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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 June 2003 (05.06.2003)

PCT

(10) International Publication Number
WO 2003/045556 A3

(51) International Patent Classification[7]: B01L 3/00, G02F 1/00, F04B 19/00, B03C 5/00

(21) International Application Number: PCT/US2002/038047

(22) International Filing Date: 26 November 2002 (26.11.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/333,621 26 November 2001 (26.11.2001) US

(71) Applicant *(for all designated States except US)*: **KECK GRADUATE INSTITUTE** [US/US]; 535 Watson Drive, Claremont, CA 91711 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **STERLING, James, D.** [US/US]; 2521 Wildrose Lane, Upland, CA 91784 (US).

(74) Agents: **ABRAMONTE, Frank** et al.; Seed Intellectual Property Law Group PLLC, Suite 6300, 701 Fifth Avenue, Seattle, WA 98104-7092 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, 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, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

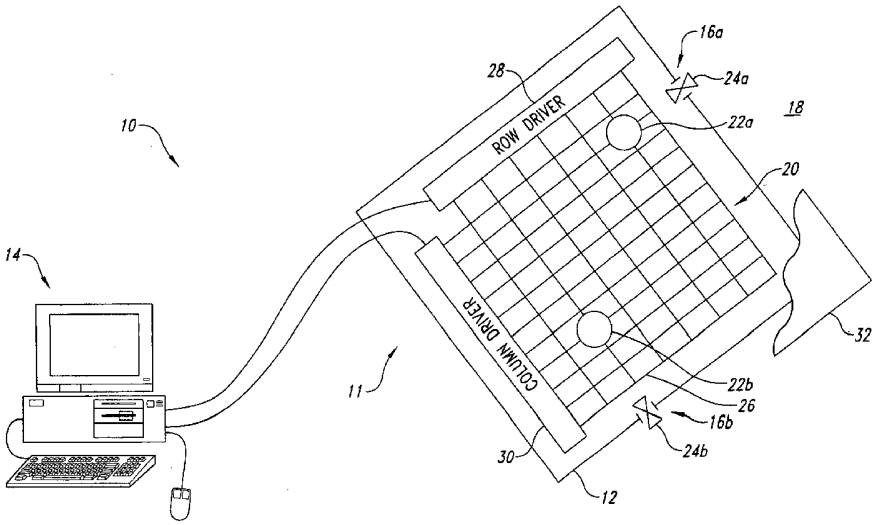
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report: 15 April 2004

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.

(54) Title: METHOD, APPARATUS AND ARTICLE FOR MICROFLUIDIC CONTROL VIA ELECTROWETTING, FOR CHEMICAL, BIOCHEMICAL AND BIOLOGICAL ASSAYS AND THE LIKE



(57) Abstract: An active matrix microfluidic platform employs thin film transistor active ("TFT") matrix liquid crystal display technology to manipulate small samples of fluid for chemical, biochemical, or biological assays without moving parts, for example, using a two-dimensional matrix array of drive electrodes. The active matrix microfluidic platform may employ existing active matrix addressing schemes and/or commercial "off-the-shelf" animation software to program assay protocols. A feedback subsystem may determine an actual location of a fluid in the microfluidic structure, and provides location information to for display, for example, on an active matrix display, and/or to control movement of one or more fluid bodies in the microfluidic structure.

WO 2003/045556 A3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/38047

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01L3/00 G02F1/00 F04B19/00 B03C5/00

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 7 F04B B01L G02F G02B B03C G06F

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2001/026935 A1 (ACKLEY DONALD E ET AL) 4 October 2001 (2001-10-04) paragraphs '0019!-'0021! paragraphs '0025!-'0040! paragraphs '0074!-'0134! figures 1A,1B,9,19 --- -/--	1-19, 34-49

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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 document 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	Date of mailing of the international search report
13 August 2003	27 08 2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Tiede, R

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	JUNGHOON LEE ET AL: "Addressable micro liquid handling by electric control of surface tension" PROCEEDINGS OF THE IEEE 14TH. ANNUAL INTERNATIONAL CONFERENCE ON MICROELECTRO MECHANICAL SYSTEMS. MEMS 2001. INTERLAKEN, SWITZERLAND, JAN. 21 - 25, 2001, IEEE INTERNATIONAL MICRO ELECTRO MECHANICAL SYSTEMS CONFERENCE, NEW YORK, NY: IEEE, US, vol. CONF. 14, 21 January 2001 (2001-01-21), pages 499-502, XP010534657 ISBN: 0-7803-5998-4 the whole document	1-19, 34-49
X	POLLACK M G ET AL: "ELECTROWETTING-BASED ACTUATION OF LIQUID DROPLETS FOR MICROFLUIDIC APPLICATIONS" APPLIED PHYSICS LETTERS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 77, no. 11, 11 September 2000 (2000-09-11), pages 1725-1727, XP000964197 ISSN: 0003-6951 cited in the application the whole document	1-19, 34-49
X	CHO S K, MOON H, FOWLER J, KIM CJ: "Splitting a liquid droplet for electrowetting-based microfluidics" PROCEEDINGS OF 2001 ASME INTERNATIONAL MECHANICAL ENGINEERING CONGRESS AND EXPOSITION, NOVEMBER 11-16, 2001, NEW YORK, vol. CONF, 16 November 2001 (2001-11-16), pages 1-7, XP002242357 the whole document	1-19, 34-49
P,A	WO 02 07503 A (KIM CHANG JIN ;LEE JUNGHOON (IL); UNIV CALIFORNIA (US)) 31 January 2002 (2002-01-31) the whole document	1-19, 34-49
T	SUNG KWON CHO ET AL: "Towards digital microfluidic circuits: creating, transporting, cutting and merging liquid droplets by electrowetting-based actuation" IEEE 0-7803-7185-2/02, 2002, pages 32-35, XP010577588 page 33, paragraph 3	1-19, 34-49

-/--

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 294 063 B1 (DE GASPERIS GIOVANNI ET AL) 25 September 2001 (2001-09-25) column 2, line 53 -column 5, line 35 column 7, line 37 -column 8, line 23 column 11, line 57 -column 22, line 4 figures 1,3,4,6-8,10,11,13	20-33, 50-60
X	WO 00 69565 A (MEDORO GIANNI ;SILICON BIOSYSTEMS S R L (IT)) 23 November 2000 (2000-11-23) page 3, line 3 -page 3, line 10 page 6, line 8 -page 7, line 7 page 12, line 3 -page 14, line 2 page 19, line 3 -page 25, line 16 figures 1-23	20-24, 27-31, 50-60
A	US 5 495 077 A (STEINBACH GUENTER ET AL) 27 February 1996 (1996-02-27) the whole document	23-26, 30-33

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/38047

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [X] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-19,34-49

   Microfluidic structure and method of using or forming the same, comprising drive electrodes, plates, thin film transistors and fluid communication ports

2. Claims: 20-33,50-60

   Microfluidic system and method of using the same, comprising feedback systems with position sensors and controllers to process their signals

Information on patent family members

International Application No
PCT/US 02/38047

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2001026935 A1	04-10-2001	US 6331274 B1	18-12-2001
		US 6099803 A	08-08-2000
		US 6287517 B1	11-09-2001
		US 5849486 A	15-12-1998
		US 5632957 A	27-05-1997
		US 6582660 B1	24-06-2003
		US 6017696 A	25-01-2000
		US 5605662 A	25-02-1997
		US 5929208 A	27-07-1999
		US 6129828 A	10-10-2000
		AU 742960 B2	17-01-2002
		AU 2763899 A	06-09-1999
		BR 9909207 A	06-11-2001
		CA 2320798 A1	26-08-1999
		CN 1296525 T	23-05-2001
		EP 1054949 A1	29-11-2000
		NZ 506204 A	30-06-2003
		WO 9942558 A1	26-08-1999
		US 2001026778 A1	04-10-2001
		US 6068818 A	30-05-2000
		US 6225059 B1	01-05-2001
		US 6254827 B1	03-07-2001
		US 6315953 B1	13-11-2001
		US 6540961 B1	01-04-2003
		US 2002028503 A1	07-03-2002
		AU 733523 B2	17-05-2001
		AU 5367198 A	29-06-1998
		BR 9713991 A	08-02-2000
		CN 1268905 A	04-10-2000
		EP 0961652 A1	08-12-1999
		JP 2002501611 T	15-01-2002
		KR 2000057400 A	15-09-2000
		WO 9824544 A1	11-06-1998
		US 6309602 B1	30-10-2001
		US 6375899 B1	23-04-2002
		US 6319472 B1	20-11-2001
		US 6423271 B1	23-07-2002
		AU 723134 B2	17-08-2000
		AU 6968996 A	17-04-1997
		BR 9610618 A	06-04-1999
		CA 2233238 A1	03-04-1997
		CN 1202929 A	23-12-1998
		EP 0852617 A1	15-07-1998
		JP 11512605 T	02-11-1999
		NZ 318253 A	28-02-2000
		US 2002085954 A1	04-07-2002
		WO 9712030 A1	03-04-1997
		US 6245508 B1	12-06-2001
		US 2002155586 A1	24-10-2002
		US 2003073122 A1	17-04-2003
WO 0207503 A	31-01-2002	AU 8079601 A	05-02-2002
		WO 0207503 A1	31-01-2002
US 6294063 B1	25-09-2001	CA 2362114 A1	17-08-2000
		EP 1154856 A2	21-11-2001
		JP 2002536167 T	29-10-2002
		WO 0047322 A2	17-08-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6294063 B1		US 2002036139 A1	28-03-2002
WO 0069565 A	23-11-2000	IT B0990262 A1	20-11-2000
		AU 4601300 A	05-12-2000
		CA 2370927 A1	23-11-2000
		CN 1361720 T	31-07-2002
		EP 1185373 A1	13-03-2002
		WO 0069565 A1	23-11-2000
		JP 2002543972 T	24-12-2002
		US 2003047456 A1	13-03-2003
		US 2002125138 A1	12-09-2002
US 5495077 A	27-02-1996	US 5374787 A	20-12-1994
		US 6414671 B1	02-07-2002
		US 6028271 A	22-02-2000
		US 5543588 A	06-08-1996
		US 5914465 A	22-06-1999
		US 5543590 A	06-08-1996
		US 5543591 A	06-08-1996
		US 5488204 A	30-01-1996
		US 6239389 B1	29-05-2001
		US 2003112228 A1	19-06-2003
		US 5942733 A	24-08-1999
		US 5889236 A	30-03-1999
		US 5880411 A	09-03-1999
		US 5861583 A	19-01-1999
		US 6380931 B1	30-04-2002
		DE 69324067 D1	29-04-1999
		DE 69324067 T2	15-07-1999
		EP 0574213 A1	15-12-1993
		US 5648642 A	15-07-1997
		US 5841078 A	24-11-1998