

Micro-Cantilever Tests on Hydride Blister and Zirconium Matrix of Zircaloy-4 Cladding Tube

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Abstract : During reactor operation, hydride blister can occur in spent nuclear fuel (SNF) claddings, and it could worsen the integrity of the claddings locally. Hydride blister can be critical when a pinch-type load is applied in the process of SNF handling and transportation. Micro-cantilever tests were performed to evaluate the risk of local hydride blister by comparing the fracture toughness of local hydride blister and pre-hydrided Zr alloy matrix of SNF cladding on a microscale. Hydride blister was generated by a gaseous charging procedure to simulate an SNF cladding. Micro-cantilevers and pre-cracks were ion-milled with the Ga⁺ ion beam of FEI Helios 600 at 30kV acceleration voltage. Micro-cantilever tests were conducted using PI 85 pico-indenter (HYSTRON) with for sided conductive diamond flat tip (1 μm x 1 μm) at a speed of 5 nm/sec. The results show that the hydride blister specimen could be fractured in the elastic deformation region, and the fracture toughness of the hydride blister specimen could drop up to 60% of that of the pre-hydrided Zr alloy matrix. Therefore, local hydride blister can degrade the integrity of SNF cladding, and the effect of hydride blister should be taken into account when evaluating failure criteria of claddings during handling, storage, and transportation of SNF.

Keywords : fracture toughness, hydride blister, micro-cantilever test, spent nuclear fuel cladding.

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