Exceptional service in the national interest

Sandia National Laboratories

Microfabricated Ion Traps & Mass Analysis

Breakthrough improvements in simplicity and reductions in the size of mass spectrometers are needed for high-consequence fieldable applications, including error-free detection of chemical/biological warfare agents, medical diagnoses, and explosives/contraband discovery. These improvements are most likely to be realized with the reconceptualization of the mass spectrometer, rather than by incremental steps towards miniaturization.

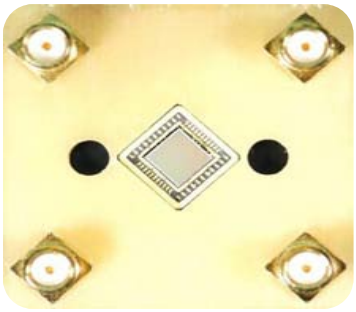

Figure 1. Duroid board.

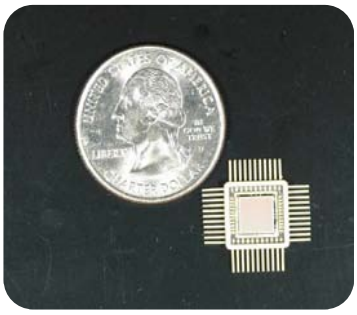

Figure 2. Cylindrical ion trap.

Microfabricated arrays of mass analyzers represent such a conceptual advance. A massively parallel array of micrometer-scaled mass analyzers on a chip has the potential to set the performance standard for hand-held sensors due to the inherit selectivity, sensitivity, and universal applicability of mass spectrometry as an analytical method.

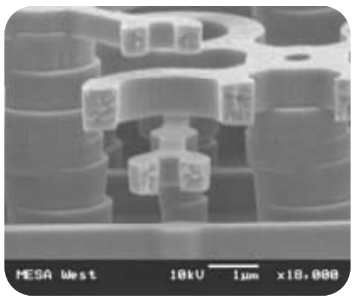

Figure 3. Cross section of cylindrical ion trap.

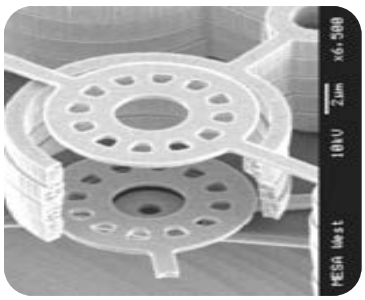

Figure 4. Cross section of cvlindrical ion

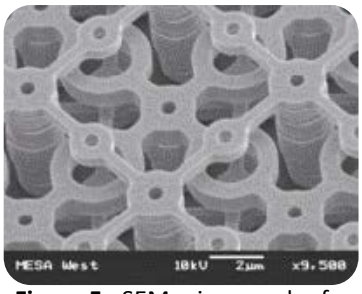

Figure 5. SEM micrograph of ion trap array.

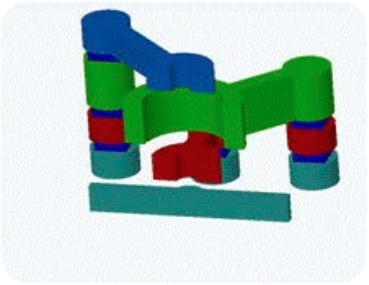

Figure 6. SolidWorks 3D representation.

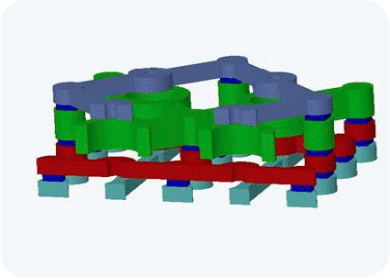

Figure 7. SolidWorks 3D representation.

Sandia has designed and built an ion trap mass analyzer consisting of 1 x 10 6 micron-sized cylindrical ion traps. We have microfabricated massive parallel ion trap arrays consisting of traps with r 0 = 1, 2, 5 and 10 µm. The instrument is the result of a conceptually radical change in the scaling of both size and number of ion traps and in the fabrication approach compared to previous embodiments. The array of micro-ion traps is a freely suspended air gap structure fabricated in tungsten using silicon-based semiconductor and MEMS microfabrication methods. Both ITSIM and SIMION simulations of an r 0 = 1 µm CIT indicate useful trapping efficiencies at low rf voltages (from a few volts to a few 10's of volts), however the influence of initial ion temperatures and rf heating due to nonlinear fields was found to be of added (and potentially useful) importance on this size scale.

For additional information or questions, please email us at Microsystems_App@sandia.gov.

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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