US007384448B2

(12) **United States Patent**
Johnson, Jr.

(10) **Patent No.: US 7,384,448 B2**
(45) **Date of Patent: Jun. 10, 2008**

(54) **METHOD AND APPARATUS FOR PRODUCING NANO-PARTICLES OF SILVER**

(75) Inventor: **Loyal M. Johnson, Jr.**, Tucson, AZ (US)

(73) Assignee: **Climax Engineered Materials, LLC**, Phoenix, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 585 days.

(21) Appl. No.: **10/780,239**

(22) Filed: **Feb. 16, 2004**

(65) **Prior Publication Data**

US 2005/0179175 A1 Aug. 18, 2005

(51) **Int. Cl.**
B22F 9/06 (2006.01)

(52) **U.S. Cl.** **75/333**; 75/331; 75/230

(58) **Field of Classification Search** 75/331, 75/333, 228, 230
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,309,214	A		1/1982	Foulard et al.
4,654,229	A		3/1987	Morita et al.
5,186,872	A		2/1993	Nishiwaki et al.
5,472,749	A		12/1995	Dravid et al.
5,514,350	A		5/1996	Kear et al.
5,536,324	A	*	7/1996	Fuchita 118/726
5,665,277	A		9/1997	Johnson et al.
5,698,483	A		12/1997	Ong et al.
5,788,738	A		8/1998	Pirzada et al.
5,851,507	A		12/1998	Pirzada et al.
5,874,684	A		2/1999	Parker et al.
5,879,715	A		3/1999	Higgins et al.
6,572,673	B2		6/2003	Lee et al.
6,660,058	B1		12/2003	Oh et al.
6,689,190	B2		2/2004	Pozarnsky
2003/0091488	A1		5/2003	Taube et al.
2003/0115986	A1		6/2003	Porzamsky et al.
2003/0116017	A1		6/2003	Porzamsky et al.

FOREIGN PATENT DOCUMENTS

GB	1307941	A	2/1973
JP	61056209	A	8/1984
JP	3034211	A	3/1989
WO	0010756	A1	3/2000

* cited by examiner

Primary Examiner—Scott Kastler
(74) *Attorney, Agent, or Firm*—Bruce E. Dahl; Susan E. Chetlin; David J. McCrosky

(57) **ABSTRACT**

Apparatus for producing silver nano-particle material comprises a furnace and a crucible positioned within the furnace, the crucible containing a quantity of precursor material, the furnace heating the quantity of precursor material contained in the crucible to vaporize the precursor material. A process gas supply operatively associated with the furnace provides a process gas to an interior region of the furnace. A conduit is operatively associated with the furnace so that an inlet end of the conduit is open to the interior region of the furnace. A particle separator system is operatively associated with an outlet end of the conduit. A pump operatively associated with an outlet end of the particle separator system causes a mixture of process gas and vaporized precursor material contained in the interior region of the furnace to be drawn into the inlet end of the conduit, the process gas cooling the vaporized precursor material to precipitate the silver nano-particle material in a carrier stream, the particle separator system separating the silver nano-particle material from the carrier stream.

14 Claims, 2 Drawing Sheets