Pulsed Ionization Source for Ion Mobility Spectrometers

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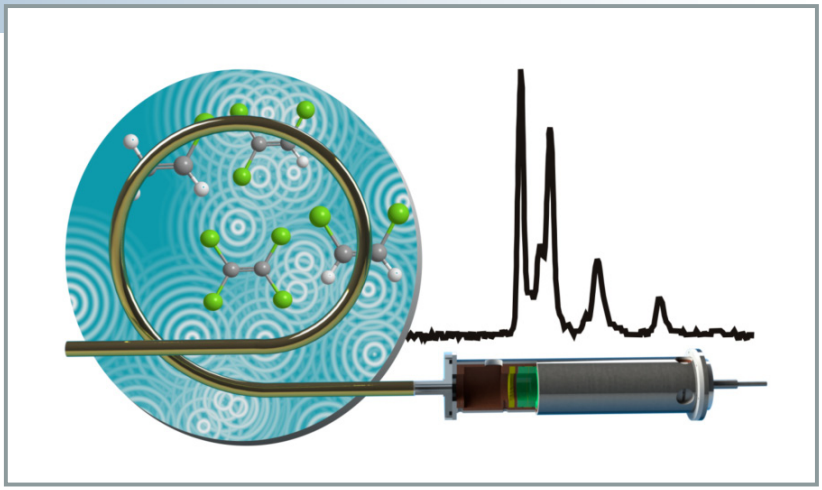

Technology Summary

ORNL's new wave of detection devices based on ion mobility spectrometry offer enhanced sensitivity and resolution and increased safety and flexibility. Leading the way is a miniature ion mobility spectrometer (IMS) that uses a pulsed corona ionization source. This detector has demonstrated both high sensitivity and high resolution without the drawbacks of other systems.

Ion mobility spectrometry is an important method for detecting drugs, explosives, volatile organic compounds, and chemical warfare agents. Miniaturization has enabled field-deployable spectrometers for security applications. However, miniaturization typically leads to a loss of specificity because as the ion drift channel is reduced in size, it becomes increasingly difficult to achieve diffusion-limited resolution. In addition, the radioactive ion sources used in many IMSs present potential safety and hazardous waste disposal issues. Other ionization sources such as lasers or ultraviolet light have also been found unsuitable for miniature IMSs because of their size.

The ORNL device consists of a nickel corona electrode ion source; a miniature IMS drift channel composed of a stack of electrodes, insulating spacers, and miniature resistors; a pulse generator coupled with a high voltage pulse amplifier; and a detector. A high voltage pulse is applied to the corona electrode, generating ions in the vicinity of the electrode tip through field-induced ionization. The pulse also serves as the start signal for ion mobility measurements. After the pulse, the ions so created move in the drift field and are separated according to their mobilities in the carrier gas. High sensitivity is maintained because the ions generated by this technology are highly concentrated.

The pulsed corona ionization source can be used with a variety of detection devices, including miniature gas chromatographs, but it is especially well suited for coupling with ORNL's family of miniature IMSs and micro ion trap spectrometers. One such system, which uses ORNL's patented miniature ion traps arranged in a two-dimensional array, can be placed before the electrode stack in the corona electrode system to increase storage capacity, improve resolution, and provide even greater sensitivity.

Potential Advantages

- Speed, high sensitivity, and high resolution
- Flexibility (can be coupled with all types of IMS detectors)
- Amenable to microfabrication techniques
- Could be interfaced with other miniature analytical instruments
- No hazardous wastes or related safety concerns
- Cost-effective

Potential Applications

- Detecting drugs, explosives, or chemical warfare agents in the field (e.g., at ports and airports)
- Field-deployable hand-held detectors
- Stack sampling
- Direct sampling of the atmosphere and airborne particles
- Detecting diseases, proteins, and other biomolecules
- Detecting metabolites in blood
- Protein characterization
- Quality assurance

Patents

William B. Whitten and J. Michael Ramsey. *Ion Trap Array-Based Systems and Methods for Chemical Analysis,* U.S. Patent US 6,933,498 B1, issued August 23, 2005.

Jun Xu, J. Michael Ramsey, and William B. Whitten. *Pulsed Discharge Ionization Source for Miniature Ion Mobility Spectrometers,* U.S. Patent US 6,822,225 B2, issued November 23, 2004.

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