European Mineralogical Conference
Vol. 1, EMC2012-472, 2012
European Mineralogical Conference 2012

Ceramic Waste Forms for Conditioning of Minor Actinides

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The disposal of high level radioactive waste is one of the most pressing and demanding challenges of the 21st century. With respect to long-term safety aspects of geological disposal Actinide elements are of particular concern due to their long half-lifes and high radiotoxicity. Ceramic waste forms for the immobilisation of actinides have been investigated extensively in the last decades since they seem to exhibit certain advantages over other waste forms (incl. borosilicate glasses and spent fuel). Currently ongoing nuclear waste management strategies mainly do not include ceramic waste forms. However, it still seems to be important to study this option, e.g. with respect to special and well defined waste streams.

The research program in Jülich is based upon fundamental science and follows an integral approach that covers the separation of elements, e.g. Americium or elemental groups with similar chemical properties from a simulated waste stream by liquid/liquid extraction as well as the immobilisation in ceramic materials as hosts. The research focuses on single phase ceramics such as Monazite and Zirconates with Pyrochlore structure and includes: 1) powder synthesis suitable for the handling of radionuclides such as sol-gel route, hydrothermal synthesis and co-precipitation, 2) structural and microstructural characterisation using state of the art spectroscopic/diffraction (TRLFS, Raman, XRD) and microscopic techniques (SEM), 3) thermodynamic stability and reactivity under conditions relevant for nuclear disposal, in particular with respect to leaching/corrosion in aqueous environments (static and dynamic dissolution experiments on powders and pellets) as well as 4.) studies on radiation damages. Finally, a fundamental understanding of the interaction of these aspects will help to improve long-term safety assessments of deep geological disposal concepts using these materials.