Improved Molecule Mass Detection Using Electron Field Emission from Kinetically Impacted Membranes

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WARF: P09192US

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing an active detector and method for sensing molecules based on the generation of electrons through field emission (FE) and/or secondary electron emission (SEE).

Overview

Mass spectrometry is a broadly applicable analysis tool for detecting and characterizing molecules and other chemical species, including complex mixtures of biomolecules such as peptides, proteins or oligonucleotides. Mass spectrometry allows for intrinsically fast and accurate quantitative measurements of a molecule's mass-to-charge ratio (m/z).

A significant obstacle in mass spectrometry is the limited mass range that can be analyzed effectively. As a molecule's mass increases, signal intensity falls off dramatically. The most sensitive detectors are cryogenic calorimeters made from superconducting junctions that operate at extremely low temperatures, sometimes less than 100 mK. These devices can analyze heavy proteins, but keeping the superconductors operating at such low temperatures is difficult. The detectors also have slow recovery time and only a limited number of detector pixels, which cannot be readily formed as arrays. As a result, cryogenic calorimeters are not feasible for widespread adoption.

A need remains for a molecule detection technique and device that is capable of resolving a single proton, does not lose sensitivity as molecular mass increases and does not require cryogenic temperatures.

The Invention

A UW-Madison researcher has developed an active detector and method for sensing molecules based on the generation of electrons through field emission (FE) and/or secondary electron emission (SEE). This device is capable of detecting large molecules at higher temperatures than previous devices.

The detector is made of a semiconductor membrane, such as silicon or silicon nitride, with an "external" and "internal" surface. The external surface contacts the desired molecules, and the internal surface is made of a thin electron emitting layer. Kinetic energy from the molecules is absorbed through the external surface to the internal surface via vibrational quanta, which cause electrons to be emitted from the internal surface. The emitted electrons then can be detected by an electron detector.

Any material that emits electrons via FE or SEE can be used on the internal surface, including highly doped semiconductors and doped diamond materials. The electron emitting layer can be electrically biased to enhance FE or SEE.

Applications

- Mass spectrometry
- Matrix-Assisted-Laser-Desorption-and-Ionization (MALDI)
- Electrospray-Ionization (ESI)

Key Benefits

- Allows detection of a large mass range
- Needs significantly less cryogenic cooling for efficient operation
- Can be incorporated into existing technology
- Can detect neutrals, which are uncharged molecules, and large proteins
- Reduces background drift and noise

Stage of Development

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

For More Information About the Inventors

- Lloyd Smith

Related Intellectual Property

- View Continuation Patent in PDF format.

Tech Fields

- Analytical Instrumentation, Methods & Materials : Mass spectrometry
- Research Tools : Detection

For current licensing status, please contact Jennifer Gottwald at jennifer@warf.org or 608-960-9854