



Contribution ID: 55

Type: Oral Presentation

Synthesis and characterisation of rare Ce_3NbO_7 compounds for use as nuclear space batteries by neutron powder diffraction and X-ray absorption spectroscopy

Wednesday, 1 November 2017 09:30 (15 minutes)

Ce_3NbO_7 weberite-type materials, an inactive analogue for Am_3NbO_7 , have potential use in americium radioisotope thermoelectric generators to be developed by the European Space Agency for scientific missions beyond the orbit of Jupiter. Ceramics with greater than 97% purity were synthesised by thermal solid-state reaction and analytically characterised by X-ray diffraction, neutron diffraction, helium pycnometry, Raman spectroscopy and X-ray absorption spectroscopy. The Magnetochemistry of the system was calculated with the Weiss temperature and magnetic moment per unit volume derived, in good agreement against the theoretical values. Reitveld refinement of neutron data was employed to identify the crystal structure of the novel cerium niobate and determine the correct orthorhombic space grouping from either Cmcm (No.63) or Pnma (No.62) space groups. Ce_3NbO_7 refined well under both systems indicating possible pseudosymmetry. Cerium in the +III oxidation state was observed by X-ray absorption spectroscopy confirming the chemical speciation within the structure.

Summary

Designing space batteries from UK reprocessed plutonium stockpiles.

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Session Classification: Ceramic and Glass-Ceramic Wasteforms

Track Classification: National and international collaborative waste management programs