



US008173959B1

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

(10) **Patent No.:** **US 8,173,959 B1**  
(45) **Date of Patent:** **May 8, 2012**

(54) **REAL-TIME TRACE DETECTION BY HIGH FIELD AND LOW FIELD ION MOBILITY AND MASS SPECTROMETRY**

2008/0142700 A1\* 6/2008 Dahl et al. .... 250/286  
2008/0179515 A1\* 7/2008 Sperline ..... 250/290  
2008/0237458 A1\* 10/2008 Wang ..... 250/282

(75) Inventors: **Saïd Boumsellek**, San Diego, CA (US);  
**Thomas J. Kuehn**, Potomac Falls, VA (US)

FOREIGN PATENT DOCUMENTS  
WO 0008454 A1 2/2000  
WO 0008455 A1 2/2000  
WO 0008456 A1 2/2000  
WO 0008457 A1 2/2000  
WO 2007014303 A2 2/2007

(73) Assignee: **Implant Sciences Corporation**,  
Wilmington, MA (US)

**OTHER PUBLICATIONS**

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 855 days.

Buryakov, I.A., et al., "Separation of ions according to mobility in a strong ac electric field," Sov. Tech. Phys. Lett., 17(6), Jun. 1991, pp. 446-447 (translation). Buryakov, I.A., et al., "A new method of separation of multi-atomic ions by mobility at atmospheric pressure using a high-frequency amplitude-asymmetric strong electric field," International Journal of Mass Spectrometry and Ion Processes, 128, 1993, pp. 143-148.

(21) Appl. No.: **11/941,939**

(22) Filed: **Nov. 17, 2007**

\* cited by examiner

**Related U.S. Application Data**

(60) Provisional application No. 60/951,205, filed on Jul. 21, 2007.

*Primary Examiner* — David A Vanore  
*Assistant Examiner* — Nicole Ippolito  
(74) *Attorney, Agent, or Firm* — Jerry Turner Sewell

(51) **Int. Cl.**  
**H01J 49/26** (2006.01)

(52) **U.S. Cl.** ..... **250/288**; 250/281; 250/282; 250/290;  
250/291

(58) **Field of Classification Search** ..... 250/281,  
250/282, 283, 288, 290, 291, 292, 293, 295,  
250/296, 297

See application file for complete search history.

(57) **ABSTRACT**

A trace detection system includes at least two stages coupled to operate in series. An ion mobility spectrometer (IMS) stage has a sampling inlet to receive a sample to be analyzed. An ion source ionizes the sample. The IMS applies an electrical field to the ionized sample to move the ionized sample toward an IMS outlet. A differential mobility spectrometer (DMS) stage coupled in series with the IMS stage receives the ionized sample from the IMS stage. Preferably, the system includes a mass spectrometer (MS) stage coupled in series with the DMS stage to receive the ionized sample from the DMS stage via a vacuum interface. A roughing vacuum pump evacuates a first stage of the MS stage to a first pressure below atmospheric pressure. A high vacuum pump evacuates a second stage of the MS stage to a second pressure below the first pressure.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,495,823 B1 12/2002 Miller et al.  
6,809,313 B1\* 10/2004 Gresham et al. .... 250/287  
7,057,168 B2 6/2006 Miller et al.  
2003/0038235 A1\* 2/2003 Guevremont et al. .... 250/287  
2004/0149902 A1\* 8/2004 Park ..... 250/288  
2005/0051719 A1\* 3/2005 Miller et al. .... 250/287  
2005/0109930 A1\* 5/2005 Hill et al. .... 250/286  
2006/0219889 A1\* 10/2006 Shvartsburg et al. .... 250/282  
2008/0073502 A1\* 3/2008 Schneider et al. .... 250/282

**17 Claims, 22 Drawing Sheets**

