Miniaturized Planar Electrode Linear Ion Trap (LIT) Mass Analyzer

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Our group has previously demonstrated several designs of radiofrequency ion traps in which electric fields are created between two ceramic plates with lithographically patterned electrodes. RF voltages applied to the electrodes through capacitor voltage dividers establish correctly shaped fields. Of the designs, the linear ion trap is the most promising for further miniaturization.

We have now demonstrated that the same plates used to create the LIT with 4.38 mm plate spacing (y0 = 2.19 mm) can also work at 1.96 mm plate spacing (y0 = 0.98 mm). Although the plates are identical, the capacitor values are different from the larger spacing in order to optimize the higher-order terms of the electric fields. Other parameters were explored, including the effect of the germanium layer deposited on top of the electrode pattern. We also optimized performance by varying the RF ramp, ionization time, cooling time, ac frequency and voltage.

For the next generation device we are trying to move away from capacitors entirely, as the uncertainty of the capacitance translates into uncertainty in the trapping fields, and also because the capacitors require too much RF power. The current design uses only the resistance of the germanium overlayer, combined with spacing and dimensions of electrodes, to create the proper field shape. Plate spacing on this new design is set at 690 microns, which results in a y0 value of 245 microns (the characteristic trapping dimension in the ejection direction).

The electric field and higher-order nonlinear effects in the trapping field profile have been optimized using SIMION 8 for the newly designed planar LIT. Based on the modeled field we expect performance equal or better that that of the rectilinear trap or the previous versions of the planar LIT, even with the very small size. This small size device will have a high aspect ratio, so that a relatively large number of ions can be trapped and analyzed.