Controlled Kinetic Energy Ion Source for Miniature Ion Trap Spectrometers

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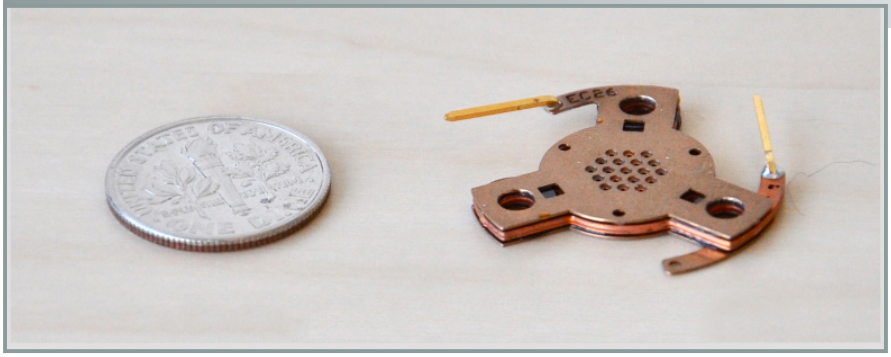

Technology Summary

Miniature ion traps such as those in ORNL's microscale ion trap mass spectrometer (ITMS) enable field-deployable mass spectrometers, useful for security applications at airports and screening for chemical warfare agents in the field. Competitor chemical analysis techniques such as gas chromatography, while precise and reliable, are not as versatile as ion trap mass spectroscopy, and not practical in the field. Also, many competing technologies require expensive, high maintenance equipment and consumable materials. However, because the ions produced by conventional methods are far too energetic to be captured by miniature ion traps, the range of substances that can be analyzed by microscale systems is relatively small. To address this problem, ORNL scientists have developed a resistive glass drift tube for use with miniature ITMSs and related spectroscopy systems, thus broadening the range of substances that can be analyzed.

The resistive drift tube in the ORNL device slows down ions both by means of pressure on the tube and the voltage applied to the tube, leading to ions with a mean translational kinetic energy less than 5 kiloelectron volts. The ions thus "cooled" are capable of being captured by miniature ion traps. In addition, because the resistive drift tube assumes some of the characteristics of a semiconductor, the surface charge typically developed by ions striking drift tubes is transferred throughout the tube, which eliminates or greatly reduces wall charging and thus creates a more uniform electric field to move the ions through to the detector.

ORNL's microscale ITMS includes a submillimeter ion trap consisting of a central electrode, insulators, and end cap electrodes united in a sandwich construction with electronic signal sources coupled to the electrodes. The ion trap can be machined with conventional materials and methods and has demonstrated improved spectral resolution over earlier miniature ion traps. A typical system incorporating this microscale ITMS and the resistive glass drift tube weighs less than 20 pounds. While the resistive glass drift tube is a good match for the ORNL microscale ITMS, it can be paired with a variety of systems and detectors, including time of flight spectrometers.

Advantages

- Fast and easy to use
- Applicable to a broad range of materials
- Highly sensitive, accurate, and reliable
- Compact, lightweight, portable
- Flexible; can be integrated with a variety of systems
- Amenable to microfabrication techniques
- Cost-effective

Potential Applications

- Detecting drugs, explosives, or chemical warfare agents in the field (e.g., at ports and airports)
- Hand-held screening devices
- Cleaning validation for industrial processes (e.g., stack monitoring)
- Direct sampling of the atmosphere and airborne particles
- Detecting proteins and other biomolecules
- Detecting diseases
- Detecting metabolites in blood
- Protein characterization
- Plasma characterization
- Quality assurance

Patents

Guido F. Verbeck, William B. Whitten, and Jeremy Moxom. *Controlled Kinetic Energy Ion Source for Miniature Ion Trap and Related Spectroscopy System and Method, U.S. Patent US 7,838,820 B2, issued November* 23, 2010.

J. Michael Ramsey, William B. Whitten , and Oleg Kornienko. *Microscale Ion Trap Mass Spectrometer*, U.S. Patent US 6,469,298 B1, issued October 22, 2002.

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