

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
13 January 2005 (13.01.2005)

PCT

(10) International Publication Number
WO 2005/004197 A3

(51) International Patent Classification⁷: **B32B 5/02**, 1/08,
B41J 2/14, H01L 31/109, 21/00, 47/00, 29/06, 31/0328,
33/00

(21) International Application Number:
PCT/US2004/010854

(22) International Filing Date: 8 April 2004 (08.04.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/461,346 8 April 2003 (08.04.2003) US
10/731,745 8 December 2003 (08.12.2003) US

(71) Applicant (for all designated States except US): **THE
REGENTS OF THE UNIVERSITY OF CALIFORNIA**
[US/US]; 1111 Franklin Street, 12th Floor, Oakland, CA
94602-5200 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **YANG, Peidong**

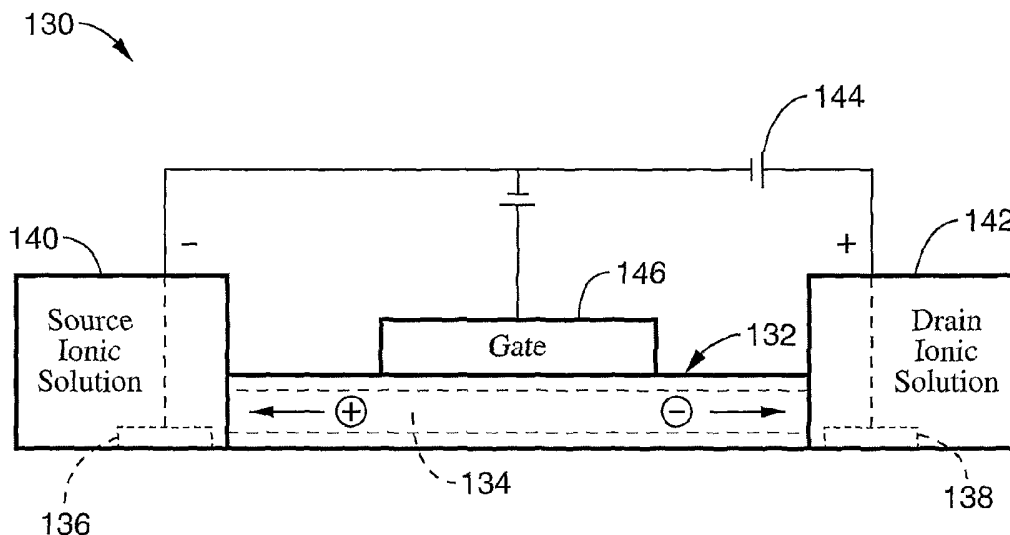
[CN/US]; 2151 California Street, Berkeley, CA 94703
(US). **HE, Rongrui** [CN/US]; 3320 Belmont Avenue,
Apt.D, El Cerrito, CA 94703 (US). **GOLDBERGER,
Joshua** [US/US]; 1329 Henry Street, Apt. 1B, Berkeley,
CA 94709 (US). **FAN, Rong** [US/US]; 5550 Central
Avenue, #7, El Cerrito, CA 94850 (US). **WU, Yiwing**
[CN/US]; 257 Wilson Street, Bldg. 79, Albany, CA 94710
(US). **LI, Deyu** [CN/US]; 435 Gooding Way #460,
Albany, CA 94706 (US). **MAJUMDAR, Arun** [US/US];
151 Ardith Drive, Orinda, CA 94563 (US).

(74) Agent: **O'BANION, John, P.**; O'Banion & Ritchey LLP,
400 Capitol Mall, Suite 1550, Sacramento, CA 95814 (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, 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, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

[Continued on next page]

(54) Title: FLUIDIC NANOTUBES AND DEVICES



(57) Abstract: Fluidic nanotube devices (29) are described in which a hydrophilic, non-carbon nanotube (152), has its ends fluidly coupled to reservoirs (154 and 156). Source and drain contacts (164 and 166) are connected to opposing ends of the nanotube, or within each reservoir near the opening of the nanotube. The passage of molecular species can be sensed by measuring current flow (source-drain, ionic, or combination). The tube interior can be functionalized by joining binding molecules (160) so that different molecular species can be sensed by detecting current changes. The nanotube may be a semiconductor (132), wherein a tubular transistor (130) is formed. A gate electrode (146) can be attached between source (136) and drain (138) to control current flow and ionic flow. By way of example an electrophoretic array embodiment is described, integrating MEMs switches. A variety of applications are described, such as: nanopores, nanocapillary devices, nanoelectrophoretic, DNA sequence detectors, immunosensors, thermoelectric devices, photonic devices, nanoscale fluidic bioseparators, imaging devices, and so forth.



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, 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, FR, GB, GR, HU, IE, IT, 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).

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:**

10 November 2005

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/US04/10854

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B32B 5/02, 1/08; B41J 2/14; H01L 31/109, 21/00, 47/00, 29/06, 31/0328, 33/00
US CL : 422/88; 347/50; 257/1, 14, 103, 200; 438/1, 2, 22, 49, 962; 423/36.9, 447.2, 447.3

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. : 422/88; 347/50; 257/1, 14, 103, 200; 438/1, 2, 22, 49, 962; 423/36.9, 447.2, 447.3

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)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/0117659 A1 (LIEBER et al) 29 August 2002 (29.08.2002) Figs. 16A-D and description	1-109
A	US 2002/0130311 A1 (LIEBER et al) 19 September 2002 (19.09.2002) claims	1-109
A,P	US 2003/0165418 A1 (AJAYAN et al) 4 September 2003 (04.09.2003) entire document	1-109
A,T	US 2004/0005723 A1 (EMPEDOCLES et al) 8 January 2004 (08.01.2004) entire document	1-109

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

☐ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

28 August 2005 (28.08.2005)

Date of mailing of the international search report

12 SEP 2005

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. (703) 305-3230

Authorized officer

Benjamin Utech

Telephone No. (571) 272-1700