Geophysical Research Abstracts
Vol. 17, EGU2015-9177, 2015
EGU General Assembly 2015

Chemical analysis of solids with sub-nm depth resolution by using a miniature LIMS system designed for in situ space research

Andreas Riedo (1), Valentine Grimaudo (2), Pavel Moreno-García (2), Maike Brigitte Neuland (1), Marek Tulej (1), Peter Broekmann (2), and Peter Wurz (1)

(1) Physics Institute, Space Research and Planetary Sciences, University of Bern, Bern, Switzerland, (2) Department of Chemistry and Biochemistry, Interfacial Electrochemistry Group, University of Bern, Bern, Switzerland

Sensitive elemental and isotope analysis of solid samples are of considerable interest in nowadays in situ space research. For context in situ analysis, high spatial resolution is also of substantial importance. While the measurements conducted with high lateral resolution can provide compositional details of the surface of highly heterogeneous materials, depth profiling measurements yield information on compositional details of surface and subsurface. The mass spectrometric analysis with the vertical resolution at sub-μm levels is of special consideration and can deliver important information on processes, which may have modified the surface. Information on space weathering effects can be readily determined when the sample composition of the surface and sub-surface is studied with high vertical resolution.

In this contribution we will present vertical depth resolution measurements conducted by our sensitive miniature laser ablation ionization time-of-flight mass spectrometer (160mm x Ø 60mm) designed for in situ space research [1-3]. The mass spectrometer is equipped with a fs-laser system ($\sim$190fs pulse width, λ = 775nm), which is used for ablation and ionization of the sample material [2]. Laser radiation is focussed on the target material to a spot size of about 10-20 μm in diameter. Mass spectrometric measurements are conducted with a mass resolution (m/Δm) of about 400-500 (at 56Fe mass peak) and with a superior dynamic range of more than eight orders of magnitude.

The depth profiling performance studies were conducted on 10μm thick Cu films that were deposited by an additive-assisted electrochemical procedure on Si-wafers. The presented measurement study will show that the current instrument prototype is able to conduct quantitative chemical (elemental and isotope) analysis of solids with a vertical resolution at sub-nm level. Contaminants, incorporated by using additives (polymers containing e.g. C, N, O, S) and with layer thickness of a few nanometres, can be fully resolved [1]. The current measurement performance, including the sensitivity and the high vertical depth resolution, opens new perspectives for future applications in the laboratory, e.g. measurements of Genesis samples, and new measurement capabilities for in situ space research.

References

1)V. Grimaudo, P. Moreno-García, M.B. Neuland, M. Tulej, P. Broekmann, P. Wurz and A. Riedo, “High-resolution chemical depth profiling of solid material using a miniature laser ablation/ionization mass spectrometer”, Anal. Chem., 2015, submitted.

2)A. Riedo, M. Neuland, S. Meyer, M. Tulej, and P. Wurz, “Coupling of LMS with a fs-laser ablation ion source: elemental and isotope composition measurements”, J. Anal. At. Spectrom., 2013, 28, 1256.

3)Tulej et al. CAMAM: A Miniature Laser Ablation Ionisation Mass Spectrometer and Microscope-Camera System for In Situ Investigation of the Composition and Morphology of Extraterrestrial Materials, Geostand. Geoanal. Res., 2014, doi: 10.1111/j.1751-908X.2014.00302.x