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Multi-scale structural characterization of Pu(IV) intrinsic colloids by synchrotron SAXS coupled with XAS

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Anthropogenic activities have released significant amounts of plutonium in the environment due to the development of nuclear energy for industrial applications, space exploration and weapon production.[1,2] Both pseudo- and intrinsic plutonium colloids have been described as potential vectors for the migration of actinides in the environment. Whereas pseudo-colloids deal with natural inorganic colloids on which Pu has been incorporated or adsorbed, intrinsic colloids are related to the propensity of tetravalent Pu to hydrolyze and form its own colloid.[1-3] Predicting the behavior and reactivity of such species in the geosphere is a challenging topic requiring their thorough characterization in order to provide a better knowledge of their local structure, morphology, size and interfacial properties. X-ray based techniques appear particularly relevant to probe the multi-scale properties of Pu colloids. The recent development of an analytical bench devoted to the quasi-simultaneous analysis of radioactive samples by small-angle X-ray scattering (SAXS) and X-ray absorption spectroscopy (XAS) on the MARS beamline of the synchrotron SOLEIL allowed us to screen intrinsic Pu(IV) colloids (**Fig. 1**). Two kinds of stable colloidal suspensions prepared by conventional hydrolysis and sonication of PuO₂ powder in pure water (20 kHz, 20 °C, Ar/10%CO atmosphere) were investigated.[4,5] The non-intrusive synchrotron SAXS/XAS approach described in this work provides in-situ information, over a large sample volume and directly in the native environment. The approach appears ideal for Pu colloidal systems and demonstrates that the preparation conditions strongly influence the multi-scale properties of intrinsic Pu(IV) colloids.

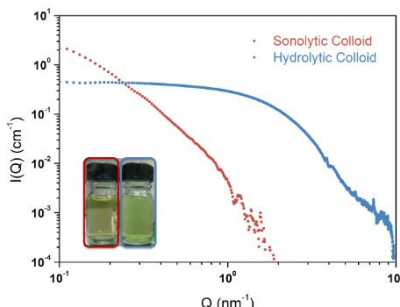


Fig. 1: SAXS scattering curves acquired on intrinsic Pu(IV) colloids prepared by hydrolysis and sonolysis (20 kHz, Ar/(10%)CO, H₂O, 20°C).

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