Deep Dive into the Periodic Table: From Formation to Reactivity of Colloidal PuO_2 Nanoparticle

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Plutonium is a highly radioactive element primarily produced in nuclear reactors, whose complex aqueous chemistry plays a central role in many aspects of the nuclear fuel cycle. Its speciation is governed by redox transformations, complexation, disproportionation, and hydrolysis reactions.[1,2] In particular, the formation of stable "intrinsic" colloidal suspensions has been reported in aqueous solutions, even under strongly acidic conditions. Recent investigations have converged toward a consensus that these species consist of quasi-spherical, crystalline PuO_2 nanoparticles with diameters of approximately 2–3 nm. Although first observed during the Manhattan Project, these colloidal species have remained relatively understudied compared with other aqueous Pu species. However, renewed interest has emerged due to concerns about the potential migration of radioactive plutonium under environmental conditions, as well as the development of advanced nuclear fuels, highlighting the need for a more comprehensive understanding of Pu(IV) colloids.[2-4]

This presentation will summarize recent insights from our group into the formation mechanisms, reactivity, and multiscale structural properties of PuO_2 nanoparticles, supported by a combination of laboratory-based and synchrotron characterization techniques.

References

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