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(54) **Title:** DIRECT OXIDATION FUEL CELLS WITH IMPROVED CATHODE GAS DIFFUSION MEDIA FOR LOW AIR STOICHIOMETRY OPERATION

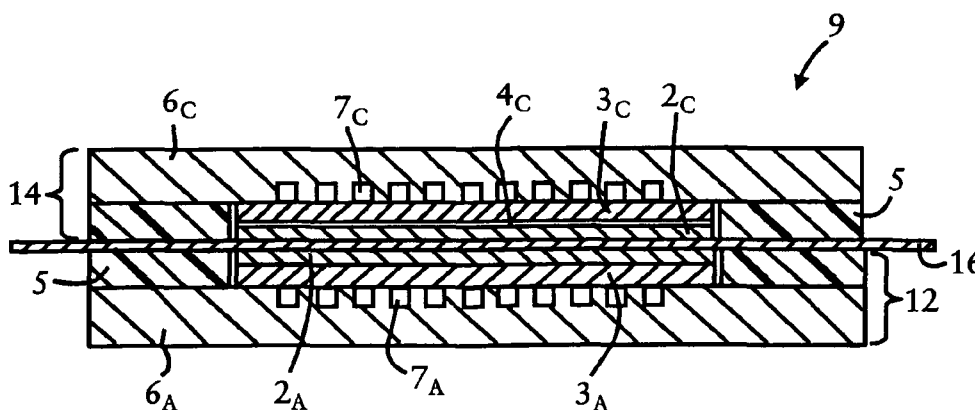


FIG. 2

(57) **Abstract:** A cathode (14) for use in a direct oxidation fuel cell (DOFC) comprises a gas diffusion 'medium (3c) (GDM) including a backing layer such as carbon' paper or woven or non-woven cloth and a microporous layer (4c) comprising a fluoropolymer and an electrically conductive material, wherein loading of the fluoropolymer in the microporous layer, is in the range from about 10 to about 60 wt. %. In use, a concentrated solution of a liquid fuel is supplied to an anode and an oxidant to the cathode of the fuel cell, and the fuel cell may be operated at a low oxidant • stoichiometry &xi;-c not. greater than about 2.5.

## INTERNATIONAL SEARCH REPORT

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**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. H01M4/86 H01M8/10

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)

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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

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, L	US 2006/141338. A1 (WANG CHAO-YANG [US] ET AL) 29 June 2006 (2006-06-29)  figure 2 paragraphs [0006] - [0009], [0014], [0038] - [0043] -----	1-3, 5, 7-12, 14, 16-19
X, P, L	WO 2007/081443 A (MATSUSHITA ELECTRIC IND CO LTD [JP]; PENN STATE RES FOUND [US]; AKIYAM) 19 July 2007 (2007-07-19) figure 2 paragraphs [0018], [0020], [0042], [0043], [0046], [0054] ----- -/-	1-3, 5-12, 14-17



Further documents are listed in the continuation of Box C.



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(^Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	<p>US 2004/121122 A1 (REYNOLDS ROBERT A [US] ET AL) 24 June 2004 (2004-06-24)</p> <p>example 1 paragraphs [0050], [0051], [0055], [0066]</p> <p>-----</p>	<p>1-3, 6-12, 14-17</p>
X	<p>EP 1 289 036 A (SANYO ELECTRIC CO [OP]) 5 March 2003 (2003-03-05)</p> <p>figure 2 table 1 paragraphs [0001], [0037], [0042] - [0045], [0062]</p> <p>-----</p>	<p>1-4, 7-14, 16, 17</p>
X	<p>WO 02/056404 A (SHOWA DENKO KK [JP]; YOSHIDA TOMOAKI [JP]; MORITA TOSHIO [JP]) 18 July 2002 (2002-07-18)</p> <p>figure 6 page 21, line 33 - page 22, line 2 examples 5-7</p> <p>-----</p>	<p>1-3, 7, 8</p>
X	<p>WO 2005/124903 A (NISSAN MOTOR [OP]; ICHIKAWA SATORU; YAMAMOTO MASAHIRO; WAKI NORIHISA) 29 December 2005 (2005-12-29)</p> <p>EP 1775788 taken as appropriate translation; citations relate thereto &amp; EP 1 775 788 A (NISSAN MOTOR [OP]) 18 April 2007 (2007-04-18)</p> <p>figure 1 paragraphs [0038] - [0041], [0047], [0065]</p> <p>-----</p>	<p>1-3, 6-8</p>

# INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/US2007/025591

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006141338 A1	29-06-2006	EP 1829144 A1 WO 2006071325 A1	05-09-2007 06-07-2006
WO 2007081443 A	19-07-2007	US 2007154777 A1	05-07-2007
US 2004121122 A1	24-06-2004	AU 2003303480 A1 BR 0317460 A CA 2511020 A1 CN 1754277 A EP 1573843 A2 JP 2006511429 T KR 20050088192 A MX PA05006597 A WO 2004058494 A2	22-07-2004 16-11-2005 15-07-2004 29-03-2006 14-09-2005 06-04-2006 02-09-2005 22-02-2006 15-07-2004
EP 1289036 A	05-03-2003	CA 2380427 A1 FR 2809814 A1 WO 0193356 A1 JP 3594533 B2 JP 2001338655 A US 2002146616 A1	06-12-2001 07-12-2001 06-12-2001 02-12-2004 07-12-2001 10-10-2002
WO 02056404 A	18-07-2002	CA 2434086 A1 EP 1354366 A1	18-07-2002 22-10-2003
WO 2005124903 A	29-12-2005	CA 2571753 A1 EP 1775788 A1 JP 2006004879 A	29-12-2005 18-04-2007 05-01-2006
EP 1775788 A	18-04-2007	CA 2571753 A1 JP 2006004879 A WO 2005124903 A1	29-12-2005 05-01-2006 29-12-2005