Accepted Manuscript

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PII: S0022-3115(17)31346-6

DOI: 10.1016/j.jnucmat.2017.12.039

Reference: NUMA 50704

To appear in: *Journal of Nuclear Materials*

Received Date: 24 September 2017

Revised Date: 21 December 2017

Accepted Date: 27 December 2017

Please cite this article as: S.V. Stefanovsky, O.I. Stefanovsky, M.I. Kadyko, B.S. Nikonov, Sodium aluminum-iron phosphate glass-ceramics for immobilization of lanthanide oxide wastes from pyrochemical reprocessing of spent nuclear fuel, *Journal of Nuclear Materials* (2018), doi: 10.1016/j.jnucmat.2017.12.039.

Sodium aluminum-iron phosphate glass-ceramics for immobilization of lanthanide oxide wastes from pyrochemical reprocessing of spent nuclear fuel

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Abstract

Sodium aluminum (iron) phosphate glass ceramics containing of up to 20 wt.% rare earth (RE) oxides simulating pyroprocessing waste were produced by melting at 1250 °C followed by either quenching or slow cooling to room temperature. The iron-free glass-ceramics were composed of major glass and minor phosphotridymite and monazite. The iron-bearing glass-ceramics were composed of major glass and minor monazite and Na-Al-Fe orthophosphate at low waste loadings (5-10 wt.%) and major orthophosphate and minor monazite as well as interstitial glass at high waste loadings (15-20 wt.%). Slowly cooled samples contained higher amount of crystalline phases than quenched ones. Monazite is major phase for REs. Leach rates from the materials of major elements (Na, Al, Fe, P) are 10^{-5}-10^{-7} g·cm^{-2}·d^{-1}, RE elements – lower than 10^{-5} g·cm^{-2}·d^{-1}.

Introduction

One of the promising methods of spent nuclear fuel (SNF) reprocessing considered since 1960s is a pyroelectrochemical technology [1,2]. In Russia this technology was developed for reprocessing of SNF from fast neutron reactors BN-350 and BOR-60 [3,4]. Technological high-level wastes (HLW) generated during SNF reprocessing are spent electrolyte, phosphate