Microfabricated Ion Sources for Portable Mass Spectrometers

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This project involves the development of MEMS-based cathodes [1-3] for use in miniature mass spectrometers. The cathodes employ a carbon nanotube (CNT)-based field-emission source which consumes at least an order of magnitude less power than conventional thermionic sources. The CNT emitter arrays are used as impact ionization sources and have demonstrated electron currents in excess of 150 μA. Field emission sources also tend to be more robust then their conventional counterparts and the arrays of CNTs enable a "self-healing" effect whereby neighbouring CNTs replace those damaged during operation. Incorporating the CNT field emitters into a MEMS-based electron source brings about certain advantages in size, power, and cost without significant loss in sensitivity. Current lifetime data shows continuous performance in excess of 130 hrs. Current development efforts are focused on improving the lifetime of the CNT-based field emission cathodes, as well as optimization for continuous and rapid on/off applications. Improving adhesion properties between the CNTs and the MEMS platform through the use of multi-layer metal catalysts are being explored to improve device lifetime. We are also investigating geometrical designs that integrate electron and ion optics onto the MEMS platform to minimize energy and angular dispersion while also enhancing current density and cathode lifetime. The charged particle simulation program SIMION is employed to demonstrate and optimize new system designs as well as to establish appropriate working conditions for the different cathode designs.

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