US008168813B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.: US 8,168,813 B2**
(45) **Date of Patent: May 1, 2012**

(54) **POROUS ORGANIC-INORGANIC HYBRID MATERIALS AND ADSORBENT COMPRISING THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 413 days.

(21) Appl. No.: **12/484,090**

(22) Filed: **Jun. 12, 2009**

(65) **Prior Publication Data**

US 2009/0263621 A1 Oct. 22, 2009

Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/KR2007/006472, filed on Dec. 12, 2007.

(30) **Foreign Application Priority Data**

Dec. 13, 2006 (KR) 10-2006-0127343
Jul. 26, 2007 (KR) 10-2007-0075205
Aug. 1, 2007 (KR) 10-2007-0077335

(51) **Int. Cl.**
C07F 15/00 (2006.01)
B32B 3/12 (2006.01)

(52) **U.S. Cl.** **556/138**; 428/116; 428/304.4; 428/402; 556/147

(58) **Field of Classification Search** 556/138, 556/147; 428/116, 304.4, 402
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,298,179	A	3/1994	Ukita et al.	
6,675,601	B2	1/2004	Ebara	
6,959,875	B2	11/2005	Yabu et al.	
6,978,635	B2	12/2005	Yabu et al.	
2006/0074160	A1	4/2006	Handa et al.	
2007/0239124	A1	10/2007	Handa et al.	
2011/0118490	A1 *	5/2011	Hwang et al.	556/44

FOREIGN PATENT DOCUMENTS

JP	04-066125	A	3/1992
JP	06-180062	A	6/1994
JP	16-210924	A	7/2004
KR	2006-0122576	A	11/2006
KR	100680767	B1	2/2007
KR	100803964	B1	2/2008
KR	20090011999	A	2/2009
WO	WO 2004/003036	A	1/2004

OTHER PUBLICATIONS

PCT International Search Report for PCT/KR2007/006472, Mailing date Mar. 20, 2008, 3 pages.
PCT Written Opinion of the International Searching Authority for PCT/KR2007/006472, Mailing date Mar. 20, 2008, 5 pages.
Office Action issued in corresponding Korean Patent Application No. 2006-0127343, dated Sep. 20, 2007.
Office Action issued in corresponding Korean Patent Application No. 2007-0077335, dated Nov. 12, 2008.
S. Kitagawa et al., "Functional Porous Coordination Polymers", *Angew. Chem. Intl. Ed.*; 2004, 43, 2334-2375.
S.L. James, "Metal-organic frameworks", *Chem. Soc. Rev.*, 2003, 32, 276-288.
M.J. Rosseinsky, "Recent developments in metal-organic framework chemistry: design, discovery, permanent porosity and flexibility", *Microporous Mesoporous Materials*, 2004, 73, 15-30.
G. Férey et al., "Crystallized Frameworks with Giant Pores: Are There Limits to the Possible?" *Accounts of Chemical Research*, 2005, 38, 217-225.
S.H. Jhung et al., "Microwave Synthesis of a Nanoporous Hybrid Material, Chromium Trimesate", *Bulletin of Korean Chemical Society*, 2005, 26, 880-881.
G. Férey et al., "A Chromium Terephthalate—Based Solid with Unusually Large Pore Volumes and Surface Area", *Science*, 2005, 309, 2040-2042.

* cited by examiner

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(57) **ABSTRACT**

The present invention relates to an adsorbent using the porous organic-inorganic hybrid material(s) containing iron having a large surface area and a high pore volume, in particular, a water adsorbent. Also, it relates to an adsorbent that can be used in humidifiers, dehumidifiers, coolers/heaters, a refrigerating machine or an air conditioner, etc., which can easily absorb or desorb at 100° C. and below, and has a great adsorption amount per weight of the adsorbent.

Also, the present invention relates to a novel preparation method of porous organic-inorganic hybrid material(s), in particular, a preparation method characterized by not using hydrofluoric acid, porous organic-inorganic hybrid material(s) prepared by said preparation method, and a use as an adsorbent thereof.

27 Claims, 6 Drawing Sheets