



- (51) **International Patent Classification:**
G11C 11/42 (2006.01) *G11C 13/04* (2006.01)
G11C 16/18 (2006.01)
- (21) **International Application Number:**
PCT/IB2014/061118
- (22) **International Filing Date:**
30 April 2014 (30.04.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
1963/CHE/2013 1 May 2013 (01.05.2013) IN
- (71) **Applicant:** INDIAN INSTITUTE OF SCIENCE
[IN/IN]; Department of Physics, Bangalore 560012 (IN).
- (72) **Inventors:** ROY, Kallol; Department of Physics, Indian Institute of Science, Bangalore 560012 (IN). PADMAN-ABHAN, Medini; Department of Physics, Indian Institute of Science, Bangalore 560012 (IN). GHOSH, Arindam; Department of Physics, Indian Institute of Science, Bangalore 560012 (IN).
- (74) **Agent:** KHURANA & KHURANA, ADVOCATES AND IP ATTORNEYS; S/19-22, GNS Plaza, Opposite Hotel Radisson Blu, UPSIDC-Site-IV, Karna Road, 201308 Greater Noida (IN).

(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, BN, 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, IR, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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, KM, ML, MR, NE, SN, TD, TG).

Published:

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

(88) **Date of publication of the international search report:**
9 April 2015

(54) **Title:** NON-VOLATILE OPTO-ELECTRONIC DEVICE

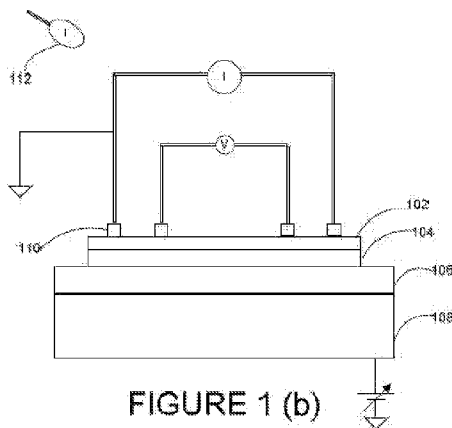


FIGURE 1 (b)

(57) **Abstract:** The present invention relates to an opto-electronic switch/memory device utilizing thin layer of exfoliated graphene laid upon monolayer or multilayer of MoS₂, forming a hetero-hybrid structure. The specific architecture of the device is planar, which can be made by laying a continuous sheet of graphene on a continuous sheet of MoS₂ (graphene-on-MoS₂) and electrode contacts are placed only on graphene layer forming an in-plane geometry.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB14/61118

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G11C 11/42, 16/18, 13/04 (2014.01)

CPC - G11C 11/42, C13/044, C16/18

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)

IPC(8) - G11C 11/42, 16/18, 13/04 (2014.01)

CPC - G11C 11/42, 13/044, 16/18; USPC - 365/10, 215, 174, 175, 208; 257/21, E21.614

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)

MicroPatent (US Granted, US Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); Google Patents; ProQuest; Google Scholar; IP.COM, IEEE Xplore; Search Terms Used: opto-electronic, optical, photonic, memory, graphene, MoS2, molybdenum disulfide, semiconductor, heterostructure, electrical contacts, exfoliat*, micromechanical, back gate, voltage, SET, RESET.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BERTOLAZZI, S et al. Nonvolatile Memory Cells Based on MoS2/Graphene Heterostructures. ACS Nano, Vol 7, 4, 3246-3252, March 19, 2013, Downloaded from the Internet: < http://pubs.acs.org/doi/abs/10.1021/nn3059136>, Page 3247, Figure 1a, Results and Discussion, paragraphs 1, 2.	1-18
Y	WO 2013/048347 A1 (NATIONAL UNIVERSITY OF SINGAPORE) April 04, 2013, Abstract.	1-18
Y	US 2012/0258311 A1 (HONG B et al.) October 11, 2012, paragraphs [0068], [0075].	3, 4, 15-18
Y	US 2012/0257446 A1 (LOU X et al.) October 11, 2012, paragraph [0031].	13

☐ Further documents are listed in the continuation of Box C.

* 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 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

25 November 2014 (25.11.2014)

Date of mailing of the international search report

24 DEC 2014

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:

Shane Thomas

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774