



- (51) International Patent Classification:  
C08G 73/10 (2006.01) B01D 71/64 (2006.01)  
C08L 79/08 (2006.01) C08J 5/18 (2006.01)
- (21) International Application Number:  
PCT/US2012/040504
- (22) International Filing Date:  
1 June 2012 (01.06.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
61/492,312 1 June 2011 (01.06.2011) US  
13/486,572 1 June 2012 (01.06.2012) US
- (71) Applicants (for all designated States except US): BOARD OF REGENTS, THE UNIVERSITY OF TEXAS SYSTEM [US/US]; 201 West 7th Street, Austin, TX 78701 (US). VIRGINIA TECH INTELLECTUAL PROPERTIES, INC.; 2200 Kraft Drive, Suite 1050, Blacksburg, VA 24060 (US).
- (72) Inventors; and  
(75) Inventors/Applicants (for US only): FREEMAN, Benny, D. [US/US]; 4007 Benedict Lane, Austin, TX 78746 (US). SANDERS, David [US/US]; 11915 Stonehollow Drive, Apt. 437, Austin, TX 78758 (US). RIBEIRO, Claudio, R. [BR/US]; 3605 Steck Avenue, Apt. 1114, Austin, TX 78759 (US). SMITH, Zachary [US/US]; 7600 Woodhollow Drive, Apt. 1102, Austin, TX 78731 (US). McGRATH, James [US/US]; 902 Elliott Drive, Blacksburg, VA 24060 (US). GUO, Ruilan [CN/US]; 3000 Richmond Lane, Apt. L, Blacksburg, VA 24060 (US).
- (74) Agents: CHALKER, Daniel J. et al.; Chalker Flores, LLP, 14951 North Dallas Parkway, Suite 400, Dallas, TX 75254 (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, CL, 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,

[Continued on next page]

(54) Title: POLYMER SYNTHESIS AND THERMALLY REARRANGED POLYMERS AS GAS SEPARATION MEMBRANES

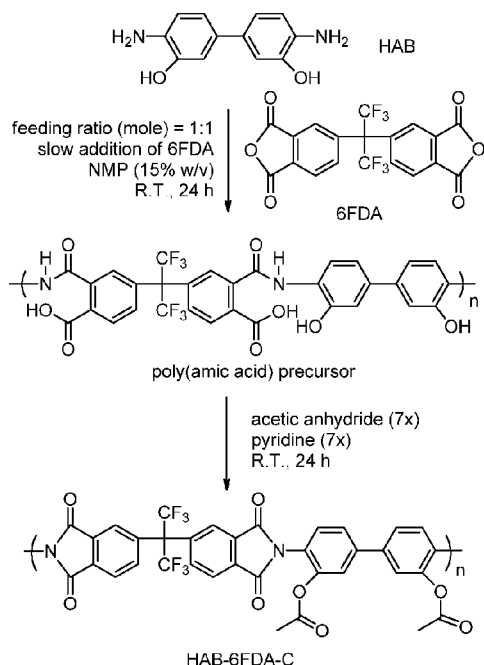


FIGURE 1

(57) Abstract: The present invention includes a polymer formed by the thermal rearrangement of an ortho-functional polyimide synthesized via chemical imidization with permeation properties for gas separation membranes higher than those synthesized via thermal imidization and a method for forming that polymer having tailored transport properties and different chemical resistance. The present invention also includes a polymer formed by the thermal rearrangement of an ortho-functional polyimide in which a portion of the ortho-position functional group is lost during thermal rearrangement to yield a thermally rearranged polymer with higher permeability than would be seen without the ortho-position group. This ortho-position group can be the result of chemical imidization, or the result of a post-imidization modification reaction.



MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**(84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

**Published:**

— *with international search report (Art. 21(3))*

**(88) Date of publication of the international search report:**  
10 May 2013

**A. CLASSIFICATION OF SUBJECT MATTER***C08G 73/10(2006.01)i, C08L 79/08(2006.01)i, B01D 71/64(2006.01)i, C08J 5/18(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)

C08G 73/10; B01D 53/22; C08L 79/08; G02F 1/1337; B01D 71/06; B01D 61/36; C08G 63/44; B01D 61/00

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

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: aromatic, polyimide, ortho, functional

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010-0242723 A1 (C. LIU; M.-W. TANG) 30 September 2010 See the abstract and claims.	1-19
A	US 2010-0133186 A1 (C. LIU et al.) 03 June 2010 See the abstract and claims.	1-19
A	US 7160356 B2 (W.J. KOROS; R.L. BURNS) 09 January 2007 See the abstract and claims.	1-19
A	US 2011-0109855 A1 (P. KILICKIRAN et al.) 12 May 2011 See the abstract and claims.	1-19

 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

22 JANUARY 2013 (22.01.2013)

Date of mailing of the international search report

**24 JANUARY 2013 (24.01.2013)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office  
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan  
City, 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

NA, SU YEON

Telephone No. 82-42-481-8297



**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2012/040504**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010-0242723 A1	30.09.2010	CN 102449041 A	09.05.2012
		EP 2411455 A2	01.02.2012
		JP 2012-521870 A	20.09.2012
		KR 10-2012-0000086 A	03.01.2012
		WO 2010-110968 A2	30.09.2010
		WO 2010-110968 A3	18.11.2010
		WO 2010-110968 A3	30.09.2010
US 2010-0133186 A1	03.06.2010	AU 2010-229241 A1	30.09.2010
		CA 2755923 A1	30.09.2010
		CN 102448593 A	09.05.2012
		JP 2012-521871 A	20.09.2012
		KR 10-2011-0130503 A	05.12.2011
		US 2010-0137124 A1	03.06.2010
		US 8127936 B2	06.03.2012
		US 8127937 B2	06.03.2012
		WO 2010-110975 A2	30.09.2010
		WO 2010-110975 A3	30.09.2010
US 7160356 B2	09.01.2007	US 2005-000899 A1	06.01.2005
US 2011-0109855 A1	12.05.2011	CN 102030901 A	27.04.2011
		JP 2011-081379 A	21.04.2011
		KR 10-2011-0037874 A	13.04.2011