Studies of nuclear waste form glasses with synchrotron radiation

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The speciation of several radionuclide and surrogate metal ions in specific formulations of nuclear waste form glasses has been investigated by synchrotron radiation methods. The primary technique to determine the oxidation state and structural information, and chemical behavior in many of these studies has been hard x-ray absorption fine structure (XAFS) [1]. There has been considerable effort utilizing XAFS to understand the conditions under which surrogates, in large part Re for Tc but also including specific metal ions such as Ce and Hf for Pu, are suitable chemical and structural analogs for the actual radionuclides of interest. Similar approaches have been utilized to validate the reliability of surrogates in glass waste form characteristics under processing and alteration conditions [2].

Recently, studies of glass waste form materials have been initiated using new soft synchrotron radiation tools that include the scanning transmission x-ray microscope (STXM) and ambient pressure x-ray photoelectron spectroscopy (APPES) endstations at the Molecular Environmental Sciences Beamline of the Advanced Light Source at LBNL [3]. Spectromicroscopy studies have been conducted using soft x-ray absorption spectroscopy of light atom constituents and metal ions in glasses with STXM. investigating the early stages of the interaction of water with glass surfaces with PES under more realistic conditions of approximately 10 Torr. New opportunities to address critical issues in nuclear waste form glass science with emerging synchrotron radiation methods will be presented and discussed.

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A novel ^{190}Pt-^{4}He method of isotope geochronology for the direct dating of native minerals of platinum

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Retention of radiogenic ^{4}He in crystals of most minerals is very low. Helium can escape easily from minerals in a course of their geological history. However, in a group of minerals, namely native metals, the retention of radiogenic helium is anomalously high [1]. Very low solubility of helium in metals leads to formation of atomic clusters of helium atoms, which manifest themselves as nanometer-scale bubbles. Migration of such "bubbles" in the crystal structure requires relatively high temperature close to the metal melting temperature.

The tendency of helium to form stable bubbles in native metals allows to propose a novel method in isotope geochronology for the direct dating of native minerals of platinum that is based on the α-decay of ^{190}Pt isotope [2].

We present nuclear-physical, isotope-geochemical and methodological aspects of the novel ^{190}Pt-^{4}He method. We validate the method on a set of new experimental ^{190}Pt-^{4}He dating measurements of four platinum deposits: (i) the Galmoenan massif, a gabbro-dunite-pyroxenite massif in the Koryak Highlands, Russia; the alkaline-ultramafic massifs of (ii) Kondyor, (iii) Inagli and (iv) Chad in the Aldanian shield, Russia. Our experimental measurements confirm the successful applicability of ^{190}Pt-^{4}He for the direct dating of the native minerals of platinum.

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