Low Power Carbon Nanotube Field Emission Electron Source for Chemical Ionization Mass Spectrometry

Charles Parker[1], Erich Radauscher[1], Adam Keil[2], Mitch Wells[2], Jason. Amsden[1], Jeffrey Piascik[3], Brian Stoner[3], Jeffrey Glass[1]

[1]Duke University, Durham, NC; [2]FLIR Systems, West Lafayette, IN; [3]Engineering and Applied Physics Division, RTI International, Research Triangle Park, NC

A novel chemical ionization (CI) source has been developed based on a carbon nanotube (CNT) field emission (FE) electron source. The CNT-based electron source was evaluated and compared to a standard filament thermionic electron source in a commercial explosives trace detection mass spectrometer (ETD-MS). This work demonstrates the first use of a CNT-based ion source capable of collecting chemical ionization mass spectra in both positive and negative modes. Spectra collected in electron ionization (EI), negative chemical ionization (NCI), and positive chemical ionization (PCI) modes for perfluorotributylamine (PFTBA) calibration gas, using both the CNT field emission and the filament thermionic emission sources. The spectra collected with the CNT field emission source correlate well with both the spectra taken with the filament thermionic source as well as NIST reference spectra. Following PFTBA spectra collection, amounts consistent with trace standards of TNT, RDX, and PETN were examined.

The CNT field emission sources demonstrate generally linear calibration curves and show similar overall sensitivity to the filament thermionic emission sources. The electrical characteristics, lifetime at operating pressure, and power requirements are reported. The ability of the CNT field emission source to cycle on and off can provide enhanced lifetime and reduced power consumption.

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