

Combination of a fast ablation cell and deconvolution approaches for high resolution LA-ICP-MS scanning of layered materials

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In recent years, LA-ICP-MS has proven to be a valuable tool in the visualization of the spatial distribution of nuclides on a μm -level in a wide variety of sample types and applications fields. The lateral resolution achievable in a scanning approach is restricted by (i) the extent of overlap of peak responses, (ii) peak broadening by impaired aerosol dispersion, (iii) limitations imposed on the accuracy of the response and sampling speed of the MS configuration and detector, (iv) the accuracy and velocity of the translation stage which traverses the laser beam over the sample surface, and (v) the radius of the beam waist of the focused laser beam, which in turn is limited by the diffraction limit in the far field, or the lack of sensitivity for the targeted nuclides. This fundamental study pursues a combined strategy of ablation cell development and post-acquisition methodology for enhancing the sensitivity, spatial resolution and throughput capabilities of LA-ICP-MS beyond state-of-the art^{1,2}. The novel laser ablation tube-cell and transport assembly developed are characterized by exceptional aerosol dispersion behaviour, enabling discrete pulse responses at pulse repetition rates up to 200-300 Hz.³ The design reported was derived from considerations of data produced by computational fluid dynamics and plasma shockwave reflection simulations. Furthermore, an iterative Richardson-Lucy deconvolution approach, capable of resolving features below the physical size of the laser beam projected onto the sample surface, was adopted. The algorithm derives the initial lateral nuclide distribution by correcting the distortion in the response profile upon oversampling a feature. The strategy demonstrated a lateral resolution in the order of 0.3 ± 0.1 micrometre for scanning of micrometre-sized layers in multi-layer ceramic capacitors by overlapping the ablation positions of a 1 micrometre diameter laser beam.

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