The Effect of Solute Additions and Pre-Irradiation Heat Treatment on the Radiation-Induced Segregation Behavior in Austenitic Stainless Steel

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Radiation-induced segregation (RIS) has been implicated as a factor contributing to irradiation-assisted stress corrosion cracking (IASCC) of austenitic stainless steels. Both bulk alloy composition and initial Cr enrichment at the grain boundaries influence the extent of grain boundary Cr depletion during irradiation. This study evaluates the role of solute additions and pre-irradiation heat treatment on RIS in a series of model austenitic stainless steel alloys. The three alloys used for this study are based on 316 stainless steel and have the following nominal compositions: Fe-16Cr-13Ni-1.25Mn, Fe-16Cr-13Ni-1.25Mn-2.0Mo and Fe-16Cr-13Ni-1.25Mn-2.0Mo-0.07P (wt%). The alloys are heat treated at temperatures ranging from 1100 to 1300°C and quenched using four different cooling paths (furnace cool, air cool, water quench and ice brine quench). Grain boundary segregation is measured prior to and following irradiation with high-energy protons on samples with and without special heat treatment. This experimental matrix allows the examination of the effects of bulk composition, heat treatment and irradiation on the grain boundary composition of austenitic steels.

Acknowledgements

Research at the Oak Ridge National Laboratory SHaRE User Facility was sponsored 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. Work supported under contract W-31-109-Eng-38 with the Department of Energy.