Analytica Acta-2013

OMICS Group Conferences
Accelerating Scientific Discovery

4th International Conference and Exhibition on
Analytical & Bioanalytical Techniques

October 15-17, 2013 Las Vegas, NV, USA

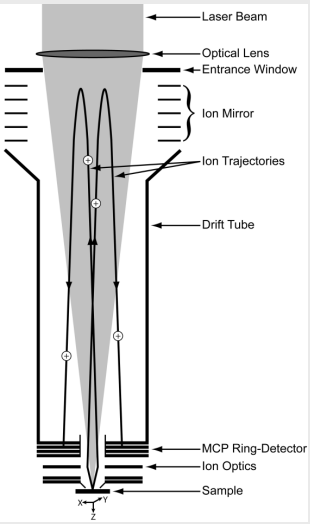
Miniature LIMS system designed for in situ quantitative elemental and isotopic composition measurements of extra-terrestrial material in space research

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Abstract

A miniature laser ablation time-of-flight mass spectrometer (LIMS) of reflectron-type designed for in situ space research of planetary objects is presented. The miniature LIMS system is designed for sensitive, accurate and quantitative elemental and isotope composition measurements. For ablation and ionisation of sample material a ns-laser ablation ion source, operated at IR (1064 nm, 4 ns, 20 Hz) and UV (266 nm, 3 ns, 20 Hz), and a fs-laser ablation ion source (775 nm, 190 fs, 1 kHz) were used. Figures of merit, e.g. dynamic range, quantitative, mass resolution, measurement accuracy, etc. will be presented. Studies were performed with high spatial resolution by focusing the laser beam through the ion-optical system onto the sample surface to spot size of 10 µm, 20 µm, and 40 µm, respectively. Measurement campaigns were conducted with a high dynamic range of at least 10^8, and mass resolution (m/Δm) in the range of 800 – 1000. In comparison with the ns laser ablation ion source operated at IR, measurements performed at UV laser irradiation offer better detection sensitivity for metallic and non-metallic elements (tens of ppb). While measurements with the ns-laser ablation ion source have to calibrated with appropriate NIST standard reference materials (SRM), using the fs laser system for ablation and ionisation of sample material the relative sensitivity coefficients (RSC) were found to close to one. Having RSCs of about one is of considerable interest of the development of standard-less instruments.

Our group also developed a dedicated measurement procedure (discussed in detail), that allows LIMS to measure for the first time isotope compositions of elements, e.g. Ti, Cr, Pb, etc., with measurement accuracy and precision at the per mill level, which is comparable to the performance of other well-known and established techniques, e.g. TIMS, LA-ICP-MS, SIMS.



Biography

Andreas Riedo received his MSc. in Physics in 2010 from the University of Bern, Switzerland under the direction of Prof. Dr. Peter Wurz. During these studies he was involved in the calibration of the neutral particle detector ENA onboard the BepiColombo spacecraft, a planetary space mission from ESA/JAXA to Mercury. In 2010 he started his PhD in the Space Research and Planetary Sciences Division at the University of Bern, Switzerland. Currently, he is involved in developments of highly sensitive, miniature mass spectrometric instruments for in situ investigations on the chemical (elemental and isotopic) composition of planetary solids. In 2010 Riedo was awarded the Greinacher Award for young scientists and is the author of a few recent featured publications.