

Miniature Mass Spectrometer with Direct Ion Detection

Mahadeva P. Sinha

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
and

Mark Wadsworth

Tangent Technologies, Inc., Monrovia, California 91016

Abstract

A high performance, focal plane miniature mass spectrometer (MMS) of Mattauch-Herzog geometry with a CCD-based array detector for the direct and simultaneous measurements of different mass ions has been developed in our laboratory*. Miniaturization (10cm x 5 cm x 5cm, 395 g) was accomplished by using high-energy-product magnet material (Nd-B-Fe alloy) and a high permeability yoke material (V-Co-Fe Alloy) for the fabrication of the magnetic sector. The electrostatic sector was machined from a single piece of machinable ceramic (MACOR). The modified-CCD based ion detector array has 1000 elements (25 μm x 2mm) and was invented in our laboratory. The photosensitive part of the CCD was replaced with a metal-oxide-semiconductor (MOS) capacitor for ion detection. The ion sensing capacitor plates are connected to the CCD gates that are operated in the fill-and spill mode providing a gain in the charge domain for the signal ions and minimizing various noises during measurements. The MMS with the array detector can measure masses up to 250 u with a unit mass resolution. The results of mass spectral measurement with this detector array and MMS will be presented.

The above attributes make MMS suitable for space applications for isotopic and chemical analysis and also for field applications on earth. A novel methodology for the determination of isotopic composition of Fe and O in minerals has also been developed. The application of the methodology in combination with MMS for the determination of biosignature and paleoenvironmental conditions of planetary bodies will also be discussed.

* Rev. Sci. Instrum. **76**, 025103 (2005)