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Advancing the Production Routes of Nanosized Actinide Oxides Solid Solutions

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Extended Abstract

The properties of actinide dioxide nanocrystals are of interest for various stages of the nuclear fuel cycle. The standard fuel for current commercial nuclear reactors is based on actinides dioxides: UO_2 (natural or enriched) or UO_2-PuO_2 mixed oxides. Essentially, the properties of the initial powders should allow reaching very high density of the fresh nuclear fuel. Besides, nanostructures of actinide dioxides are formed in the high burn-up structure of spent fuel. This is why JRC has built-up expertise in the formation and characterisation of actinide dioxide nanoparticles during the past ten years.

We present here our recent progress in the field of nanoparticle synthesis under hot compressed water [1]. We will focus on the methods used for the production of different solid solutions containing actinides and lanthanides.

The oxalate decomposition under hot compressed water allows formation of nanosized mixed oxides such as $(U,Th)O_2$ [2] and $(Np,Pu)O_2$ [3]. Moreover, the method is effective for the production of multicomponent actinide solid solutions, as demonstrated for $(Th,U,Np)O_2$ and $(Th,Np,Pu)O_2$ [3].

On the other hand, the reaction product of the cerium oxalate decomposition at 400°C/ 250 bar is the hexagonal $Ce(CO_3)(OH)$, in which cerium has a trivalent oxidation state. Thus, the method cannot be used for the synthesis of CeO_2 and associated $(Ce,U)O_2$ solid solution. Nevertheless, such nanopowders may be produced by decomposition of mixed hydroxides [4]. The hydroxide decomposition method under hot compressed water proved to be straightforward in the case of CeO_2, ThO_2 and $(U,Th)O_2$ solid solutions. However, the formation of $(Ce,U)O_2$ solid solutions through this synthetic route is not always successful and the method still needs optimisation. An alternative approach is to start from reagent end-members; this is to be evaluated more in detail yet.

References

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