Performance Enhancement for Miniature QMS Through Application of a Magnetic Field

Student of Note

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One of the challenges of deploying miniature mass spectrometers (MS) in harsh environments is that of reducing the size (to render the MS system portable), whilst at the same maintaining instrument performance in terms of MS resolution, sensitivity and mass range. Previous work has identified that application of a static magnetic field can improve the resolution of a miniature quadrupole mass spectrometer (QMS) and this simple method of performance enhancement offers advantages for field deployment. The magnetic field may be applied transversely (radially) to the quadrupole mass filter (QMF) or axially and performance improvements have been observed experimentally in both cases. The experimental results have been successfully simulated on the basis of our QMS model, which computes the individual trajectories of large numbers of ions (typically 108) injected randomly into the QMF. Mass spectra may be obtained for a range of applied voltages (U/V), electrode length and inscribed radius (r0), RF frequency and ion energy. We have recently adapted our QMS model to allow simulation of any electrode geometry (circular, square or hyperbolic) and configuration. The program now allows instrument simulation not only for the range of conditions above but also allows r/r0 ratio to be specified. The program allows electrodes to be misaligned or displaced so as to examine the effect of manufacturing tolerances on QMS performance. We present here the results of recent instrument simulations for two HEMS application areas: (i) detection of low mass isotopes ($1<m/z<6$ Da) and (ii) detection of 12C/13C for medical diagnosis.