Irradiation Assisted Stress Corrosion Cracking in SA508-304 Weldment under BWR/NWC Simulated Environment

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Reactor pressure vessel steel SA508 (a low-alloying steel) and 304 (Fe-Cr-Ni austenitic stainless steel) are widely employed in both PWRs and BWRs. Weldments typically have high residual stress and composition gradients within the fusion zone (FZ) and heat affected zone (HAZ) that lead to greater stress corrosion cracking (SCC) susceptibility. Irradiation assisted SCC can be controlled by factors including water chemistry, localized deformation, tensile stress, radiation induced segregation and radiation damage. In particular, the redistribution of Cr, the element responsible for oxidation/corrosion resistance via chromia formation, can sensitize these alloys to SCC phenomenon. These materials can be preferentially attacked at active paths, such as GBs in the FZ and HAZ, when exposed to chemically reactive environment and to radiation.

Slow strain rate tests (SSRT) with strain rate up to 10^{-8}/s were applied on proton irradiated EPRI SA508-309 weldment in an autoclave system with simulated the BWR/NWC environment (10.2 MPa, 288 °C and 2000 ppb oxygen) in order to investigate the radiation assisted SCC. The effect of radiation to induce segregation in the FZ and HAZ of SA508-309 weldment is of typical interest. In addition, SSRTs were employed on as-received SA508-309 weldment to separate the effect of irradiation from environment factors such as LWR water chemistry and applied tensile load. Moreover, SSRTs were conducted on as-received weldment at room temperature and atmosphere pressure. The yield strength and ultimate tensile strength of as-received and proton irradiated SA508-304 weldment under NWC environment is around 25% lower compared to that under room temperature and atmosphere pressure. The redistribution of elements such as Cr in the grain boundary of as-received and irradiated weldment is investigated with STEM-EDS. The initiation of cracking was studied by SEM and TEM in the as-received and irradiated weldment. This talk will focus on identification of the primary factors of SCC in Fe-based weldments.