A Miniature LIMS System for Accurate Isotope Composition Measurement *in-situ* Planetary Surfaces

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The development of space instrumentation capable of sensitive measurements of elements and their isotopes in solar system objects is of considerable interest to current space research. Accurate measurements of isotope variations in planetary materials provide an insight into a number of geochemical processes and constraint the time of planetary material formation (crystallisation ages). Isotopes are also robust tracers of presolar events and stellar processes producing elements. Both, a detailed understanding of the chronology of the early solar system and dating of planetary materials require precise and accurate measurements of isotope composition in various planetary materials. However, accurate in situ measurements of isotope abundance in solar system objects are extremely challenging and until now, they were not attempted in space research. We present the results of the performance investigations conducted by a miniature laser ablation reflectron time-of-flight mass spectrometer designed by our group for in situ space research. The studies indicate that the instrument can be used for sensitive and accurate measurements of the elemental and isotopic composition of extraterrestrial material. Both, a ns-laser (266 nm, 5 ns, 20 Hz) and a fs-laser (775 nm, 190 fs, 1 kHz) were used for laser ablation and ionisation to investigate analytical figure of merits (dynamic range, detection sensitivity and accuracy of measurements, etc.). The studies are performed with high spatial resolution by focussing a pulsed laser radiation to the spot size of about Ø 20 µm and 40 µm, respectively on the sample surface. Measurements are conducted with high dynamic range of at least 108 and mass resolution (m/Δm) of up to 800 – 900 (measured at 56Fe). High detection sensitivity is achieved on both metallic and non-metallic elements (tens of ppb). A measurement procedure for accurate and precise isotope analysis will be discussed in detail. The procedure will allow LIMS to measure the isotope composition of elements (e.g. Pb) with a measurement accuracy and precision down to the sub per mill level.

References

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