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Actinide targets for fundamental research in nuclear chemistry and -physics

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Abstract
Thin actinide layers deposited on metallic or non-metallic substrates are widely used as calibration sources in nuclear spectroscopy. Other applications include fundamental research in nuclear chemistry and –physics, e.g. the chemical and physical properties of super-heavy elements (SHE, Z > 103) or nuclear reaction studies with heavy ions. For this, layers of actinide target nuclei such as 238U, 242/244Pu, 248Cm, 249Bk and 249Cf with areal mass densities up to 1 mg/cm2 deposited on 1-2 µm thin metallic foils are required. For the design of future nuclear reactors like fast-fission reactors and accelerator-driven systems for transmutation of nuclear waste, precise data for neutron absorption as well as neutron-induced fission cross section data for 242Pu with neutrons of different energies are of particular importance. A recent application include studies of nuclear transitions in 229Th. For this, a thin and very smooth layer of 233U is used.
We report here on the production of actinide layers by Molecular Plating (MP). MP is currently the only fabrication method in cases where the desired actinide material is available only in very limited amounts or possess a high specific activity. Here, deposition is performed from organic solution applying a current density of 1-2 mA/cm2. Under these conditions target thicknesses of 500-1000 µg/cm2 are possible applying a single deposition step with deposition yields approaching 100 %.). For yield determination α-particle spectroscopy, γ-spectroscopy and Neutron Activation Analysis is routinely used. Layer homogeneity can be checked with Radiographic Imaging. For target characterization on a µm-scale a Scanning Electron Microscope in combination with X-ray Fluorescence is also available. The combination of these analytical techniques is essential to improve the current target fabrication technology and to understand target performance under long-term irradiations conditions. As an alternative technique to MP the production of thin lanthanide and actinide layers by ink-jet printing is currently investigated.

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