Redesign of the VAPoR Miniaturized Pyrolysis TOFMS for Improved Sensitivity

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We are developing the VAPoR (Volatile Analysis by Pyrolysis of Regolith) instrument to study gases evolved from regolith during upcoming NASA analog field campaigns and future robotic or human missions to the Moon, asteroids, and Mars. VAPoR can heat powdered rock samples up to temperatures of 1300□C and analyze the water, organic compounds and other volatiles released from solid samples by time-of-flight mass spectrometry. Recent efforts to improve the electron beam current emitted from our carbon nanotube field-emission source have led to the development of a larger emitter and redesign of the ion source geometry. These efforts lead to orders of magnitude higher beam current. This beam current will provide greater sensitivity with the introduction of a larger microchannel plate detector in the future.

Currently, the time of flight mass spectrometer can be used in two modes with or without a gridless reflectron enabling us to optimize the ion spectrum for mass resolution or sensitivity. Modeling using SIMION indicates an expected mass resolution of 500 given assumptions about the geometry of the ionization volume and initial kinetic energy distribution. Efforts are underway to reach this resolution target by optimization of the extraction voltages, pulse times, and reflectron fields. Until now, we have achieved a mass resolution of 270. Our current geometry offers excellent shielding of fringing fields associated with the electron beam focusing in the ion source but sacrifices spatial focusing ability of the ions formed. Still, spatial focusing appears to be a less significant source of error.