Evaluation of Aperture Materials for Coded Apertures Used in a Portable Cycloidal Miniature Mass Spectrometer

Tanouir Aloui[†], Raul Vyas[†], Kathleen Horvath[†], Charles B. Parker[†], Roger P. Sperline*, M. Bonner Denton*, Michael E. Gehm[†], Jeffrey T. Glass[†], Jason J. Amsden[†]

†Department of Electrical and Computer Engineering, Duke University, Durham, NC, USA 27708, *Department of Chemistry and Biochemistry, University of Arizona, Tucson, AZ USA 85721

Performing mass spectrometry in harsh environments requires robust small mass spectrometry instruments. However, mass spectrometer miniaturization requires surmounting a throughput vs. resolution trade-off. Spatially coded apertures have been proven to increase the throughput by an order of magnitude without any loss in resolution thus enabling miniaturization with minimal loss in performance. Our group has fabricated a prototype cycloidal coded aperture miniature mass spectrometer for detection of natural gas and volatile organic compounds in the mass range of 10 – 130 amu. We found that for ions of <40 amu, aperture imaging is satisfactory to achieve a good spectral reconstruction. However, for m/z > 40 amu, the aperture imaging degrades significantly. A potential cause for aperture image degradation at high m/z is accumulation of charges on the edges of the aperture slits preventing ions from being in the tolerated range of angular dispersion once they exit the ion source. Thus, the coded-aperture material and surface treatment are critical parameters to define the initial state of ions at the entrance of the cycloidal mass analyzer. In this study we report comparative results of different aperture materials as well as multiple surface treatments and cleaning procedures in order to quantify the impact of the aperture properties on the final data collected with a cycloidal mass spectrometer.

The information, data, or work presented herein was funded in part by the Advanced Research Projects Agency-Energy (ARPA-E), U.S. Department of Energy, under Award Number DE-AR0000546 and the National Science Foundation under Award Number 1632069. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.