Characterizing capabilities of a 213 nm high resolution laser ablation inductively coupled plasma mass spectrometry imaging system

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Laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) is a method for direct solid sampling which can provide concentrations of major, minor, trace and ultra-trace elements in almost any solid sample. Of particular interest in research is high-resolution, high-speed, multi-elemental imaging by LA-ICPMS. The particular challenges in this approach related to crater sizes in the low µm-range for high spatial resolution, high data acquisition rate for high throughput, simultaneous detection of multi-elemental capabilities, and application to different sample types. [1-3]

The LA system consists of a solid state Nd:YAG-based 213 nm laser with beam homogenization and a low-dispersion ablation chamber. The optical system allows for ablation with spot sizes in a range of 1 to 5 µm in diameter with flat-bottom crater profiles. Laser ablation can be carried out with a repetition rate up to 20 Hz and pulse energy of ca. 1 mJ and ion signals from each individual laser pulse can be discretely detected due to the tube-cell arrangement, which provides a washout time < 20 ms. For compositional analysis it is coupled to an ICP-TOFMS (icpTOF, TOFWERK, Thun, CH) for simultaneous detection of elemental mass spectra. In order to reduce the plasma ion background, to avoid spectral interference and to improve spectral resolution, a reaction/collision cell with hydrogen as collision gas was used.

A characterization of the setup was carried out with the standard reference material NIST 610. Limits of detection were found to be similar to a conventional ArF eximer laser based ablation system (GeoLas C, Coherent, Göttingen, DE). Furthermore, we present imaging applications for both soft thin tissue and geological samples. In both cases, the elemental distribution is acquired at µm pixel resolution corresponding to single laser pulses. In order to address quantitative imaging of thin tissue sections, we investigated a multi-layer approach to correct for variations of material removal for each laser shot.

[1] Wang et al., *Anal Chem*., **2013**, *85*, 10107.
[2] Gundlach-Grahm et al., *Anal. Chem*., **2015**, *87*, 8250.
[3] Burger et al., *Anal Chem*., **2015**, *87*, 8259.