Fabrication of simulated minor actinide containing fuel particles and analytical characterization methods

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Introduction

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Sol-gel method by internal gelation

Characterization

- $\text{U/Nd}$ microspheres ($\chi(\text{Nd}) = 0 - 42.63\%$) prepared via internal gelation.
- Average masses and diameters with small standard deviations.
- EDX results (top 5 μm) in good correlation with ICP-MS measurements.
- Sphericity proven by SEM, cracks found for air dried particles.
- Proper surface integrity after treatment in $\text{H}_2/\text{Ar}$.
- Crack formation proven by ESEM (850 Pa → 70 Pa).
- Linear dependence of lattice parameter on $\chi(\text{Nd}) \leq 25\%$.
- Unexpected behaviour for $\chi(\text{Nd}) > 25\%$ (1300 °C → 2 phases).

Weak-acid resin process

Characterization

- Adsorption equilibrium reached after 18 h.
- Decrease of $\text{Nd}^{3+}$ fraction after $t > 18$ h
- $\text{Nd}^{3+}$ kinetically favoured; $\text{UO}_2^{2+}$ thermodynamically favoured.
- The pH value is a major factor on the adsorption.
- Treated in air: Amberlite IRC-86 broken, Lewatit TP-207 suitable.
- No equilibrium solid solution has been achieved (reducing atmosphere).


[Thanks to F. Sadowski (ICP-MS analyses) and J. Dellen (XRD measurements).]
[This research was partially supported by the European Atomic Energy Community’s 7th Framework Programme within the project ASGARD - grant agreement No. 295825.]

[Example for production of $\text{UO}_2$ microspheres using Amberlite IRC-86.]

[TP-207 $\text{Nd}^{3+}$ $\text{UO}_2^{2+}$
Lewatit IRC-86 $\text{Nd}^{3+}$ $\text{UO}_2^{2+}$
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