Anharmonic Resonant Trap Mass Spectrometry (ART MS)

Jeffrey G. Rathbone, Gerardo A. Brucker, Ken Van Antwerp
Granville-Phillips Product Center, Brooks Automation, Inc.

This poster describes a novel mass spectrometer, under development at the Granville-Phillips® Product Center of Brooks Automation, Inc., based on mass separation technology recently discovered by A. Ermakov and B. J. Hinch at Rutgers University. The new mass spectrometer uses purely electrostatic fields to store ionized gases within a cylindrical ion trap. Ions are generated directly inside the trap by electron impact of gas molecules. An anharmonic trapping potential well confines the ion trajectories of all ion masses, and of a wide range of initial energies, to stable oscillatory motions along the axis of the trap. Mass selective ejection is achieved through a novel autoresonant energy pumping process. The new mass spectrometer has unlimited mass range, is capable of achieving high sensitivity at high and ultrahigh vacuum levels, has demonstrated very fast scan rates, is very compact, and requires extremely low power to operate as it uses only static bias potentials and a very small RF signal levels (in the 100mV range). The sensor currently under development is approximately 15 cm in length, with a 2.5 cm ion-trap component capable of scanning a mass range of 1-300amu with a mass resolving power of >130x. The entire structure that includes the ionizer, mass analyzer and detector was integrated into a pre-existing Stabil-Ion® gauge total pressure ionization sensor envelope. The improved sensor provides fast sampling speeds of approximately 70ms for 1-100amu scans and mW RF ion-trap drive requirements that allow for a remote gauge cable connection to the controller electronics. The simple structure and intelligent electronics were developed to allow for self- calibration of partial pressure measurements and automated recalibration of the electron multiplier detector. A novel dual-filament ionization source design was incorporated into the ion trap to allow fast and easy field replacement of filaments. Small size, low power consumption and reliable operation make ART MS technology an ideal candidate for in situ mass spectrometry in a wide variety of remote sampling applications.