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Interaction between sodium and nanosized mixed oxide fuel (U1-xPux)O2: focus on the structural characterization of Na4(U1-xPux)O5.

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The mixed oxide (U1-xPux)O2 is currently the reference fuel for the Sodium-cooled Fast Reactors. In case of severe accident, the irradiated fuel would interact with the sodium in a large temperature range. In order to assess the safety of the Sodium-cooled Fast Reactor, the study of the Na-U-Pu-O system is mandatory. In previous studies [1] [2] [3], some compounds have been reported but no thermodynamic data exist on the quaternary phases and the synthesis of pure phases was challenging.
In this work, we used the oxalate decomposition under hot compressed water at low temperature [4] to get the starting materials (U1-xPux)O2 (x= 0.06, 0.13, 0.29, 0.46). Thanks to this new way of synthesis, the mixed oxide fuels produced are nano-sized and have a spherical shape instead of plate-like agglomerates [5] [6]. Moreover, they are more reactive than the previous compounds, facilitating the synthesis of pure phases.
These nanocrystals were mixed with different amounts of Na2CO3 or NaOH to explore which compounds will be formed. Along this talk, the first results on the interaction between nano-sized mixed oxide fuels and sodium will be presented. Especially, we have obtained pure Na4(U1-xPux)O5 which has been analysed by X-ray powder diffraction (XRD) and U M4/Pu M5 high-energy resolution X-ray absorption near-edge structure (HR-XANES) spectroscopy. Analysis of the XRD patterns demonstrate that the lattice parameters are not following the Vegard's law between Na4UO5 and Na4PuO5. As expected from the structure of the ternary compounds, the HR-XANES spectra show that uranium is in a +VI oxidation state whereas the plutonium has a lower oxidation state. This would explain the deviation from Vegard's law.

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