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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2007 (07.09.2007)

PCT

(10) International Publication Number
WO 2007/101174 A3

(51) International Patent Classification:
B32B 9/00 (2006.01)

(21) International Application Number:
PCT/US2007/062842

(22) International Filing Date:
27 February 2007 (27.02.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/777,679 27 February 2006 (27.02.2006) US

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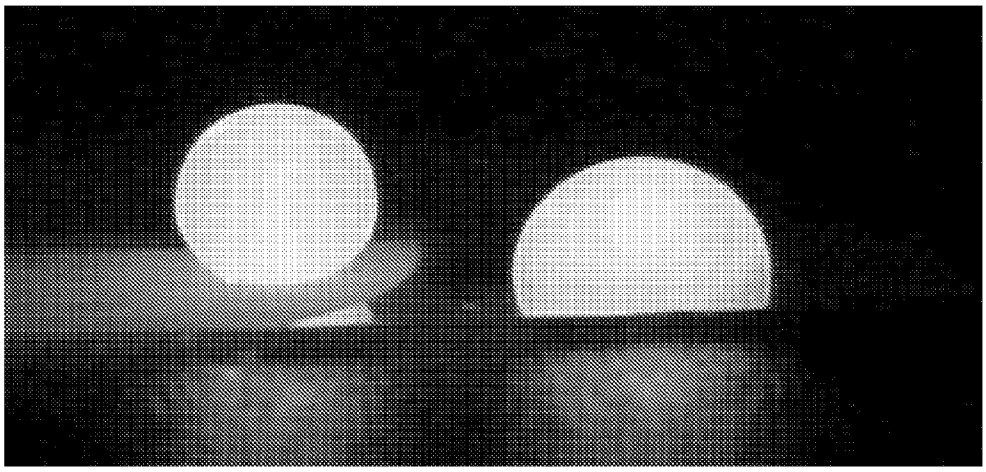
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,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

[Continued on next page]

(54) Title: DIGITAL MAGNETOFLUIDIC DEVICES AND METHODS



(57) Abstract: Disclosed are devices and methods for moving and controlling droplets of fluids on hydrophobic surfaces through the use of magnetic fields. For example, droplets can be moved, immobilized, dispensed, coalesced, and/or divided. Also disclosed is a digital magnetofluidic device comprising a hydrophobic surface; a magnetically active fluid droplet in contact with the surface; and a magnetic field coupled with at least a portion of the droplet. Also disclosed is a digital isoelectric focusing method using the devices and methods. Also disclosed are digital microelectrochemical detection methods and digital microelectrochemical reaction methods. This abstract is intended as a scanning tool for purposes of searching in the particular art and is not intended to be limiting of the present invention.

WO 2007/101174 A3

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, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, 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:
21 December 2007

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/US 07/62842

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B32B 9/00 (2007.01)
USPC - 428/403
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)
USPC 428/403

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC 428/402, 403, 405, 407; 252/62.52, 62.54

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PUBWEST (USPT, PGPB, USOC, EPAB and JPAB); Google Scholar.
Search terms: digital magnetofluidic, microfluidic, magnetic field, contact angle, roatting, hydrophobic surface, magnetic field, superhydrophobic, polyacrylate, polyacrylamide, spiropyran, isomerization, drop dynamics, microelectrochemical method, chronoamperometr

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X – Y	ATENCIA et al, "Controlled microfluidic interfaces", in Nature, 29 September 2005 (29.09.2005), Vol 437, pgs 648-655; refer to pg 648, RHS para 2; pg 651, RHS para 2, last para, "Patterened surfaces & pinnedinterfaces" para 1; pg 649, 1st para below Fig 1 on LHS, Fig 1, last para on RHS; pg 651, "Dispersion & floating interfaces" para 1; pg 650, RHS last para and 1st para and LHS 1st para below Fig 2; pg 652, LHS para 1, RHS para 1 below Fig 3.	1, 6, 7, 11, 26, 27, 87 and 99-101 ---------- 2-5, 8-10, 12-25, 28-86, 88-98, 102-105 and 108-131
X -- Y	CAMPBELL et al, "Microfluidic mixers : from microfabricated to self-assembling devices", in Phil. Trans. R. Soc. Lond. A, 2004(2004); pgs 1-18; refer to pg 11 last para and "Magnetic flux concentrators" para; pg 3 para 2; pg 1 abstract	106 ---------- 16 and 107-110
Y	STONE et al, "Enginering flows in small devices: Microfluidics toward a Lab-on-chip", in Annu. Rev. Fluid Mech. 2004 (2004). 36:3817411; refer to pg 381 "Introduction" para; pg 382 1st para and last para; pg 394, "Lamianr flow patterning & confinement" para.	8, 10, 94, 95, 113, 115-119, 131
Y	ZAHN, "Magnetic fluid and nanoparticle applications to nanotechnology", in Journal of Nanoparticle Research 2001(2001), Vol 3: 73?78; refer to pg 74 Fig 1, Fig 3; pg 73, LHS "Background to magnetic fluid technology" para 2; pg 75 "Ferrofluid behavior in AC magnetic fields" para; pg 76, "Proposed mecahnical and electrical micropower generation using roatting particles" para	3-5, 12, 13, 88-90, 93, 115-119 and 131
Y	US 2005/0250220 A1 (KOZULIC), 10 November 2005 (10.11.2005); para 0023], [0017], [0009]	9, 117- 119 and 131
Y	LEE, "Dynamic wettability switching by surface roughness effect", in Micro Electro Mechanical Systems, Jan 2003 (2003), MEMS-03 Kyoto. IEEE The Sixteenth Annual International Conference, refer to abstract.	2, 20-23, 29, 30, 54, 107, 109, 116 and 118

☒ 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
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"P" document published prior to the international filing date but later than the priority date claimed
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"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
30 August 2007 (30.08.2007)	16 OCT 2007
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: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 07/62842

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	HEMPELMANN et al., "Magnetic colloidal fluids: Preparation, characterization, Physical properties and Applications", July 20-22, 2005 (22.07.2005); refer to pg P53 1st para; pg P28 para 1; pg P58 para 1; pg T11 ln 1-2; pg P55 1st para.	13-19, 92, 96-98 and 102 -105
Y	US 20050181195 A1 (DUBROW), 18 August 2005 (18.08.2005), refer to para [0007], [0013], [0003], [0044], [0113], [0109], [0018], [0047], [0090], [0019], [0089], [0020]	24, 25, 28, 29, 31-46, 48-50, 52, 53, 55 and 60-72
Y	US 2004/0067339 A1 (CHRISTOPHE et al.),08 April 2004 (08.04.2004), refer to para [0024], [0001], [0055]	47 and 52
Y	HAN et al., "Fabrication of Superhydrophobic Surface from a Supramolecular Organosilane with Quadruple Hydrogen Bonding", in, J. Am. Chem. Soc.,Mar. 26, 2004 (26.03.2004), 126 (15), 4796 -4797; refer to abstract	51 and 55
Y	ROSARIO et al., "Lotus effect amplifies light-induced contact angle switching", in J. Phys. Chem. B, 29 Jul 2004 (29.07.2004), pgs 1-3; refer to pg 1 last para on LHS and abstract; pg 2 Fig 2 and LHS last and 2nd para; pg 1 LHS para 2 below abstract.	17, 55-59, 73-86, 91, 98 and 105
Y	GREIVELL et al., "The Design of a Ferrofluid Magnetic Pipette", in In Press, IEEE Trans. Biomedical Engineering, Sep 1996 (30.09.1996), 104, pgs 1-23;; refer to pg 5 "3. Experiments" para 2; pg 10 last para; pg 4 para 2.	111-116
Y	US 2001/0055812 A1 (MIAN et al), 27 Dec 2001 (27.12.2001), para [0003], [0049], [0098], [0199], [0200], [0177] - [0197], [0049], [0137], [0143], [0144], [0273]	120-130
Y	LU et al., "A diffuse interface model for electrowetting droplets in a Hele-Shaw cell", 31 July 2005 (31.07.2005) , pg 7 para 1; pg 8 last lien adn 2nd para; pg 9 para 1 and para below Fig 3; pg 1 para 1; pg 3 paras 2 and 3; pg 4 last 2 lines, pg 5 1st line	20-23
Y	US 2005/0086424 A1 (SCHEMBRI), 06 May 2005(06.05.2005); para [0062], [0002]	30, 46 and 54
Y	KUO et al., "A prototype high-density microfluidic optical switch", 19 February 2003 (19.02.2003); refer to abstract	86
Y	SIA et al., "Microfluidic devices fabricated in poly(dimethylsiloxane) for biological studies", in Electrophoresis 6 Nov 2003 (06.11.2003), 24, 3563?3576; refer to pg 3563 "Introduction" para 1; pg 3564 RHS para 2; pg 3570 RHS para 1 below Fig 3; pg 3571 RHS Fig 4.	45 and 65-66
Y	FONSECA et al., "A microelectrochemical actinometer for scanning electrochemical microscopy studies of photochemical processes", in Photochem. Photobiol. Sci., 6 Jan 2003 (06.01.2003), 2, 98?103, refer to pg 98, abstract	124