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Cesium-containing complex oxides of the pollucite structure. Synthesis, properties, preparation of ceramics with high relative density and its radiation tests

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Complex oxides with the structure of the mineral pollucite (CsAlSi2O6) represent a large group of compounds and they are basic for the development of materials for different purposes, including immobilization of cesium from waste of radiochemical industries and preparation of medical sources radiation. The number of such oxides has increased significantly basing on isomorphism of atoms in the crystal lattice and calculations modeling compounds of phosphorus-containing phases [1].
Isomorphic substitution of aluminum by boron leads to the increase of cesium mass fraction and growth of the specific activity of the compound in the case of a radioactive isotope. Inclusion of boron in the phosphorus-containing pollucite-like phases provides new possibilities for the development of materials for nuclear medicine (boron neutron capture therapy, BNCT) and ceramics - neutron absorbers.
Oxides with pollucite structure containing boron and aluminum Cs[MgR0.5P1.5O6], where R = B and Al, were synthesized using a sol-gel process, and they were characterized by X-Ray diffraction. Structural studies for obtained compounds were performed (Rietveld refinement). The thermal expansion was studied by using of the methods of high- and low-temperature X-Ray analysis at temperatures range from -100 to 800 ℃ (α = (7.3 - 8.6)·10-6 deg-1), thermal (tested up to 1200 ℃) and hydrolytic stability (T = 90 ℃, 1.46·10-5 g/(cm2•d)) were studied also.
The obtained compounds were used for synthesis of the ceramics by spark plasma sintering. The relative densities of ceramics were up to 98 % [2]. We found that the complex oxides –analogues of pollucite - have high chemical and radiation stability. The obtained ceramic materials were irradiated with 132Xe26+ ions (E = 167 MeV) in the fluence interval from 6•1010 to 1•1013 cm-2. The amorphization took place at a fluence of 1.2•1012 cm-2. The conditions of the metamict form transition into the crystalline form on heating were found.
The crystal-chemical modeling of isostructural compounds was carried out with a deficit of cesium in the cavities of the structure of the general formula Cs1-x[Mg1+x-yR0.5-2x +0.5yLi0.5yP1.5+xO6], where R = B, Al; 0 ≤ x ≤ 0.2; 0 ≤ y ≤ 0.8.

References:

1. Loginova E.E., Orlova A.I., Mikhailov D.A. et al. // Radiochemistry, 2011. V. 53. № 6. P. 593-603.
2. Orlova A.I., Troshin A.N., Mikhailov D.A. et al. // Radiochemistry, 2014. V. 56. № 1. P. 98-104.

Primary author: Mr TROSHIN, Aleksey (Lobachevsky State University of Nizhni Novgorod)

Presenter: Mr TROSHIN, Aleksey (Lobachevsky State University of Nizhni Novgorod)

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