US007963116B2

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

(10) **Patent No.: US 7,963,116 B2**
(45) **Date of Patent: Jun. 21, 2011**

(54) **BULK-SCAFFOLDED HYDROGEN STORAGE AND RELEASING MATERIALS AND METHODS FOR PREPARING AND USING SAME**

(75) Inventors: **S. Thomas Autrey**, West Richland, WA (US); **Abhijeet J. Karkamkar**, Richland, WA (US); **Anna Gutowska**, Richland, WA (US); **Liyu Li**, Richland, WA (US); **Xiaohong S. Li**, Richland, WA (US); **Yongsoon Shin**, Richland, WA (US)

(73) Assignee: **Battelle Memorial Institute**, Richland, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/435,268**

(22) Filed: **May 4, 2009**

(65) **Prior Publication Data**

US 2009/0258215 A1 Oct. 15, 2009

Related U.S. Application Data

(60) Continuation-in-part of application No. 11/941,549, filed on Nov. 16, 2007, now abandoned, which is a division of application No. 10/778,997, filed on Feb. 12, 2004, now Pat. No. 7,316,788.

(51) **Int. Cl.**

H01M 8/06	(2006.01)
F03G 7/00	(2006.01)
C01B 3/02	(2006.01)
C01B 3/04	(2006.01)

(52) **U.S. Cl.** **60/721**; 252/188.25; 423/648.1; 429/416; 429/421

(58) **Field of Classification Search** 423/648.1; 429/416, 421; 60/721; 252/188.25
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,383,837	A	5/1983	Smith	
4,433,063	A	2/1984	Bernstein et al.	
4,507,263	A	3/1985	Ron	
4,716,736	A	1/1988	Schwarz	
5,653,951	A	8/1997	Rodriguez et al.	
6,589,312	B1	7/2003	Snow et al.	
6,764,552	B1	7/2004	Joyce et al.	
7,316,788	B2 *	1/2008	Autrey et al.	252/182.34
2004/0077485	A1	4/2004	Purta et al.	
2005/0180916	A1 *	8/2005	Autrey et al.	423/658.2
2009/0258215	A1	10/2009	Autrey et al.	

FOREIGN PATENT DOCUMENTS

DE	10211600	A1	9/2003
WO	2005080256	A1	9/2005

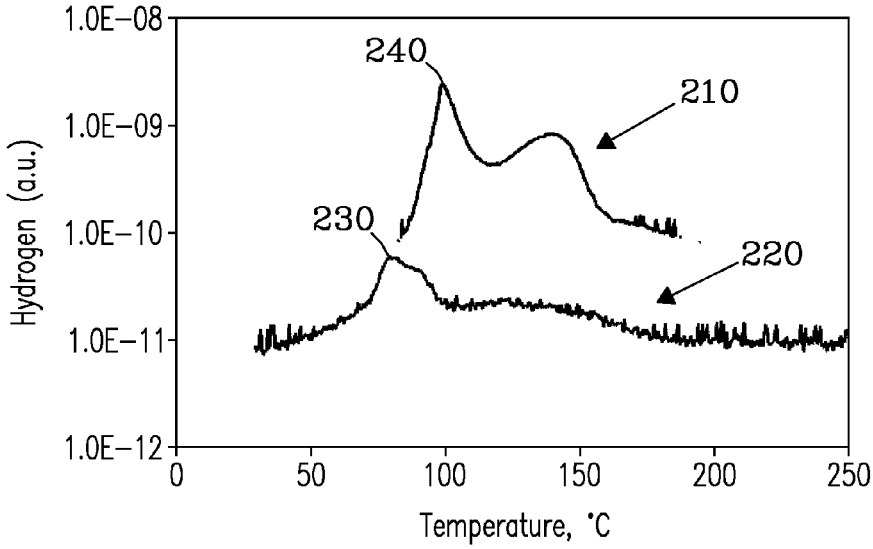
OTHER PUBLICATIONS

Autrey, Tom, et al., Chemical Hydrogen Storage in Nano-Structured Materials. Control of Hydrogen Release and Reactivity From Ammonia Borane Complexes, Prepr. Pap.-Am. Chem. Soc., Div. Fuel Chem., 2004, 49 (1) 150.

(Continued)

Primary Examiner — Wayne Langel
(74) *Attorney, Agent, or Firm* — James D. Matheson

(57) **ABSTRACT**

Compositions are disclosed for storing and releasing hydrogen and methods for preparing and using same. These hydrogen storage and releasing materials exhibit fast release rates at low release temperatures without unwanted side reactions, thus preserving desired levels of purity and enabling applications in combustion and fuel cell applications.

27 Claims, 6 Drawing Sheets