Transport efficiency and particle size distribution of laser induced aerosols

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The acceptance of laser ablation in combination with ICP-MS, MC-ICP-MS and ICP-OES for the determination of major, minor and trace elements as well as for isotopic and elemental ratios in solids has grown over the past decade. This sample introduction system, now mainly operating using UV laser light of different wavelengths is one of the most versatile technique currently available in the field of inorganic trace element analysis. The spatial resolution of laser ablation is limited only by the optical elements used for focussing of the laser beam. Sub-micron features can be generated in micro-machining using this technique. However the analytically useful spatial resolution is currently limited by the sensitivity of the ICP-MS instrumentation used, which is partly related to the amount of material transported from the ablation site to the plasma source for ionisation. In order to expand the analytically useful range in spatial resolution towards smaller spot sizes the transport efficiency, currently estimated to be in between 5 and 25 Vol. % [1] of the ablated material, needs to be enhanced. Preliminary results for silicate matrices yield, for an ablation in argon using a 266 nm Nd:YAG, a transport efficiency of 8-10% [2]. Besides the transport efficiency, the particle size distribution of the aerosol may also influence the sensitivity obtainable by ICP-MS, which is currently under investigation. Results obtained using two different ablation wavelengths (266/193nm), at identical ablation conditions and with similar beam profiles, will illustrate the effects of energy density and the ablation gas environment on the particle size distribution transported from the site of ablation to the plasma of the mass spectrometer. The influence of transported particle size distribution on the transient signal structure recorded by ICP-MS will be discussed.

References

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Meteorites as potential source of microorganisms on early Earth and Mars

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Meteorites may be natural vehicles for transporting resistant life forms, such as bacterial spores, from one planet to another in our solar system, e.g. from Mars to Earth or vice versa. To tackle the question whether and to what extent soil or rock material may protect bacterial spores against the harsh environment of space, especially solar UV radiation, we have exposed spores of Bacillus subtilis to space (i) unprotected, (ii) under a thin filter of clay, and (iii) mixed with different soil, rock or meteorite powders. Exposure was done in the BIOPAN facility of the European Space Agency onboard of the Russian Earth-orbiting Foton satellite. After about 2 weeks in space, the survival was tested from the number of colony formers. Unprotected spores in layers open to space or behind a quartz window, even behind a thin layer of clay, survived barely, if at all, the space trip. Mixing the spores with powder of clay, rock or meteorites increased the survival rate by 5 orders of magnitude. Up to 100 % survival was reached in 1 cm cubes of soil mixtures containing spores in concentrations comparable to that in natural soil. These data confirm the deleterious effects of extraterrestrial solar UV radiation. However, they suggest that in a scenario of interplanetary transfer of life, small rock ejecta of a few cm in diameter could be sufficiently large to protect bacterial spores against the intense insolation.

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