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Fluorapatite as immobilization matrix for nuclear waste

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The safe confinement of the nuclear waste coming from fuel reprocessing operations is one of the key points in the sustainable development of the nuclear fuel cycle and, in general, of nuclear energy.

Fluoride-containing radioactive wastes are generated during the pyrochemical reprocessing of spent nuclear fuels. They differ significantly from the wastes arising from hydrochemical processing, due to the high halides content. The vitrification of these wastes in alkali borosilicate glass is not viable due to the low solubility of fluoride ions in such host matrices. For this reason, alternative wasteform candidates were investigated, including apatite. Apatites, $M_5(XO_4)_3Y$, are known to accommodate a large variety of cations (mono-, bi- and trivalent) and anions in non-stoichiometric compositions, thanks to the high flexibility of their structure. Moreover, these host systems exhibit a good resistance towards leaching and radiation-induced damage, which mitigates against release of radioactive isotopes from the matrices into the environment. Of particular interest in environmental and materials sciences is the use of apatite to sequester radionuclides such as ^{90}Sr . In the present work, a new approach for the preparation of the Sr-substituted fluorapatites by solid state reaction was investigated. The obtained apatitic phases were characterized by powder X-ray diffraction, Raman spectroscopy, Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS). The influence of some synthetic parameters, such as the temperature, the SrF_2 amount and the homogeneization, was evaluated. The results suggest that the considered synthetic procedure could be reasonably applied to the confinement of the radionuclides contained in some types of nuclear waste.

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