Symposium R on the Effects of Radiation on Materials

Isolation of the Effect of Microstructure on IASCC in Proton-Irradiated Austenitic Stainless Steels

B.R. Grambau and G.S. Was, Department of Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor, MI 48109

E.A. Kenik, Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831

Irradiation affects both the microstructure and microchemistry of materials. In order to better understand the mechanism of irradiated assisted stress corrosion cracking (IASCC), it is necessary to separate microstructure effects (radiation hardening) from microchemistry effects (radiation-induced segregation). Under typical light water reactor (LWR) neutron-irradiation conditions (T=288°C), the microstructure is dominated by faulted dislocation loops which result in hardening and an increase in yield strength. A commercial purity 304 SS, known to be susceptible to IASCC under these conditions, was irradiated with 3.2 MeV protons at 50°C to a dose of 0.3 dpa. The low-temperature irradiation suppressed vacancy motion and FEG-STEM measurements showed no RIS. The microstructure was dominated by "black-dots," and a small population of faulted loops was present. Microhardness testing revealed an as-irradiated hardness about 40% higher than that caused by irradiation under LWR conditions to 1.0 dpa, an IASCC susceptible condition. Post-irradiation annealing was performed in a vacuum furnace for temperatures ranging from 350-500°C for times ranging from 0.5 to 36.0 hours to evolve the loop microstructure. Constant extension rate tests in normal (BWR) water chemistry at 288°C were conducted to evaluate IASCC susceptibility of the microstructures. Results of microstructure characterization, hardness measurements and IASCC susceptibility will be discussed with regard to the role of microstructure in IASCC.

This work was supported by the U. S. Department of Energy under grant #DE-FG07-99ID13768. Research at the ORNL SHaRE User Facility is partially supported by the Division of Materials Sciences and Engineering, U.S. Department of Energy under contract DE-AC05-00OR22725 with UT-Battelle, LLC, and through the SHaRE Program under contract DE-AC05-76OR00033 with Oak Ridge Associated Universities.