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5 February 2009

(54) Title: SELF-EXCITING, SELF-SENSING PIEZOELECTRIC CANTILEVER SENSOR FOR DETECTION OF AIRBORNE ANALYTES DIRECTLY IN AIR

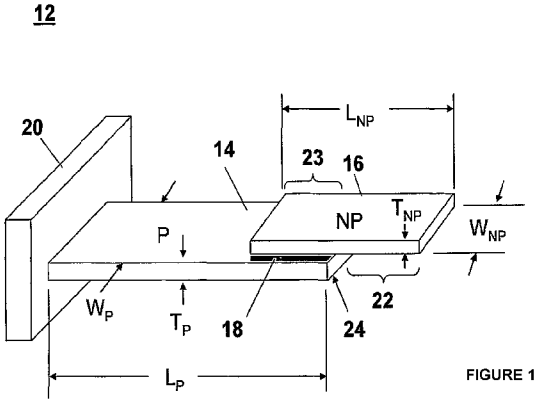


FIGURE 1

(57) Abstract: A method for detection of airborne biological agent using a piezoelectric cantilever sensor that includes a piezoelectric layer and a non-piezoelectric layer. A recognition entity is placed on one or both of the two layers. The antibody that recognizes and binds to the airborne species may be chemically immobilized on the cantilever sensor surface. In one embodiment, the cantilever sensor is attached to a base at only one end. In another embodiment, the sensor includes first and second bases and at least one of the piezoelectric layer and the non-piezoelectric layer is affixed to each of the first and second bases to form a piezoelectric cantilever beam sensor. In this embodiment, resonance is measured via stress on the piezoelectric layer and it has been demonstrated that such sensors are robust and exhibit excellent sensing characteristics in gaseous media with sufficient sensitivity to detect airborne species at relatively low concentrations.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N27/00 G01N29/02 G01N29/036 B06B1/06 B81B3/00
H01L41/113

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)
G01N B06B B81B H01L G01P

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, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CAMPBELL ET AL: "Detection of pathogen Escherichia coli 0157:H7 using self-excited PZT-glass microcantilevers" BIOSENSORS & BIOELECTRONICS, ELSEVIER SCIENCE PUBLISHERS, BARKING, GB, vol. 21, no. 3, 15 September 2005 (2005-09-15), pages 462-473, XP005001261 ISSN: 0956-5663	47-50
Y	abstract; figures 1-3 page 463, left-hand column, last paragraph - page 468, right-hand column, last paragraph	1-17
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family 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
23 November 2007	20/02/2008

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/011402

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ZHOU J ET AL: "Zeolite-modified microcantilever gas sensor for indoor air quality control" SENSORS AND ACTUATORS B, ELSEVIER SEQUOIA S.A., LAUSANNE, CH, vol. 94, no. 3, 1 October 2003 (2003-10-01), pages 337-342, XP004442296 ISSN: 0925-4005 abstract; figures 1-4 page 338, left-hand column, paragraph 2 - page 341, right-hand column, paragraph 1	1-17, 47-50
X	YI JEONG W ET AL: "In situ cell detection using piezoelectric lead zirconate titanate-stainless steel cantilevers" JOURNAL OF APPLIED PHYSICS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 93, no. 1, 1 January 2003 (2003-01-01), pages 619-625, XP012057718 ISSN: 0021-8979	47-50
Y	abstract; figures 1-4 page 620, left-hand column, paragraph 2 - page 622, right-hand column, paragraph 1	1-17
Y	EP 1 536 227 A (KOREA INST SCIENCE TECHNOLOGY [KR]) 1 June 2005 (2005-06-01) abstract; figures 2,3 paragraphs [0015] - [0043]	1-17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/011402

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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 No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

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

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers 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.:

see annex

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ 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: 1-17, 47-50

Monitoring an airborne target analyte with a millimeter-sized sensor comprising a piezoelectric layer attached to a base and a non-piezoelectric layer associated with a recognition entity, wherein the sensor is mounted in an air flow.

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2. claims: 18, 51

Apparatus for monitoring a target analyte comprising a second non-piezoelectric layer overlapping and being attached to the piezoelectric layer, wherein the second non-piezoelectric layer is associated with the recognition entity

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3. claims: 19-38, 52-56

Monitoring a target analyte with an apparatus comprising a non-piezoelectric and a piezoelectric layer, respectively, attached to two bases forming a beam between the two bases, wherein a piezoelectric and a non-piezoelectric layer, respectively, are adhered to the beam layer.

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4. claims: 39-43

Monitoring a target analyte with an exposure tube assembly comprising a millimeter-sized cantilever sensor, a nebulizer, an air supply and an analyzer to indicate the amount of mass of the airborne target analyte collected in the sensor.

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5. claims: 44-46

Apparatus for holding an airborne target analyte sensor, the apparatus comprising a gas inlet, a gas flow chamber channelling the flow of gas from the gas inlet to an exhaust port and a mounting portion holding the sensor.

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6. claims: 57-61

Monitoring a target analyte with a millimeter-sized sensor wherein enhanced detectably of the target analyte is achieved by selecting a geometry of the piezoelectric layer and a geometry of the non-piezoelectric layer to achieve at least one dominant higher order mode of the sensor at a location of the electrodes.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US2007 /011402

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2007/011402

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1536227 A	01-06-2005	JP 2005156526 A	16-06-2005
		KR 20050050425 A	31-05-2005
		US 2005112621 A1	26-05-2005