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(54) Title: ORGANELLES IN BIOANODES, BIOCATHODES, AND BIOFUEL CELLS

(57) Abstract: Bioanodes, biocathodes, and biofuel cells comprising an electron conductor, at least one anode organelle or cathode organelle, and an organelle immobilization material. The anode organelle is capable of reacting with a fuel fluid to produce an oxidized form of the fuel fluid, and capable of releasing electrons to the electron conductor. The cathode organelle is capable of reacting with an oxidant to produce water, and capable of gaining electrons from the electron conductor. The organelle immobilization material for both the anode organelle and the cathode organelle is capable of immobilizing the organelle, and is permeable to the fuel fluid and/or the oxidant. In various embodiments, the organelle immobilization material is further capable of stabilizing the organelle.



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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/073596A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M8/16 C12Q1/00 C12N11/02

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)
H01M C12Q C12N

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 A	US 4 224 125 A (NAKAMURA KENICHI ET AL) 23 September 1980 (1980-09-23) column 4, line 32 - line 40 column 13, line 12 - line 65 example 1 column 7, line 50 - line 56 ----- -/--	1-46

 Further documents are listed in the continuation of Box C. 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)
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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
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- *&* document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/073596

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LAM K B ET AL: "Biological self-assembled monolayers for photosynthetic solar cell and sensing applications" SOLID-STATE SENSORS, ACTUATORS AND MICROSYSTEMS, 2005. DIGEST OF TECHNICAL PAPERS. TRANSDUCERS '05. THE 13TH INTERNATIONAL CONFERENCE ON SEOUL, KOREA JUNE 5-9, 2005, PISCATAWAY, NJ, USA, IEEE, vol. 2, 5 June 2005 (2005-06-05), pages 1772-1775, XP010828838 ISBN: 978-0-7803-8994-6 page 1772, left-hand column, paragraph 2 - paragraph 3 page 1773, left-hand column, paragraph 2 page 1773, right-hand column, paragraph 1	1-46
X	JP 56 039785 A (JAPAN ATOMIC ENERGY RES INST) 15 April 1981 (1981-04-15) abstract	4,5
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A	WO 2005/093888 A (UNIV ST LOUIS [US]; MINTEER SHELLEY D [US]; TOPCAGIC SABINA [US]; TREU) 6 October 2005 (2005-10-06) the whole document	1-46
A	US 2004/101741 A1 (MINTEER SHELLEY D [US] ET AL) 27 May 2004 (2004-05-27) cited in the application the whole document	1-46
A	US 4 117 202 A (BECK TIMOTHY A) 26 September 1978 (1978-09-26) column 2, line 8 - line 19 column 5, line 20 - column 6, line 52	1-46
A	LAM K B ET AL: "A bio-solar cell powered by sub-cellular plant photosystems" MICRO ELECTRO MECHANICAL SYSTEMS, 2004. 17TH IEEE INTERNATIONAL CONFERENCE ON (MEMS) MAASTRICHT, NETHERLANDS 25-29 JAN. 2004, PISCATAWAY, NJ, USA, IEEE, US, 25 January 2004 (2004-01-25), pages 220-223, XP010767864 ISBN: 978-0-7803-8265-7 page 220, right-hand column, paragraph 1 - page 221, left-hand column, paragraph 1 page 223, left-hand column, paragraph 3	1-46

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/073596

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	<p>LAM ET AL: "Bioelectrocatalytic self-assembled thylakoids for micro-power and sensing applications" SENSORS AND ACTUATORS B, ELSEVIER SEQUOIA S.A., LAUSANNE, CH, vol. 117, no. 2, 12 October 2006 (2006-10-12), pages 480-487, XP005591601 ISSN: 0925-4005 page 480, left-hand column, paragraph 2 page 481, right-hand column, paragraph 2 - paragraph 3 page 484</p>	1, 30, 34, 35
T	<p>ARECHEDERRA R ET AL: "Organelle-based biofuel cells: Immobilized mitochondria on carbon paper electrodes" ELECTROCHIMICA ACTA, ELSEVIER SCIENCE PUBLISHERS, BARKING, GB, vol. 53, no. 23, 1 October 2008 (2008-10-01), pages 6698-6703, XP022940429 ISSN: 0013-4686 [retrieved on 2008-02-05] the whole document</p>	1-46

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/073596

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 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.:

1-46

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: 1-46

A bioelectrode comprising an electron conductor, at least one organelle comprising at least one enzyme; and an organelle immobilization material capable of immobilizing the organelle, wherein the organelle is isolated from a cell or the organelle immobilization material is non-microbial.
Biofuel cell comprising the bioelectrodes.

2. claims: 47-50

A bioanode comprising
a) an electron conductor;
b) at least one enzyme capable of reacting with a fuel fluid to produce an oxidized form of the fuel fluid, the enzyme either being capable of releasing electrons to the electron conductor or capable of releasing electrons to an electron mediator; and
c) an enzyme immobilization material capable of immobilizing and stabilizing the enzyme, the material being permeable to the fuel fluid;
wherein the enzyme comprises a glycolysis enzyme, a Krebs cycle enzyme or a combination thereof.

3. claims: 51,52

A biofuel cell wherein the organelle is mitochondria, the fluid is pyruvate, and the bioanode further comprises an agent which inhibits the enzyme from reacting with the fuel fluid until the mitochondria is exposed to a nitroaromatic explosive; an alarm signal being produced when the nitroaromatic explosive is present; and an alarm that detects the alarm signal and provides an alert to the presence of the explosive.
A method for detecting a nitroaromatic explosive using the biofuel from above.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2007/073596

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