US009308585B2

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

(10) **Patent No.: US 9,308,585 B2**
(45) **Date of Patent: Apr. 12, 2016**

(54) **AEROSOL REDUCTION/EXPANSION SYNTHESIS (A-RES) FOR ZERO VALENT METAL PARTICLES**

(75) Inventors: **Zayd Leseman**, Albuquerque, NM (US); **Claudia Luhrs**, Rio Rancho, NM (US); **Jonathan Phillips**, Rio Rancho, NM (US); **Haytham Soliman**, Houston, TX (US)

(73) Assignee: **STC.UNM**, Albuquerque, NM (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 299 days.

(21) Appl. No.: **13/884,746**

(22) PCT Filed: **Nov. 10, 2011**

(86) PCT No.: **PCT/US2011/060211**

§ 371 (c)(1),
(2), (4) Date: **Jul. 12, 2013**

(87) PCT Pub. No.: **WO2012/064972**

PCT Pub. Date: **May 18, 2012**

(65) **Prior Publication Data**

US 2013/0276583 A1 Oct. 24, 2013

Related U.S. Application Data

(60) Provisional application No. 61/456,680, filed on Nov. 10, 2010.

(51) **Int. Cl.**

B22F 9/26	(2006.01)
B82Y 40/00	(2011.01)
B22F 1/00	(2006.01)

(52) **U.S. Cl.**
CPC . ***B22F 9/26*** (2013.01); ***B82Y 40/00*** (2013.01); *B22F 1/0018* (2013.01); *B22F 1/0096* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,439,502	A	8/1995	Kodas et al.	
6,679,938	B1	1/2004	Kim et al.	
6,689,192	B1	2/2004	Phillips et al.	
8,709,126	B1 *	4/2014	Luhrs et al.	75/351
2002/0006470	A1	1/2002	Eberspacher et al.	
2008/0064767	A1 *	3/2008	Chou et al.	516/97
2010/0143721	A1 *	6/2010	Chen et al.	428/407

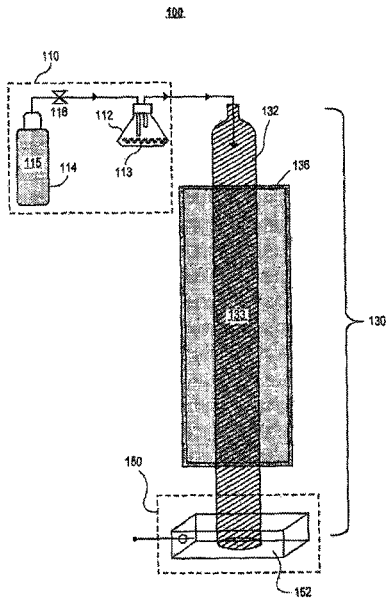
FOREIGN PATENT DOCUMENTS

WO WO-2011/063028 A1 * 5/2011

* cited by examiner

Primary Examiner — George Wyszomierski
(74) *Attorney, Agent, or Firm* — MH2 Technology Law Group, LLP

(57) **ABSTRACT**

Various embodiments provide methods of forming zero valent metal particles using an aerosol-reductive/expansion synthesis (A-RES) process. In one embodiment, an aerosol stream including metal precursor compound(s) and chemical agent(s) that produces reducing gases upon thermal decomposition can be introduced into a heated inert atmosphere of a RES reactor to form zero valent metal particles corresponding to metals used for the metal precursor compound(s).

12 Claims, 1 Drawing Sheet