Microstructural Evoluation in Wolsong 1 Zr-2.5Nb tube with Neutron Irradiation

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Abstract

With the aim of assessing the degradation of Zr-2.5Nb pressure tubes operating in the Wolsong Unit-1 nuclear power plant, characterization tests are being conducted on irradiated Zr-2.5Nb tubes removed after a 10-year operation. The examined tube had been exposed to temperatures ranging from 264 to 306 o C and a neutron fluence of 8.9x10 25 n/m 2 (E>1MeV). A change in the a-type and c-type dislocations were determined using TEM at the three different locations of the irradiated Wolsong 1 Zr-2.5Nb tube to evaluate the neutron irradiation effect. Further, the phase decomposition of the -Zr phase with the neutron irradiation were also investigated using selected area diffraction patterns on the foil specimens and the electron diffraction spectroscopy analysis on the extracted particles using carbon replicas. Neutron irradiation up to 8.9x10 25 n/m 2 (E>1MeV) yielded an increase in an a-type dislocation density to 7.5x10 14 n/m 2 from 4.0x10 14 n/m 2 , corresponding to the a-type dislocation density of the unirradiated Zr-2.5Nb tube. An increase in the a-type dislocation density was found to be the largest at the inlet part of the irradiated tube that was exposed to the lower temperature. However, there is no change in the c-type dislocation density at the neutron fluence of up to 8.9x10 25 n/m 2 (E>1MeV). The decomposition of the β-Zr phase was higher at the outlet part of the tube exposed to higher temperature compared to the other parts while the lower Nb concentration in the β-Zr grains was observed at the inlet part region. The effect of the microstructural evolution of Zr-2.5Nb tubes on the in-reactor performances is discussed.