EFFICIENT SMALL SAMPLE ANALYSIS VIA LASER POST-IONIZED NEUTRALS DESORBED FROM SURFACES: LPI-SNMS

I. V. Veryovkin (1), W. F. Calaway (1), M. J. Pellin (1), J. F. Moore (1), D. S. Burnett (2)

(1) Materials Science Division, Argonne National Laboratory, (2) Department of Geological Planetary Sciences, Caltech (WFCalaway@anl.gov /Fax: +630-252-9555)

A number of popular analytical techniques rely on ion sputtering or laser desorption to probe solid samples. The popularity of this class of techniques is derived from the fact that they produce information on elemental and molecular compositions at trace levels. These techniques are particularly amenable to small sample analysis, since both ion and photon beams can be focused to sub-micron dimensions. Because ion sputtering and laser desorption consume material, there exists a trade off between sample size and achievable detection limit. This trade off is quantified by an instrument’s useful yield, which is defined as the number of atoms detected per atoms consumed. Laser post-ionization secondary neutral mass spectrometry (LPI-SNMS) has useful yields significantly higher than competing techniques and is thus well suited for trace analysis of small samples. With LPI-SNMS, either a pulse of energetic ions or photons remove material from a solid surface into the gas phase. The desorbed material, predominantly ground state neutral atoms, is photo-ionized by one or more lasers and then extracted into a mass spectrometer for detection. At Argonne National Laboratory, we have developed a new reflectron time-of-flight (TOF) mass spectrometer especially designed to optimize useful yield in LPI-SNMS measurements. Using ion optics simulations, an improved extraction design has been developed that allows photo ions from a large (4 x 4 x 3 mm$^3$) volume above a sample surface to be transmitted through a TOF mass spectrometer with $> 98\%$ efficiency. Efficient extraction from such a large ionization volume means that more than 40% of all desorbed species are available for detection, producing an overall useful yield of $> 30\%$. Such a high sensitivity allows analysis of small samples at trace levels never before achievable, opening many new appli-
cations. For example, the new LPI-SNMS instrument will allow (1) part-per-trillion detections of solar wind elements implanted in the top 100 nm layer of the collectors of NASA’s Genesis Discovery mission; (2) part-per-billion detection of 100 nm particles, such as interstellar dust; and (3) part-per-million detection in 100 nm surface features with monolayer depth resolution. Construction of the new instrument has recently been completed. Measurements to characterize its sensitivity have begun and will be presented.