URANIUM FREE NITRIDE FUEL MODELLING, FABRICATION, CHARACTERISATION AND IRRADIATION

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Abstract

In the European Union CONFIRM project, modelling, fabrication, characterisation and irradiation of uranium free nitride fuel for transmutation are performed. In the present contribution, the status of the project is reviewed.

Carbo-thermic nitridation of oxide powders has been used at PSI to fabricate (Pu,Zr)N. Heat capacity and thermal diffusivity of (Pu,Zr)N pellets with a density up to 89% TD and oxygen impurity levels of about one weight percent was measured at CEA. The inferred thermal conductivity was in the range of 15-25 W/(m/K), slightly higher than prior theoretical assemssments for pure (Pu,Zr)N.

Thermo-chemical modelling of the fabrication process indicated that use of nitrogen gas during the entire process should provide better nitride yields. Thus switching gas phase from Ar-H2 to N2-H2 during the de-carburisation stage, residual impurity levels of oxygen could be reduced to less than 0.2 weight percent. The density of the pellets pressed from this powder could however not be increased above 82% TD.

Pellets with 20& and 30% Pu content and density ranging from 78 to 82 percent TD were manufactured for irradiation in R2. Four pins were delivered to Studsvik in december 2003. Irradiation is expected to begin in summer 2004.

Modelling of the hafnium shielded irradiation has showed that 12% fission in actinides can be achieved during 14 cycles in R2. The planned linear power starts at 40 kW/m, being raised to 50 kW/m half way through the irradiation. A maximum fuel temperature of 2350 Kelvin is expected.

A detailed design of a 800 MWth ADS with (Pu,Am,Cm,Zr)N fuel has been completed. An average linear rating of 35 kW/m combined with a small pin diameter (5.72 mm) and a high P/D (1.75) allowed maintaining an inermatrix fraction above 50%, while guaranteeing benign safety parameters. Transient analysis showed that both cladding and fuel would survive a 50% accelerator overpower as well as an unprotected loss of flow accident.

In 2004, fabrication and characterisation of (Am,Zr)N will be performed in the MA-lab at ITU. For this purpose, a novel method of fabricating oxide microspheres with carbon added to the feed solution has been developed, yielding good results for test fabrication of (U,Zr)N.