Use of Computational Sensing Techniques to Improve the Performance of Mass Spectrometers in Harsh Environments

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Measurements from analytical instruments are a convolution of the instrument response and the spectrum. In a conventional instrument, the system is designed to make the instrument response a delta function so that measured spectrum is equivalent to the actual spectrum and thus straightforward to interpret. However, the design choices required to make the instrument response a delta function actually limit system performance. In a computational sensor, the system response does not have to be a delta function. The system response can be designed to maximize parameters of interest (such as throughput and resolution). Using the computational sensing technique of spatially coded apertures, one can increase the instrument throughput while maintaining resolution after spectral reconstruction, thus enabling miniaturization without loss in performance. This paper describes the challenges in the application of spatially coded apertures to a cycloidal mass analyzer and the design, fabrication and performance of a 15 x 20 x 8 inch 40 lb prototype cycloidal coded aperture miniature mass spectrometer building on the proof of concept demonstration described previously (Amsden, J. J.; et al., *J. Am. Soc. Mass Spectrom.* 2018, 29, (2), 360-372.). This paper will describe changes to the proof of concept instrument that improved alignment, electric field uniformity, and depth of focus that resulted in improved coded aperture imaging and better spectral reconstruction. The improved instrument also includes a flow through membrane inlet system for environmental analysis of natural gas and other volatile organic compounds.
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