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## Sonochemistry of Plutonium

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### Abstract

Sonochemistry (i.e., chemical reactions driven under power ultrasound) has attracted considerable attention as a promising alternative in nuclear reprocessing due to the mild and efficient reaction conditions it enables. The arising acoustic cavitation, (i.e., the nucleation, growth, and rapid implosive collapse of gas and vapor-filled micro-bubbles) allows the in-situ generation of active species that can react in solution and lead to redox interactions. In heterogeneous systems, this phenomenon goes with strong physical effects such as erosion of surfaces, grain fractures, increase of mass transfer, and decrease of diffusion layers. This presentation aims to summarize the investigations carried out in the topic of Pu sonochemistry since 2010 at ICSM and Atalante facilities in Marcoule. The talk will focus on (i) the redox behavior of Pu(III), Pu(IV), Pu(V), and Pu(VI) ions in aqueous nitric solutions under ultrasound irradiation, (ii) the ultrasound-assisted reductive dissolution of refractory PuO<sub>2</sub>, and (iii) the sonochemical preparation of stable and salt-free nanometric Pu colloids (Figure 1). Related characterizations are performed with UV-Vis absorption spectroscopy, SEM, HR-TEM, EXAFS and XANES.

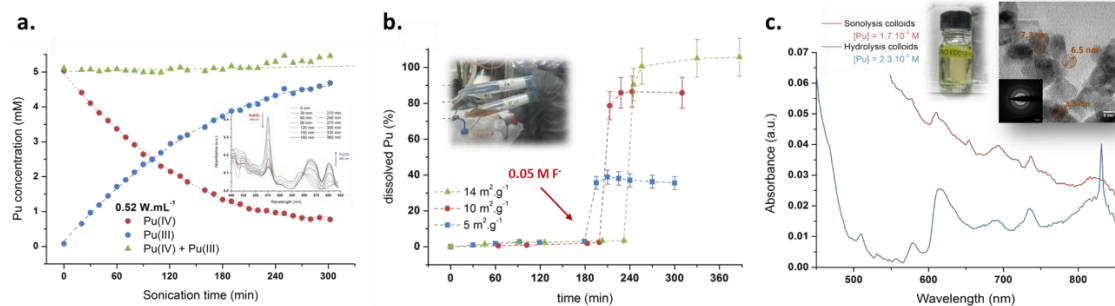


Figure 1: (a.) Sonochemical kinetics illustrating the reduction of Pu(IV) in 1 M HNO<sub>3</sub> / 0.1 M HN at 20 kHz and 26°C (inset: UV-Vis spectra as example); (b.) Sonochemical (20 kHz, Ar, Ti 325 mesh, 35°C) dissolution curves obtained for PuO<sub>2</sub> samples in 0.5 M HNO<sub>3</sub> / 2 M HCOOH / 0.1 M HN with injection of 0.05 M NH<sub>4</sub>F (inset: Pu(IV) and Pu(III) solutions); (c.) UV-Vis absorption spectra of hydrolytic and sonolytic Pu colloids (inset: sonolytic colloids, and HR-TEM picture of the crystalline particles).

Sonochemistry, Ultrasound, Plutonium, Redox reactions, Dissolution, Colloids

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