

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
7 May 2009 (07.05.2009)

PCT

(10) International Publication Number  
**WO 2009/058548 A3**

(51) International Patent Classification:

**C01B 25/36** (2006.01)    **B01J 27/18** (2006.01)  
**C01B 37/04** (2006.01)    **B01J 29/04** (2006.01)

(21) International Application Number:

PCT/US2008/079766

(22) International Filing Date: 14 October 2008 (14.10.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

11/934,200                      2 November 2007 (02.11.2007)    US

(71) Applicant (for all designated States except US): **UOP LLC** [US/US]; 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **LIU, Chunqing** [CN/US]; Uop Llc, 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US). **WILSON, Stephen T.** [US/US]; UOP LLC, 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US). **LESCH, David A.** [US/US]; Uop Llc, 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US).

(74) Common Representative: **UOP LLC**; 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:  
9 July 2009



**WO 2009/058548 A3**

(54) Title: MICROPOROUS ALUMINOPHOSPHATE MOLECULAR SIEVE MEMBRANES FOR HIGHLY SELECTIVE SEPARATIONS

(57) Abstract: The present invention discloses microporous aluminophosphate (AIPO<sub>4</sub>) molecular sieve membranes and methods for making and using the same. The microporous AIPO<sub>4</sub> molecular sieve membranes, particularly small pore microporous AIPO-14 and AIPO-18 molecular sieve membranes, are prepared by three different methods, including in-situ crystallization of a layer of AIPO<sub>4</sub> molecular sieve crystals on a porous membrane support, coating a layer of polymer-bound AIPO<sub>4</sub> molecular sieve crystals on a porous membrane support, and a seeding method by in-situ crystallization of a continuous second layer of AIPO<sub>4</sub> molecular sieve crystals on a seed layer of AIPO<sub>4</sub> molecular sieve crystals supported on a porous membrane support. The microporous AIPO<sub>4</sub> molecular sieve membranes have superior thermal and chemical stability, good erosion resistance, high CO<sub>2</sub> plasticization resistance, and significantly improved selectivity over polymer membranes for gas and liquid separations, including carbon dioxide/methane, carbon dioxide/nitrogen and hydrogen/methane separations.

**A. CLASSIFICATION OF SUBJECT MATTER***C01B 25/36(2006.01)i, C01B 37/04(2006.01)i, B01J 27/187(2006.01)i, B01J 29/04(2006.01)i*

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)

IPC C01B 13/00, C01B 21/04, B01D 53/22, B01D 63/04,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975.

Japanese Utility models and applications for Utility models since 1975.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal) &amp; keyword : membrane, aluminophosphate molecular sieve, secondary growth, thin film

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	M. VILASECA et al. Applied Surface Science Vol. 226, pp 1-6, 2004 See the experimental section	1-6,8,9
X	US 7138006 B2 (STEPHEN J. MILLER et al.) 21 November 2006	7-15
Y	See the abstract, column 10 line 5 - column 14 line 9 and figure 1	1-6,8,9
A	US 6472016 B1 (RAYMOND SORIA and PHILIPPE CHANAUD) 29 October 2002 See the abstract and column 2 line 66 - column 4 line 22	1-15
A	US 6060415 A (KUEI-JUNG CHAO et al.) 09 May 2000 See the abstract and column 2 lines 26-47	1-15

 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 application or patent 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 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

25 MAY 2009 (25.05.2009)

Date of mailing of the international search report

**25 MAY 2009 (25.05.2009)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office  
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

LEE Sung Reol

Telephone No. 82-42-481-5598



**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 the extra 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 fee, this Authority did not invite payment of any additional fee.
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.

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2008/079766**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7138006 B2	21.11.2006	AU 2004-311704 A1	21.07.2005
		PI 0418097 A	17.04.2007
		CA 2551499 A1	21.07.2005
		GB 0614168 D0	30.08.2006
		JP 2007-516828 A	28.06.2007
		WO 2005-065152 A2	21.07.2005
		WO 2005-065152 A3	05.01.2006
US 6472016 B1	29.10.2002	AT 234665 T	15.04.2003
		AU 1279700 A	26.06.2000
		AU 2000-12797 A1	26.06.2000
		CA 2290248 A1	04.06.2000
		CN 1272391 A	08.11.2000
		DE 69906141 D1	24.04.2003
		DE 69906141 T2	29.01.2004
		EP 1144099 A1	17.10.2001
		EP 1144099 B1	19.03.2003
		FR 2786710 A1	09.06.2000
		FR 2786710 B1	16.11.2001
		JP 2000-225327 A	15.08.2000
		KR 10-2000-0052414 A	25.08.2000
		NO 20012635 A	01.08.2001
		NO 20012635 D0	29.05.2001
		PL 336967 A1	05.06.2000
US 6472016 B1	29.10.2002		
WO 00-33948 A1	15.06.2000		
US 6060415 A	09.05.2000	None	

Box No III

Claims 1-6, 8 and 9 are directed to a method of making the aluminophosphate molecular sieve membrane by the secondary growth after depositing aluminophosphate molecular sieve

Claims 7-9 are directed to a method of making a the aluminophosphate molecular sieve membrane by coating with the template-free aluminophosphate molecular sieve and polymers

Claims 10-11 are directed to a process for separating a mixture of gases or liquids.

Claims 12-15 are directed to the aluminophosphate molecular sieve membrane.

The only common technical feature between claims 1-15 is the aluminophosphate molecular sieve layer on a porous membrane. However this feature lacks novelty or inventive step with respect to the following documents cited in this ISR. M. VILASECA et al. Applied Surface Science Vol. 226, pp 1-6, 2004, US 7138006 B2 (STEPHEN J. MILLER et al.) 21 November 2006

Thus there is no technical relationship left over the prior art among the claimed invention, leaving the claims without a single general inventive concept. Hence there is lack of unity "a posteriori"(PCT Rules 13.1 and 13.2).