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Production and Characterization of Monodisperse Reference Particles

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Individual particle analysis of nuclear materials is an important tool in nuclear safeguards and nuclear forensics. Particles in the sub-micrometer to micrometer range are investigated routinely for nuclear safeguards analysis. Different techniques are utilized for particle discrimination and characterization, including scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM/EDX) for identification of the particles of interest and mass spectrometric methods such as (laser ablation-) multi-collector inductively coupled plasma mass spectrometry ((LA)-MC-ICP-MS), large geometry secondary ionization mass spectrometry (LG-SIMS), and thermal ionization mass spectrometry (TIMS) for the determination of their isotopic composition.
The quality control of analytical methodologies, including instrument and method validation, as well as the assurance of the quality of the reported results, requires the use of suitable reference materials. The availability of such reference materials with precisely defined characteristics such as the number of uranium or plutonium atoms per particle, size, density, chemical form, elemental and isotopic composition is very limited. Monodisperse particles with uranium content can be produced using a Vibrating Orifice Aerosol Generator (VOAG). The particle production is an integrated two-step process: (1) generation of monodisperse aerosols using the VOAG and (2) subsequent drying and calcination of those aerosols to the corresponding oxides.
An important follow up operation is the sampling and subsequent transfer of particles to appropriate substrates for further analysis. This project also addresses these issues. Depending on the subsequent analysis that is being performed with those reference particles, different substrates and sample preparation techniques have to be applied. This paper describes the experimental setup for production of monodisperse particles and discusses the issues related to sampling and handling of individual particles depending on their future application and analysis with the use of analytical techniques such as SEM/EDX and LG-SIMS.

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