PATENT COOPERATION TREATY

237

From the
INTERNATIONAL SEARCHING AUTHORITY

To: John T. Pienkos
Whyte Hirschboeck Dudek S.C.
555 East Wells Street, Suite 1900
Milwaukee, Wisconsin 53202

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43bis.1)

Date of mailing
01 NOV 2007
(day/month/year)

FOR FURTHER ACTION
See paragraph 2 below

Applicant’s or agent’s file reference
UCSD-33524-A

International application No.
PCT/US 06/60313

International filing date (day/month/year)
27 October 2006 (27.10.2006)

Priority date (day/month/year)

International Patent Classification (IPC) or both national classification and IPC
IPC(8)- G02B 6/10
USPC - 385/129

Applicant
The Regents of the University of California

1. This opinion contains indications relating to the following items:
   ✓ Box No. I  Basis of the opinion
   ✓ Box No. V  Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
   □ Box No. II  Priority
   □ Box No. III  Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   □ Box No. IV  Lack of unity of invention
   □ Box No. VI  Certain documents cited
   □ Box No. VII  Certain defects in the international application
   □ Box No. VIII  Certain observations on the international application

2. FURTHER ACTION
   If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1(a)(ii) that written opinions of this International Searching Authority will not be so considered.

   If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 22 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

   For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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

Date of completion of this opinion
06 August 2007 (06.08.2007)

Authorized officer:

Form PCT/ISA/237 (cover sheet) (April 2007)
Box No. I       Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
   ☒ the international application in the language in which it was filed.
   ☐ a translation of the international application into _________ which is the language of a 
     translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to 
   this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been 
   established on the basis of:
   a. type of material
      ☐ a sequence listing
      ☐ table(s) related to the sequence listing
   b. format of material
      ☐ on paper
      ☐ in electronic form
   c. time of filing/furnishing
      ☐ contained in the international application as filed
      ☐ filed together with the international application in electronic form
      ☐ furnished subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been 
   filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that 
   in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Form PCT/ISA/237 (Box No. I) (April 2007)
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<td>1. Statement</td>
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<td>Claims: 1-36</td>
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2. Citations and explanations:

Claims 1-36 lack novelty under PCT Article 33(2) as being anticipated by the article entitled *High-Sensitivity Cytometric Detection Using Fluidic-Photonic Integrated Circuits With Array Waveguides* by (Lien et al.) (hereinafter, Lien)

As for Claim 1, Lien teaches a device comprising:
- a fluidic channel capable of conducting a fluid containing at least one particle (p. 827, para 1)
- a source of electromagnetic radiation arranged to provide the electromagnetic radiation into the fluidic channel to interact with the at least one particle contained within the fluid as the fluid is conducted by the fluidic channel (abstract); and a first plurality of optical waveguides having respectively a plurality of ends positioned along the fluidic channel (abstract), wherein the optical waveguides receive at least some of the electromagnetic radiation after the electromagnetic radiation has interacted with the at least one particle (abstract).

As for Claim 2, Lien teaches the device of claim 1, wherein the fluidic channel is a microfluidic channel and includes at least one of a substantially linear section and a substantially curved section (p. 828, Fig. 1).

As for Claim 3, Lien teaches the device of claim 2, wherein the microfluidic channel includes the substantially linear section, and wherein the substantially linear section is aligned substantially with a vertical axis, and wherein the particle includes an analyte (p. 827, para 1).

As for Claim 4, Lien teaches the device of claim 1, wherein the fluidic channel includes a substantially linear section, and wherein the source is arranged in a manner that is aligned with the substantially linear section (p. 827, para 1).

As for Claim 5, Lien teaches the device of claim 1, wherein the electromagnetic radiation is light, and wherein the source includes at least one additional waveguide that communicates the light to the fluidic channel (p. 828, para 1).

As for Claim 6, Lien teaches the device of claim 5, wherein the at least one additional waveguide includes first and second additional waveguides that are aligned with one another and with a substantially linear section of the fluidic channel, and wherein the first and second additional waveguides extend away from one another and from the fluidic channel at respective opposite ends of the substantially linear section of the fluidic channel (p. 828, para 1).

As for Claim 7, Lien teaches the device of claim 1, wherein the first plurality of optical waveguides form a first array of waveguides that extend substantially parallel to one another away from the fluidic channel, the ends of the waveguides being spaced apart along the fluidic channel (p. 828, para 1).

As for Claim 8, Lien teaches the device of claim 7, further comprising a second plurality of optical waveguides forming a second array of waveguides (p. 828, para 1).

As for Claim 9, Lien teaches the device of claim 8 as the following is true: each of the first and second arrays includes a respective set of eight waveguides (p. 828, para 1).

As for Claim 10, Lien teaches the device of claim 1, further comprising a demultiplexer by which signals from the plurality of waveguides are combined (p. 828, para 2).

As for Claim 11, Lien teaches the device of claim 1, wherein the plurality of waveguides and the fluidic channel are formed on an integrated circuit structure that is a fluidic-photonic integrated circuit (FPIC) device (abstract).

As for Claim 12, Lien teaches the device of claim 11, wherein the FPIC device is formed substantially entirely from a polymer material (p. 829, para 1).

As for Claim 13, Lien teaches a system comprising the device of claim 1, and further comprising at least one additional device selected from the group consisting of a CCD camera, and another sensor, wherein at least one signal from the plurality of waveguides is received at least indirectly by the at least one additional device (p. 829, Fig. 3).

(Continued in Supplemental Box)
In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Box V. 2. Citations and explanations:

As for Claim 14, Lien teaches the system of claim 13, further comprising at least one of a pumping unit governing a flow of the fluid, and a laser excitation source delivering light to the source so that the source can further provide the electromagnetic radiation to the fluidic channel (p. 829, Fig. 3).

As for Claim 15, Lien teaches a flow cytometry system comprising the device of claim 1 (abstract).

As for Claim 16, Lien teaches a system comprising the device of claim 1 and further comprising a processing device, wherein the processing device is configured to perform at least one of the following based upon information derived from the at least some electromagnetic radiation received by the plurality of waveguides: a calculation to determine a time-of-flight (p. 829, para 2).

As for Claim 17, Lien teaches a fluidic-photic integrated circuit (FPIC) device comprising:
a microfluidic channel (abstract); means for exciting a material within the microfluidic channel; and a first optical waveguide for receiving electromagnetic radiation as a result of the exciting of the material (abstract), wherein information regarding the material is detected based upon the received electromagnetic radiation (abstract).

As for Claim 18, Lien teaches the FPIC device of claim 17, further comprising a plurality of electrodes extending toward a target region within the microfluidic channel (p. 828, para 1).

As for Claim 19, Lien teaches the FPIC device of claim 18, further comprising a second optical waveguide capable of delivering incident light to the target region, wherein the incident light is scattered upon reaching the material, and wherein the scattered light is the electromagnetic radiation received by the first optical waveguide (para 829, para 2) (p. 827, para 2).

As for Claim 20, Lien teaches the FPIC device of claim 19, wherein the plurality of electrodes includes four pairs of electrodes, and wherein each of the first and second waveguides are embedded within an integrated circuit between first and second planes along which lie respective first and second electrodes of each of the respective four pairs of electrodes (para 829, para 1).

As for Claim 21, Lien teaches the FPIC device of claim 17, further comprising a second optical waveguide, wherein the first and second waveguides extend substantially parallel to one another and away from the microfluidic channel (p. 828, para 1).

As for Claim 22, Lien teaches the FPIC device of claim 17, wherein the integrated circuit is a polydimethylsiloxane (PDMS)-based microchip, and wherein the device is configured for use in a flow cytometry application (p. 829, para 1).

As for Claim 23, Lien teaches a method of forming the FPIC device of claim 17, the method comprising:

• assembly a first electrode upon a polymer substrate; positioning the first waveguide in relation to the first electrode so that the first electrode is positioned between the first waveguide and the polymer substrate; assembling a second electrode in relation to the first waveguide such that the first waveguide is positioned between the first electrode and the second electrode; and assembling an additional polymer substrate in relation to the first and second electrodes and the first waveguide so that a fluidic channel is formed between the waveguide, the electrodes, and the polymer substrates (p. 829, para 1).

As for Claim 24, Lien teaches a method of manufacturing a fluidic-photic integrated circuit (FPIC) device, the method comprising: casting pre-polymer onto a photo-lithographically patterned mold, thermally-curing the pre-polymer; demolding a first piece of thermally-cured polymer from the mold; bonding the first piece to a second piece of polymer material to form a fluidic channel; and implementing the fluidic channel in relation to a further structure capable of receiving and guiding electromagnetic radiation away from the fluidic channel (p. 829, para 1).

As for Claim 25, Lien teaches the method of claim 24, wherein the implementing of the fluidic channel includes: filling an additional channel with additional polymer having a higher refractive index that that of the first piece; and performing a curing operation in relation to the filled additional channel to generate at least one waveguide (p. 829, para 1).

As for Claim 26, Lien teaches the FPIC device formed using the method of claim 24, wherein the FPIC device includes a plurality of waveguides extending away from the fluidic channel (p. 829, para 2).

As for Claim 27, Lien teaches the FPIC device of claim 26, wherein the fluidic channel is a microfluidic channel (abstract).

As for Claim 28, Lien teaches a method of obtaining information regarding at least one particle suspended within a flowing fluid, the method comprising:

• applying incident light to the fluid and to the at least one particle suspended within the fluid as the fluid flows through a fluidic channel;

• guiding scattered or fluorescent light resulting from an interaction between the incident light and the at least one particle by way of a plurality of optical waveguides extending away from the fluidic channel to at least one detection device; and

• performing a calculation based upon the at least one signal resulting in the information, the information being indicative of at least one characteristic of the at least one particle (p. 830, para 1).

(Continued in Supplemental Box)
In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Box V, 2. Citations and explanations:

As for Claim 29, Lien teaches the method of claim 28, wherein the waveguides of the plurality form an array of substantially-parallel waveguides having respective ends that are spaced apart from one another along the fluidic channel (p. 829, para 2).

As for Claim 30, Lien teaches the method of claim 29, wherein the waveguides merge with one another as they extend away from the fluidic channel, so that the scattered or fluorescent light of the waveguides is demultiplexed to arrive at a single, overall signal (p. 829, para 2).

As for Claim 31, Lien teaches the method of claim 29, wherein the at least one signal includes a plurality of signals, and wherein the calculation involves determining a product of a plurality of values corresponding respectively to the plurality of signals corresponding to a plurality of shifted times (p. 831, para 1).

As for Claim 32, Lien teaches the method of claim 31, wherein the plurality of shifted times are shifted relative to one another by respective multiples of a transit time required for the at least one particle to proceed between a neighboring pair of the substantially-parallel waveguides (p. 831, para 2) (p. 831, eq. (3)).

As for Claim 33, Lien teaches the method of Claim 26, wherein the performing of the calculation based upon the at least one signal is based upon a first assumed transit time required for the at least one particle to proceed between a neighboring pair of the substantially-parallel waveguides, and further comprising iteratively performing additional calculations based upon the at least one signal that are respectively based upon additional assumed transit times required for the at least one particle to proceed between the neighboring pair of the substantially-parallel waveguides, wherein each additional calculation results in a respective additional piece of information (p. 831, para 1 and 2).

As for Claim 34, Lien teaches the method of claim 33, further comprising determining whether a threshold number of successive ones of the respective additional pieces of information have been determined to be substantially equal to zero and, if so, ceasing to perform the additional calculations (page 831, para 2).

As for Claim 35, Lien teaches the method of claim 33, comprising calculating a sum of the information and the additional pieces of information, and outputting at least one of the information, the sum, and derivative information based upon at least one of the information and the sum (p. 831, para 2).

As for Claim 36, Lien teaches the method of claim 27, wherein the calculation involves a calculation to determine a time-of-flight (p. 829, para 2).

Claims 1-36 have industrial applicability as defined by PCT Article 33(4) because the subject matter claimed can be made or used in industry.