**Clay-based matrices for chloride- and fluoride-containing radioactive wastes**

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Closure of the nuclear fuel cycle is a great issue for nuclear energy nowadays. It enhances sustainability by recovering uranium/plutonium and transmuting minor actinides through spent nuclear fuel (SNF) reprocessing, innovative reactor types and technologies development, but these approaches create complex new waste streams and pose new challenges for radioactive waste management [1]. So, the Russian Proryv project suggests pyrochemical or combined technology to reprocess mixed uranium-plutonium nitride SNF from fast neutron reactors (FNR) with the use of LiCl-KCl molten salt electrolytes [2]. FLiNaK as a molten salt medium plays a central role in molten salt reactors (MSR) due to its high efficiency and low cost, and supports efficient and safe reactor operation at high temperatures and low pressures due to its excellent thermal stability and low vapour pressure characteristics [3]. As a result, the high-level waste (HLW) generated after such reprocessing contains a large amount of alkali metal chlorides and fluorides. This requires the development of novel immobilization technologies, without which achieving the closed nuclear fuel cycle would be impossible.

Borosilicate glasses, despite their widespread use for immobilization, have a limited ability to retain such special waste types. Though some kinds of phosphate glasses can hold for example fluoride more effectively and exhibit greater chemical resistance. With regard to chlorides, conventional glass and cement matrices encounter difficulties in effectively immobilizing them, which results in reduced chemical stability and an increased risk of radionuclide release. Conversely, ceramics have demonstrated superior immobilization performance due to their exceptional chemical and thermal stability, as well as mechanical strength. In previous works of our scientific group bentonite clay were investigated as matrix materials for spent electrolyte, this strategy represents as rational for radioactive waste management [4]. A specific percentage of sample compositions, the time-temperature annealing regimes were determined, and ceramic samples were successfully fabricated and characterized.

In this work three new clays with different chemical and mineralogical compositions were used to prepare samples with radioactive waste imitators. These samples were analyzed for comparison to contrast their capabilities of immobilizing chlorides from pyrochemical or combined FNR spent fuel reprocessing and fluoride electrolytes from MSR. We are focusing on the mechanical strength, thermal and frost stability, phase composition, morphology, leaching and radiation resistance of the obtaining matrix samples. The mechanism of immobilization and the main physico-chemical parameters important for the matrix material are identified using multiscale methods: X-ray diffraction (XRD), inductively coupled plasma spectrometry/mass spectrometry (ICP-OES/MS), scanning electron microscope (SEM) and X-ray fluorescence (XRF). The experiments demonstrate the efficacy of the clay-based samples in immobilizing spent chloride or fluoride electrolyte imitators. Furthermore, the correlation between the immobilization performance and the type of clay minerals is still under investigation.

**References**

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