international search report

**26 FEBRUARY 2013 (26.02.2013)**

Name and mailing address of the ISA/KR

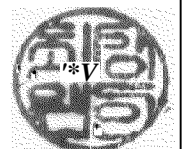


Facsimile No. 82-42-472-7140

Authorized officer

CHOI, Sang Won

Telephone No. 82-42-481-8291



**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2012/040232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011-005266 A <sup>1</sup>	13.01.2011	CN 102484129 A KR 10-2012-0037984 A TW 201121113 A US 2012-0032134 A <sup>1</sup>	30.05.2012 20.04.2012 16.06.2011 09.02.2012
US 7830698 B2	09.11.2010	US 2009-0257265 A <sup>1</sup>	15.10.2009
US 2004-0170040 A <sup>1</sup>	02.09.2004	US 6870755 B2	22.03.2005
JP 2011-023645 A	03.02.2011	None	
US 2011-0089391 A <sup>1</sup>	21.04.2011	TW 201138088 A US 8274130 B2 WO 2011-049907 A <sup>1</sup>	01.11.2011 25.09.2012 28.04.2011
US 2010-0243983 A <sup>1</sup>	30.09.2010	JP 2012-523119 A KR 10-2012-0006018 A WO 2010-117818 A2 WO 2010-117818 A3	27.09.2012 17.01.2012 14.10.2010 13.01.2011