PLANAR RESISTIVE ELECTRODE ION TRAPS: A NEW TOOL FOR PLANETARY ATMOSPHERE ANALYSIS. Ying Peng[1], Miao Wang[1], Ivan W. Miller[1], Brett J. Hansen[2], Zhiping Zhang[1], Samuel E. Tolley[3], Aaron R. Hawkins[2], Jani Radebaugh[4], Milton L. Lee[1], and Daniel E. Austin[1], [1]Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT 84602, yingpeng@chem.byu.edu, austin@chem.byu.edu. [2]Department of Electrical and Computer Engineering, Brigham Young University, Provo, UT 84602, [3]Torion Technologies, Inc., Highland, UT, [4]Department of Geological Sciences, Brigham Young University, Provo, UT 84602.

Introduction: We are developing a novel type of ion trap mass spectrometer to be used for in situ measurements of planetary atmospheres. Mass spectrometers have been included on the vast majority of planetary landers to study the composition of atmospheric gases, evolved gases or volatiles, soils, and even in the search for molecules of astrobiological interest [1]. Mass spectrometers are an important analytical tool in planetary exploration because of their high chemical specificity, high sensitivity, and the application to a wide variety of sample and analyte types. Ion traps, in which a radiofrequency electric field traps and analyzes ionized analyte molecules, are ideal for continuous ionization systems, such as analysis of atmospheric components.

Whereas traditional ion traps are made using machined metal electrodes [2], we have developed a novel technique using planar electrodes with deposited resistive material overlaying metal rings [3]. Using the metal rings, the electric field on the planar electrode can be made to fit a quadratic function, producing a quadrupolar trapping field. Other field and trapping geometries are possible, such as a toroidal geometry [4]. This approach allows multi-variate optimization of the trapping and analyzing field. The resulting mass analyzer is lighter and consumes less power than existing trap designs, making it ideal for portable and spacecraft applications.

Instrument Description: The planar resistive electrode ion trap is made using two parallel ceramic plates, the facing surfaces of which are imprinted with sets of concentric gold ring electrodes, and then covered with a 5-10 nm thick layer of germanium. Radii of the imprinted rings range from 5-12 mm, and the spacing between the plates is 4 mm (Figure 1). A capacitive voltage divider is used to put the correct potential on each of the rings, and hence on the germanium. Electric field contours are shown in Figure 2. Edge effects (at the ends of the plates) are corrected for by adding a higher order (octopole) field to the quadratic function, and also by using an outer steel ring between the plates.

Versions of this instrument using quadrupolar and also toroidal trapping geometry have been constructed and tested (Figure 3). Initial testing used electron ionization at 70 eV, and RF of 1.3-1.9 MHz. Resolution in preliminary experiments with the toroidal geometry is 65-100. Simulations of instrument performance with the quadrupolar geometry indicate achievable resolution to be in the range of 1000 ($m/\Delta m$).

References: [1] Niemann, H. B. et al (2005) *Nature*, *438*, 779. Kissel, J. et al. (2004) *Science*, *304*, 1774. Palmer, P.T. and Limero, T. F. (2001) *J. Am. Soc. Mass Spectrom*. *12*, 656-675. [2] Paul, W. and Steinwedel, H. *Z.* (1953) *Naturforsch.*, *8A*, 448-450. [3] Austin D. E. et al, (2007) *Anal. Chem*. *79,* 2927-2932. [4] Lammert, S. A. et al. (2001) *Int. J. Mass Spectrom.*, *212*, 25.

Figure 1. Design of planar resistive electrode ion trap, consisting of two ceramic plates, each coated with metal rings (not visible) and germanium (dark gray).

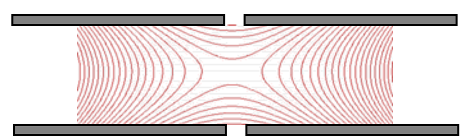

Figure 2. Electric field lines on the planar resistive electrode ion trap.

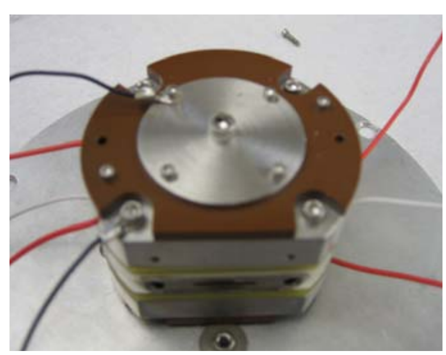

Figure 3. Prototype model of planar resistive electrode ion trap (toroidal geometry), including mounts and voltage divider.