Probe of plutonium oxide nanoparticles at the large-scale facility

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Plutonium is a chemical element of a most significant concern at the nuclear legacy sites. The problem of the plutonium migration plays an important role in the environmental radioactivity because of its high radiological toxicity. It was shown previously that plutonium migrates in the subsurface environment on the kilometer scale at some previously contaminated sites [1-2]. During the last few years due to the evolution of spectroscopic and microscopic techniques it was found that so called “colloidal Pu(IV) polymers” actually represents as aggregates of PuO2 nanoparticles with size ~ 2 nm. [3-4]. Investigation of plutonium oxides nanoparticles is complicated, as plutonium can exist in four partially unstable oxidation states in aqueous solution: III, IV, V, VI under environmental conditions. At the same time, presence of Pu in different oxidation states in PuO2 structure is still an open question.

This contribution will show first results of plutonium oxide nanoparticles studies at the large-scale facility – The European Synchrotron (ESRF) by X-ray spectroscopy and X-ray diffraction methods. Plutonium nanoparticles were prepared by rapid chemical precipitation using precursors in the different oxidation states. These precursors were obtained by chemical reduction or oxidation of Pu stock solution. The obtained nanoparticles were characterized by high energy resolution fluorescence detection (HERFD) [5] X-ray absorption spectroscopy, extended X-ray absorption fine structure (EXAFS) and X-ray diffraction (XRD) techniques. The experiments were performed at the Rossendorf Beamline (ROBL) at the ESRF, dedicated to actinide science, where we recently installed a novel X-ray emission spectrometer with ground-breaking detection limits. The recently upgraded ROBL beamline at the ESRF provides now a unique opportunity to study actinide materials by several experimental techniques - HERFD, XES, RIXS [6], EXAFS and XRD simultaneously. We will show how the detailed information about local and electronic structure and plutonium oxidation state in different nanoparticles can be obtained using the variety of methods at large scale facilities.

**References**

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