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Thorium incorporation in phosphates matrices: the case of xenotime

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The management and the conditioning of radwaste represents a major challenge in the nuclear industry. Therefore a variety of host matrices have been studied, including several phosphate based ceramics.¹ They represent promising candidates for the specific conditioning of actinides (III, IV) owing to their easy way of preparation and high chemical durability.²

The incorporation of actinides in such phases has been extensively studied through solid-state routes. Thus, it often requires repetitive grinding steps and re-heating to avoid the formation of heterogeneous compounds.³ For such reasons, the synthesis of target compounds in aqueous solution were developed to prepare pure and homogenous phases.

In this study, a particular attention was paid to the incorporation of tetravalent actinides (Th^{4+} , U^{4+}) in the zircon structure type through the coupled mixed ($\text{An(IV)} + \text{SiO}_4 / \text{Ln(III)} + \text{PO}_4$) substitution.

In this frame, solid solutions of $\text{Er-xTh}_x(\text{PO}_4)_{1-x}(\text{SiO}_4)_x$ were obtained in application of the method developed to prepare pure coffinite (USiO_4), i.e. hydrothermal conditions at 250°C for 7 days.⁴ The analysis of the PXRD data showed the formation of single phases. The structure crystallizes in the zircon-type structure (I41/amd group, tetragonal system) as observed for the end-members ThSiO_4 and ErPO_4 . From Rietveld refinements, the formation of a complete solid solution was confirmed in agreement with the Vegard's law. A thorough analysis was also carried out by Raman spectroscopy and EXAFS at the Er and Th edges and showed an exciting structural evolution.⁵

References

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