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Actinide targets for fundamental research in nuclear chemistry and -physics

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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.in super-heavy element (SHE) research or in nuclear reaction studies. For the production of neutron-rich isotopes of SHE up to Z=120 hot fusion reactions of actinide target nuclei such as ^{238}U, $^{242/244}$Pu, ^{248}Cm, ^{249}Bk and ^{249}Cf with light ion beams are applied. 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 ^{242}Pu with neutrons of different energies are of particular importance. For the production of actinide layers with the required thickness Molecular Plating (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 1-2mA/cm^2. Under these conditions target thicknesses of 500-1000 µg/cm^2 are possible applying a single deposition step with deposition yields approaching 100 %.). For yield determination α-particle spectroscopy, γ-spectroscopy and Neutron Activation Analysis (NAA) is frequently applied. Layer homogeneity can be checked with Radiographic Imaging (RI). Layer characterization with modern analytical techniques (e.g. XRF, XPS, SEM and AFM) is essential to understand target performance under long-term irradiations and to improve the current fabrication technology.

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On property of fission chain reaction to resist quick runaways in fast and thermal nuclear reactors

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It has been shown that the in-hour equation characterizes the barriers and resistibility of fission chain reaction (FCR) against rapid runaways in nuclear reactors. Traditionally, nuclear reactors are characterized by the presence of barriers based on delayed and prompt neutrons. A new barrier based on the reflector neutrons that can occur when the fast reactor core is surrounded by a weakly absorbing neutron reflector with heavy atomic weight was proposed. It has been shown that the safety of this fast reactor is substantially improved, and considerable elongation of prompt neutron lifetime "devalues" the role of delayed neutron fraction as the maximum permissible reactivity for the reactor safety. The following main results were obtained: New interpretation was proposed for the terms of the in-hour equation. The summands in the right part should be considered as the contribution deficits into the FCR balance from prompt and delayed neutrons, respectively. The left part of the in-hour equation is the reactivity needed to compensate the contribution deficits caused by time delays of prompt and delayed neutrons and to provide the runaway with given asymptotic period. The FCR resistibility to rapid runaways in fast reactors can be significantly strengthened by surrounding the reactor core with the neutron reflector made of weak neutron absorber with heavy atomic weight. The modified in-hour equation with accounting for neutrons from the reflector was derived and analyzed. Neutrons from the reflector can play a significant role in upgrading the FCR resistibility to rapid runaways.

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