2 - 38 Internal-gelation Process to Fabricate Sphere-pac Nuclear Fuel

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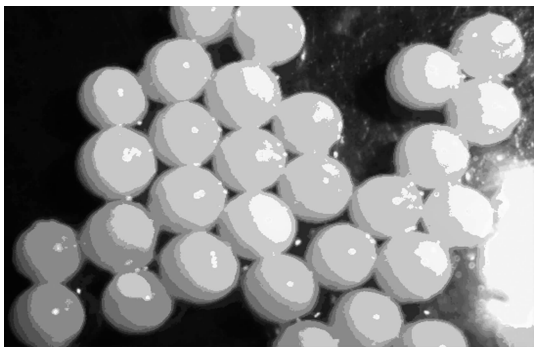

Fig. 1 UO_3 sphere fabricated in Class b, IMP.

Sphere-pac fuel is a concept of fabricating MOX fuel, composed of particles, which are directly filled into a fuel pin. Sphere-pac production is the preferred succeeding step to a wet reprocessing route. This can be a PUREX (plutonium and uranium recovery by extraction) process, combined with one of its follow-up processes (e. g. , selective actinide extraction (SANEX) . . .)[1].

An internal-gelation process for UO_2 microsphere was originally developed at the KEMA laboratories, located in the Netherlands. Since that time, various modifications of the process have been evaluated and utilized in a number of laboratories throughout the world[2].

Sphere-pacoxide fuel was selected as candidate ADS fuel in IMP because of some unique advantages. Therefore, uranium spheres were fabricated as following steps in our laboratory (Fig. 1). Firstly, in common with such process concentrated metal nitrite feed solution are prepared, cooled, and then mixed with cold concentrated solution of HMTA and urea to form a broth that can be dispensed as droplets into a hot medium or microwave cave in which gelation occurs.

The main chemistry reaction as follows:

decomplexation, $UO_2(NH_2\text{-}CO\text{-}NH_2)_2^+ \rightarrow UO_2^{2+} + 2CO(NH_2)_2$

hydrolysis, $UO_2^{2+} + 2H_2O \rightarrow UO_2(OH)_2 + 2H^+$

HMTA protonation, $(CH_2)_6N_4 + H^+ \rightarrow [(CH_2)_6N_4H]^+$

HMTA decomposition, $[(CH_2)_6N_4H]^+ + 3H^+ + 4NO_3^- + 6HOH \rightarrow 4NH_4^+ + 4NO_3^- + 6CH_2O$

References

[1] M. A. Pouchon, G. Ledergerber, Sphere-Pac and VIPAC Fuel, 2012, Elsevier Ltd.
[2] J. L. Collins, M. H. Lloyd, Radiochimica Acta, 42(1987)121.