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80401-1887 (US). **AIETA, Niccolo, V.**; 1500 Illinois Street, Golden, Colorado 80401-1887 (US).

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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

[Continued on next page]

(54) Title: POLYMER ELECTROLYTES INCLUDING HETEROPOLYACIDS

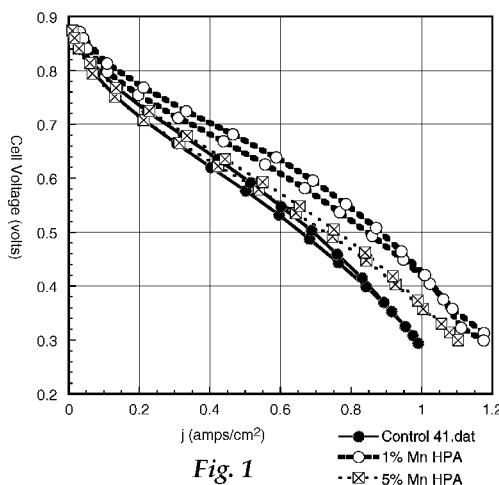


Fig. 1

(57) Abstract: This disclosure provides polymer electrolytes, polymer electrolyte membranes (PEM's) and membrane electrode assemblies (MEA's) such as may be useful in fuel cells which contain or comprise polyoxometalates (POM's) or heteropolyacids (HPA's). In some embodiments the polyoxometalate, it's counterions or both may comprise Mn and/or Ce. In some embodiments the polymer electrolyte is fluorinated. In some embodiments the polymer electrolyte comprises a second acidic functional group other than a polyoxometalate. In another aspect, the present disclosure provides methods of making polymer electrolytes including methods comprising a step of copolymerizing monomers comprising a covalently bound polyoxometalates and methods which comprise a step of covalently attaching a polyoxometalate to the polymer.



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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/082783

A. CLASSIFICATION OF SUBJECT MATTER
INV. 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)
H01M

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, INSPEC

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 2006/159975 A1 (KIM HAE-KYOUNG [KR]; BALKUS KENNETH J JR [US]; CHANG HYUK [KR]; FERRAR) 20 July 2006 (2006-07-20) paragraph [0028] paragraph [0037] - paragraph [0040] paragraph [0045] - paragraph [0051] paragraph [0052] - paragraph [0053] claims 1-27 ----- -/--	1-10, 14-19, 25-26 11-13,23

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)
- "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.
- "Z" document member of the same patent family

Date of the actual completion of the international search

14 January 2010

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International application No

PCT/US2008/082783

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 427 043 A1 (SEKISUI CHEMICAL CO LTD [JP]) 9 June 2004 (2004-06-09)	23
A	paragraph [0054] paragraph [0089] paragraph [0090] paragraph [0092] paragraph [0093] - paragraph [0094] paragraph [0152] - paragraph [0158] paragraph [0165] paragraph [0166] - paragraph [0184] examples 1,5,8 claims 1,6,7,34	1-19
A	----- W0 03/073543 A2 (CREAVIS TECH & INNOVATION GMBH [DE]; HENNIGE VOLKER [DE]; HYING CHRIS) 4 September 2003 (2003-09-04) page 1, line 1 - line 9 page 1, line 20 - line 324 page 15, line 5 - line 13 page 17, line 1 - page 6, line 22 page 18, line 6 - line 25 claims 11,13,15,39	1-19,23, 25-26
A	----- EP 1 772 919 A1 (ASAHI GLASS CO LTD [JP]) 11 April 2007 (2007-04-11) cited in the application claims 1,5-8	1-19,23, 25-26
A,P	----- EP 1 914 824 A1 (ASAHI GLASS CO LTD [JP]) 23 April 2008 (2008-04-23) paragraph [0008] paragraph [0052] paragraph [0056]	1-19,23, 25-26
X	----- US 6 706 833 B1 (MAATTA ERIC A [US] ET AL) 16 March 2004 (2004-03-16)	18, 20-22, 27-29
A	paragraph [0002] paragraph [0004] paragraph [0006] paragraph [0008] paragraph [0009] - paragraph [0010] paragraph [0011] - paragraph [0015] paragraph [0029] paragraph [0032] paragraph [0035] - paragraph [0036] paragraph [0038] the whole document -/--	19,24,30

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2008/082783

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	& P. JUDEINSTEIN: "Synthesis and Properties of Polyoxometalates Based Inorganic-Organic Polymers" CHEMISTRY OF MATERIALS, vol. 4, no. 4, 1992, pages 4-7, XP002563240 American Chemical Society	18, 20-22, 27-29
A	page 4, column 2, paragraph 1 - paragraph 3 page 5, column 1, paragraph 1 - column 2, paragraph 2 page 6, column 1, paragraph 1 page 7, column 1, paragraph 2 - paragraph 3	19, 24, 30
A	----- EP 1 085 038 A1 (AGENCY IND SCIENCE TECHN [JP]; SEKISUI CHEMICAL CO LTD [JP]; HONMA IT) 21 March 2001 (2001-03-21) paragraph [0001] paragraph [0004] - paragraph [0005] paragraph [0013] - paragraph [0014] paragraph [0022] - paragraph [0024] paragraph [0053] - paragraph [0054] paragraph [0067] - paragraph [0070] paragraph [0072] paragraph [0093] - paragraph [0095] claims 9, 10, 11, 21	18-22, 24, 27-30
A	----- WO 2007/041473 A1 (BATTELLE MEMORIAL INSTITUTE [US]; RAMANATHAN LALGUDI S [IN]; SAYRE JAY) 12 April 2007 (2007-04-12) page 3, line 11 - line 26 -----	18-22, 24, 27-30

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/082783

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 all searchable 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.:

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, 23, 25-26(completely); 18-19(partially)

A polymer electrolyte composition comprising: a polymer electrolyte and heteropolyacid and a counterion to the heteropolyacid as additive, characterised in that the counterion to the heteropolyacid comprises a transition metal selected from the group consisting of Mn or Ce.

2. claims: 20-22, 24, 27-30(completely); 18-19(partially)

Methods of making an inorganic organic hybrid polymer electrolyte comprising the steps of: a) providing a polymer comprising three or more silane groups or phosphonic acid groups which serve as binding sites for lacunary heteropolyacids; and b) covalently attaching the lacunary heteropolyacids to a silane group or a phosphonic acid group of the polymer.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2008/082783

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006159975	A1	20-07-2006	NONE
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