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# Ultrasonically assisted conversion of colloidal PuO<sub>2</sub> nanoparticles into an unexpected intermediate plutonium species

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Nano-sized plutonium oxide (PuO<sub>2</sub>) holds a pivotal role in current nuclear energy research. Gaining an understanding of its properties at this scale is crucial to investigate and understand the migration behavior of the radioactivity in the environment but also for the development of advanced nuclear materials tailoring specific properties.<sup>[1]</sup>

Research on actinides under ultrasonic waves revealed diverse behaviors in homogenous solutions and heterogeneous solid-liquid systems.<sup>[2-3]</sup> Recent research demonstrated intriguing outcomes in an acidic solution under oxygen-rich atmosphere. For instance, the sonochemical treatment of micrometric UO<sub>2</sub> or nanometric ThO<sub>2</sub> samples allowed the conversion of the respective oxides into uranium and thorium peroxides, with a partial conversion for the latter.<sup>[3-4]</sup>

This study aimed to improve fundamental knowledge about PuO<sub>2</sub> behavior under ultrasonic irradiation in aqueous solutions. Colloidal suspensions of PuO<sub>2</sub> nanoparticles were sonicated under 20 kHz and 205 kHz ultrasound in acidic media (HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>) under Ar/O<sub>2</sub> atmosphere. Spectroscopic (Vis-NIR absorption, EXAFS) and small-angle X-ray scattering techniques (SAXS) revealed the dramatic impact of the acoustic cavitation phenomenon on the PuO<sub>2</sub> nanoparticle speciation. In particular, the generation of unprecedented Pu intermediate species was observed (e.g. Figure 1) and revealing to be strongly influenced the physical effects of ultrasound and the sonochemical formation of hydrogen peroxide.

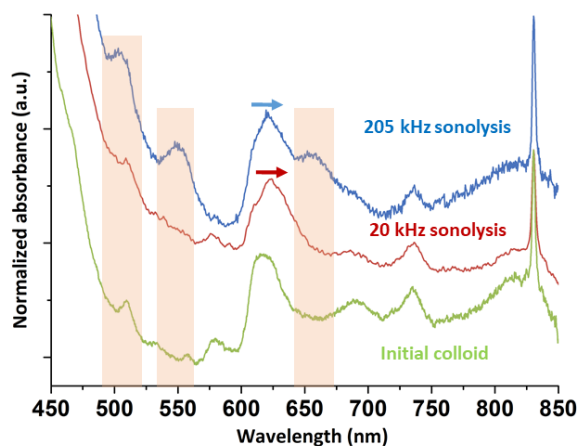


Figure 1: a) Vis-NIR absorption spectra acquired for (a) the colloidal Pu suspension (1mM) before and after sonolysis (20-205 kHz, Ar/20%O<sub>2</sub>, 20°C)

## Keywords (max. 3)

Sonochemistry, , Plutonium, Nanoparticles

## References

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- <sup>[3]</sup> Margate J et al., 2023 *Journal of Hazardous Materials*, 458, 132059
- <sup>[4]</sup> Bonato L. et al. 2020, *Ultrasonics Sonochemistry*, 69, 65235