Ultra-trace characterization of natural and anthropogenic nanoparticles by SN MS

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Frequently, the isotopic composition of single particles is required for unambiguous source identification. The composition analysis and spatial imaging of these particles in environmental samples necessitates an excellent sensitivity, complete suppression of any kind of background and isobaric contamination in combination with high spatial resolution while maintaining the natural structure of the sample. The new resonant Laser-SNMS system at the IRS Hannover was developed to achieve these specifications by combining the high element selectivity of resonance ionization with the non-destructive analysis of a static TOF-SIMS instrument exhibiting spatial resolution down to 70 nm. In contrast to dynamic SIMS, the present system works quasi non-destructive.

To analyze identified particles, they are separated from the surrounding environmental material. A micromanipulator with mounted tungsten tips built into the electron microscope is used to extract single particles out of the surrounding soil material. Using a vacuum compatible glue, which can be cured in the SEM electron beam, single particles are fixed to individual tungsten needles.

We measured U, Pu, Sr, Cs and Tc isotopic compositions as well as spatially resolved full mapping of all elements on one single µm-sized particle, which after analysis is still available for subsequent investigations. Interfering isobaric elements, Pu-238 and U-238, were successfully discriminated. Since surface charging effects play a minor role in static SIMS, no kind of sample preparation, such as surface coating is required. We present Laser-SNMS Measurements on Pu and U containing samples including natural minerals from Afghanistan collected close to Kabul and containing enhanced levels of natural radioactivity and particles from the Chernobyl exclusion zone and from the evacuated zone close to the Fukushima Daichii nuclear power plant.