

# Towards deciphering the nucleation and growth stages of colloidal PuO<sub>2</sub> nanoparticles in aqueous solution

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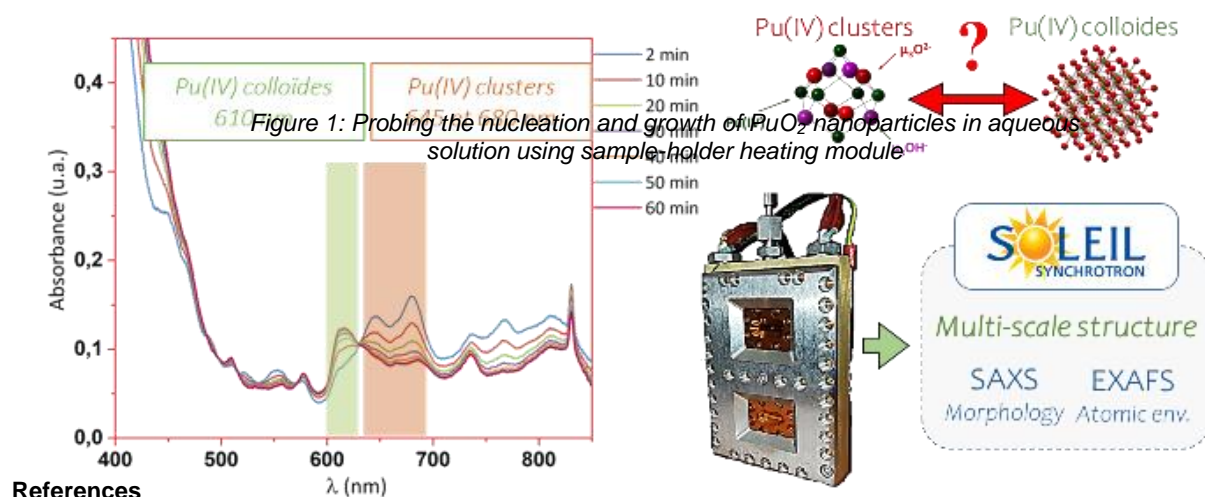
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A better understanding of the structural and physico-chemical properties of colloidal nanoparticles of plutonium oxide (PuO<sub>2</sub>) is of interest not only for elucidating their environmental migration patterns but also for the potential development of advanced nuclear fuels.[1,2] Colloidal suspensions resulting from the hydrolysis of Pu(IV) are now described as crystalline PuO<sub>2</sub> nanoparticles measuring approximately 2 nm in diameter and exhibiting a structural disorder associated to a surface effect.[3] Although a Pu(IV) hexameric cluster has been recently identified as a reaction intermediate during the formation of these nanoparticles, questions remain regarding their general formation mechanism.[4] In this context, small-angle X-ray scattering (SAXS) and X-ray absorption spectroscopy (XAS, including XANES/EXAFS) available at synchrotron SOLEIL/MARS beamline appear particularly relevant for characterizing both the morphology and atomic environment variations occurring during the nucleation and growth stages of PuO<sub>2</sub> colloidal nanoparticles. To monitor the hydrolysis of Pu on the facility, a heating module (Figure 1), meeting the specifications of the installation for handling radioactive samples at controlled temperatures, has been developed. The kinetic monitoring of Pu(IV) hydrolysis will then be achieved through the thermal decomposition of a complexing agent stabilizing Pu(IV). Preliminary investigations have demonstrated the feasibility of the chemical approach, where the degradation of a Pu(IV) peroxide complex at approximately 80°C, followed by the formation of Pu(IV) colloids, have been confirmed by UV-Vis absorption spectroscopy.

This poster will present the progress on this project by discussing the steps that were necessary for the development of the heating module as well as the preliminary results obtained with Pu and Zr.



## References

- [1] Virost et al. *Nanoscale Adv.* 4 (2022) 4938.
- [2] Gerber et al. *Nanoscale* 12:35 (2020): 18039.
- [3] Micheau et al. *Environ. Sci.: Nano* 7 (2020) 2252.
- [4] Cot-Auriol et al. *Chem. Commun.* 58 (2022) 13147.