



US007634937B2

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

(10) **Patent No.:** **US 7,634,937 B2**

(45) **Date of Patent:** **Dec. 22, 2009**

(54) SYSTEMS AND METHODS FOR MONITORING SOLIDS USING MECHANICAL RESONATOR	4,466,989 A	8/1984	Haller et al.	427/185
	4,543,399 A	9/1985	Jenkins, III et al.	526/70
	4,588,790 A	5/1986	Jenkins, III et al.	526/67
	4,858,144 A	8/1989	Marsaly et al.	364/496
(75) Inventors: Ian Burdett , Charleston, WV (US); Timothy Lynn , Glen Gardner, NJ (US); Oleg Kolosov , San Jose, CA (US); Daniel Paul Zilker, Jr. , Charleston, WV (US); Leonid Matsiev , San Jose, CA (US)	4,993,264 A	2/1991	Cody et al.	73/579
	5,028,670 A	7/1991	Chinh et al.	526/73
	5,148,405 A	9/1992	Belchamber et al.	367/13
	5,317,036 A	5/1994	Brady, III et al.	523/223
	5,352,749 A	10/1994	DeChellis et al.	526/68
	5,405,922 A	4/1995	DeChellis et al.	526/68
(73) Assignee: Symyx Solutions, Inc. , Sunnyvale, CA (US)	5,408,882 A	4/1995	McKinley et al.	73/597
	5,435,972 A	7/1995	Daw et al.	422/108
	5,436,304 A	7/1995	Griffin et al.	526/68

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 764 days.

(Continued)

(21) Appl. No.: **11/296,597**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Dec. 6, 2005**

CA 2178238 12/1997

(65) **Prior Publication Data**

US 2007/0003450 A1 Jan. 4, 2007

(Continued)

Related U.S. Application Data

OTHER PUBLICATIONS

(60) Provisional application No. 60/696,444, filed on Jul. 1, 2005.

International Search Report and Written Opinion from PCT Application No. PCT/US06/25385 mailed Nov. 13, 2007.

(Continued)

(51) **Int. Cl.**

G01N 19/00 (2006.01)
G01N 33/44 (2006.01)
C08F 2/34 (2006.01)

Primary Examiner—Fred M Teskin

(74) Attorney, Agent, or Firm—Zilka-Kotab, PC

(52) **U.S. Cl.** 73/24.06; 73/24.01; 422/68.1; 700/269; 702/24

(57) **ABSTRACT**

(58) **Field of Classification Search** 73/24.01, 73/290, 597, 628, 24.06; 422/68.1; 702/24; 700/269

Particle and multi-phase system monitoring methods, systems and apparatus are disclosed. Preferred embodiments comprise one or more mechanical resonator sensing elements. In preferred embodiments a sensor or a sensor subassembly is ported to a fluidized bed vessel such as a fluidized bed polymerization reactor.

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,999,421 A 12/1976 Creswick 73/32

77 Claims, 16 Drawing Sheets

