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The contribution of ultrasound to the synthesis of colloidal uranium oxide nanoparticles

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The tetravalent state is the main oxidation state of uranium in the nuclear fuel, and it is also the most prevalent reduced form under environmental conditions, particularly in the anoxic and reducing conditions of deep natural waters.[1-3] The speciation of uranium under these conditions is complex, and the potential formation of intrinsic colloids resulting from the hydrolysis of U(IV) is rarely reported in the literature. However, it has been shown that colloidal species can significantly contribute to the migration of radionuclides in the environment.[4-6] Therefore, the preparation of reproducible and size-controlled nanoparticles is of particular interest for environmental studies, but also for the development of materials tailoring specific properties, particularly when organized at the nanoscale.

This presentation will describe the synthesis and characterization of intrinsic colloids of U(IV), prepared by hydrolysis (65 °C, Ar) or ultrasonic irradiation (20 kHz, 65 °C, Ar/10%CO) from a HCl-stabilized U(IV) solution. The application of ultrasound in the presence of carbon monoxide, to inhibit the formation of hydrogen peroxide and thus the oxidation of U(IV), allowed the preparation of colloidal suspensions of uranium in aqueous solution. Characterization of these suspensions by SAXS, TEM-HR, and XRD revealed that they are composed of quasi-spherical nanoparticles with a crystalline structure similar to that of UO_{2+x}, measuring 18.0 ± 0.1 nm and 7.8 ± 0.1 nm after sonolysis and hydrolysis, respectively. The application of power ultrasound appears as an original and relevant synthesis route for the preparation of actinide oxide nanoparticles with controlled size and crystalline properties.

Keywords

Nanoparticle, Uranium, Colloid

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