Neutron Attenuation Effect on Cu-rich Precipitate Formation and Evolution in a Pressure Vessel Weldment from the Zion NPP

Philip D Edmondson, Thomas M Rosseel, Mikhail A Sokolov
Materials Science & Technology Division, Oak Ridge National Laboratory,
Oak Ridge, TN 37831

Recently, material from the decommissioned Zion nuclear power plant Unit 1 reactor pressure vessel (RPV) has become available for microstructural characterization. This unit operated from 1973-1998 and was exposed to service irradiation for approximately 13.7 effective full power years (EFPYs). Of particular interest is the circumferential beltline weld – a high Cu, low Ni Linde-80 composition that was exposed to a peak neutron fluence of ~0.75×10^{19} $n.cm^{-2}$ at the operational temperature of approximately 320 C. In this presentation, atom probe tomography of several samples taken from different placements throughout the thickness of the RPV weld ranging from the inside to the mid-plane of the wall to investigate the role of neutron energy attenuation on the formation and evolution of Cu-rich precipitates. This characterization will focus on the variance in composition, size and number densities of the precipitates throughout the RPV wall and place these variances into the context of mechanical property changes especially the change in ductile to brittle transition temperatures (DBTT). Chemical segregation of P to dislocations in the matrix will also be discussed. This data is unique as it originates from an ex-service component, rather than from a surveillance capsule that has been irradiated at an accelerated rate. Comparisons will be made to other ex-service materials, including that of the Ringhals reactor surveillance capsule program which was observed to have a very high DBTT.

ORNL is operated by UT-Batelle, LLC, under Contract No. DE-AC-00OR22725 with the U.S. Department of Energy.