
Micro-nano meter scale characterization of austenitic alloys and welds and the correlation to SCC behavior in high temperature water

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Abstract Stress corrosion cracking of nuclear power plant materials originates from the coupling of the crack tip mechanics and the interface oxidation reaction field. The author and the research team have established and improved an integrated technical system for evaluating SCC performance of structural materials in high-temperature and high-pressure water, combined with material micro-nano scale analyses. In response to the requirements of key experimental data and engineering applicability, several hundreds of thousands hours of stress corrosion cracking tests were conducted in high-temperature and high-pressure water, combined with monitoring of crack length and other technologies. The stress corrosion cracking growth kinetics of typical materials of nuclear island main equipment under various alloy materials, loading modes, and various conditions of high-temperature water environments were systematically tested and studied. The interface reaction behavior of alloys in high-temperature water was tested using electrochemical methods, and the micro nano multilayer structure of oxide films generated by alloys in high-temperature water was characterized by TEM and SEM. During the accumulating experimental data, analyses on data mining, data reliability, data validity, and engineering applicability. Focusing on the service reliability of austenitic stainless steel and nickel-base alloys and weldments in nuclear power plant coolant, the characteristics of the relevant stress corrosion cracking mechanism and model were analyzed.

Keywords Stress corrosion cracking, nuclear power plants, high temperature water, crack tip mechanics, crack tip oxidation, localized oxidation