



**HAL**  
open science

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

Matthieu Viot, Cyril Micheau, Sandrine Dourdain, Thomas Dumas, Denis Menut, Pier lorenzo Solari, Laurent Venault, Olivier Diat, Philippe Moisy, Sergey I. Nikitenko

### ► To cite this version:

Matthieu Viot, Cyril Micheau, Sandrine Dourdain, Thomas Dumas, Denis Menut, et al.. Multi-scale structural characterization of Pu(IV) intrinsic colloids by synchrotron SAXS coupled with XAS. JDA 2021 - 50èmes Journées des Actinides and the 13th School on The Physics and Chemistry of the Actinides, Mar 2021, Rennes, France. hal-04764810

**HAL Id: hal-04764810**

**<https://hal.science/hal-04764810v1>**

Submitted on 4 Nov 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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

**Matthieu Virot,<sup>1</sup> Cyril Micheau,<sup>1</sup> Sandrine Dourdain,<sup>1</sup> Thomas Dumas,<sup>2</sup> Denis Menut,<sup>3</sup> Pier L. Solari,<sup>3</sup> Laurent Venault,<sup>2</sup> Olivier Diat,<sup>1</sup> Philippe Moisy<sup>2</sup> and Sergey I. Nikitenko<sup>1</sup>**

<sup>1</sup> ICSM, UMR 5257, CEA, CNRS, ENSCM, Univ Montpellier, Marcoule, France,  
e-mail: matthieu.virot@cea.fr

<sup>2</sup> CEA, DES, ISEC, DMRC, Univ Montpellier, Marcoule, France

<sup>3</sup> Synchrotron SOLEIL, MARS beamline, l'Ormes des Merisiers, Gif/Yvette, France

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 PuO<sub>2</sub> 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.

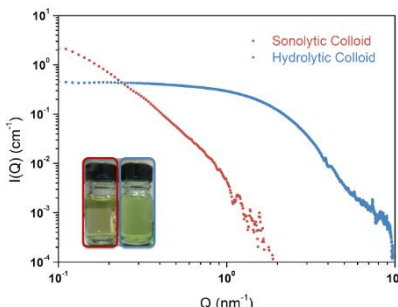


Fig. 1: SAXS scattering curves acquired on intrinsic Pu(IV) colloids prepared by hydrolysis and sonolysis (20 kHz, Ar/(10%)CO, H<sub>2</sub>O, 20°C).

## References

- [1] Romanchuk et al. *Frontiers in Chemistry* **8**, 630 (2020).
- [2] Kersting. *Inorganic Chemistry* **52**, 3533 (2013).
- [3] Walther et al. *Chemical Reviews* **113**, 995 (2013).
- [4] Dalodiere et al. *Scientific Reports* **7**, 43514 (2017).
- [5] Micheau et al. *Environ. Science: Nano* **2**, 214 (2020).