Geophysical Research Abstracts
Vol. 18, EGU2016-17755, 2016
EGU General Assembly 2016

icpTOF: a new way for the detection of synthetic nanoparticles in environmental systems

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Tons of engineered nanoparticles are yearly released into the environment as a result of human activity and utilization of nano-containing products. Driven by demand and innovations, the production volumes of nanomaterials are predicted to grow further and already in 2020 will reach >500000 tons [1]. The current challenge faced by society is the lack of information about the fate, behavior, and implications of nanomaterials. This gap has to be filled in order to develop an appropriate strategy for the regulation of nanotechnologies. This is not a simple task because we are still unable to detect and monitor nanoparticles once they have been released into the environment. The list of analytical techniques which can be applied for nanoparticle detection in complex media and at environmentally relevant concentrations (ppt-ppb) is very short and for most of the studies complementary approaches are applied. Single particle (sp)-ICP-MS is a new technique which provides an easy and routinely applied way to quantitatively determine size and number concentration of metal-containing nanoparticles [2]. Moreover, element-specific detection makes sp-ICP-MS more tolerant to high levels of natural background (e.g. organic matter, bacteria).
The measurement of single particles implies the detection of extremely short signals (100-500 μm) and requires sensitive and fast instrumentation. Sequentially scanning instruments based on quadrupole or sector-field technology cannot accurately measure more than one isotope per particle and determine elemental composition of single particles.
A new icpTOF mass spectrometer (TOFWERK AG, Switzerland) provides simultaneous detection over the whole mass range of elements at μs-time resolution and with >3000 mass resolving power. These unique features render the determination of multi-element composition of single nanoparticles possible [3]. This additional information is extremely valuable to study chemical transformations of particles once they have entered the real ecosystem. Besides, element ratios of single particles can be used as a specific merit for the identification of synthetic nanoparticles in the presence of naturally occurring particulate background [4]. In addition to higher mass resolving power, the instrument is equipped with a collision/reaction cell, which helps to improve detection limits for elements suffering from interferences (e.g. Fe, Ti, P, S). The icpTOF performance will be shown in combination with different sample introduction systems, including novel discrete microdroplet introduction. The single droplet introduction approach enables particle quantification without particulate reference materials and significantly simplifies the analysis. The advantages of fast simultaneous detection for the characterization of multi-component nanoparticles in environmental media will be demonstrated on several studies.

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