Spatially Resolved Residual Strains and Stresses in As-Fabricated Nuclear Fuel Plates

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In the United States there is currently an ongoing effort to replace highly-enriched uranium (HEU) nuclear fuels with low-enriched uranium fuels in both research and test reactors. This effort has a two-fold purpose of the proliferation mitigation and the minimization of HEU utilization. The fuel that will be used for the conversion of these high-performance nuclear reactors is U-10wt.%Mo (U10Mo) alloy foil that is encapsulated within an Al-6061 cladding. These fuel plates are fabricated by various rolling processes followed by hot isostatic pressing (HIP’ing) to bond the fuel and cladding together. During the fabrication process, residual stresses are introduced into the plates during both the rolling of the U10Mo fuel foils, as well as during the HIP’ing process due to the difference in thermal expansion coefficients in the U10Mo and Al. Synchrotron x-ray diffraction was utilized to measure the spatially resolved residual strains and stresses in a number of as-fabricated nuclear fuel plates subjected to foil heat treatments and two separate HIP cooling processes. The measurements were carried out in Laue geometry with \textasciitilde90 keV x-rays. These results will also be compared to neutron diffraction experiments.