A Comparison of Thermionic Filament and Carbon Nanotube Field Emitter Array-based Ion Sources in Coded Aperture Miniature Mass Spectrometers

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This work presents a comparative study of thermionic filament and CNT emitter array-based electron sources in a cycloidal-coded aperture miniature mass spectrometer (C-CAMMS). The use of spatially coded apertures in mass spectrometry enables miniaturization by improving throughput without sacrificing resolution. To enable the full advantages of spatial aperture coding, the ion source must produce a spatially and temporally uniform sheet of ions directed at the coded aperture. Carbon nanotube (CNT)-based electron ionization sources for mass spectrometers provide several potential benefits over conventional thermionic emitters, including low voltage and power operation, room temperature operation, long lifetime, and ability to operate in a pulsed mode. In this study, electron emission stability and coded aperture image (as a measure of ion signal stability) over time were compared for C-CAMMS containing a CNT-based, and a thermionic filament-based ion source. We found that the thermionic filament produced a much more stable coded aperture image than the CNT-based ion source. The greater fluctuations in the CNT-based source are a result of adsorption and desorption of molecules on the CNT surface that cause local work function changes. These work function changes lead to spatial and temporal fluctuations in the electron emission and ion signal. Possible solutions to the CNT spatial and temporal fluctuations are discussed.

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