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Inter-Diffusion Layer Formation in U-Mo/Al Dispersion Fuel at High Power

B. Ye[a], G.L. Hofman[a], A. Leenaers[b], A. Bergeron[a], V. Kuzminov[b], S. Van den Berghe[b], Y.S. Kim[a], H. Wallin[a]

[a]Argonne National Laboratory, 9700 S. Cass Ave., Lemont, IL 60439, USA
[b]SCK·CEN, Boeretang 200, B-2400 Mol, Belgium

ABSTRACT

Post irradiation examinations of full-size U-Mo/Al dispersion fuel plates fabricated with ZrN- or Si- coated U-Mo particles revealed that the reaction rate of irradiation-induced U-Mo-Al inter-diffusion, an important microstructural change impacting the performance of this type of fuel, transited at a threshold temperature/fission-rate. The existing inter-diffusion layer (IL) growth correlation, which does not describe the transition, was modified with a temperature-dependent multiplication factor that transits around a threshold fission rate. In-pile irradiation data from four tests in the BR2 reactors, including FUTURE, E-FUTURE, SELEMIUM, and SELEMIUM-1a, were utilized to determine and validate the updated IL growth correlation. Irradiation behavior of the plates was simulated with the DART-2D computational code. The general agreement between the calculated and measured fuel meat swelling and constituent volume fractions as a function of fission density demonstrated the plausibility of the updated IL growth correlation. The simulation results also suggested the temperature dependence of the IL growth rate is similar to the temperature dependence of the inter-mixing rate in ion-irradiated bi-layer systems. The simulation results will be verified with planned in-pile irradiation tests (the EMPIRE test in the US and the SEMPER FIDELIS test in Europe) and a series of ion irradiation experiments.