# Quantification of Local Stress Fields in Crack Initiation in Irradiated Austenitic Stainless Steels

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While the full mechanism by which irradiation assisted stress corrosion crack initiation occurs in irradiated austenitic stainless steels is not fully understood, localized deformation has emerged as a key factor in this process. High angular resolution electron backscatter diffraction (HREBSD) was used to calculate the full stress tensor near a number of dislocation channel–grain boundary (DC-GB) interaction sites. A serial-sectioning technique enabled the identification of the grain boundary plane orientation and tensile stresses were resolved in a direction normal to the boundary. By calculating the full stress tensor and resolving the tensile component normal to the grain boundary, it was possible to determine the relationship between the magnitude of the grain boundary normal stress and intergranular crack initiation. Two lab purity alloys, Fe13Cr15Ni and Fe21Cr32Ni, were strained in an argon environment at 288° C to 4.5% plastic strain after proton irradiation. Specific DC-GB sites were scanned with a 100 nm step size to quantify the residual stress state after high temperature deformation. MD simulations using a modified nickel potential and measurements on the same Fe13Cr15Ni alloy after high temperature straining up to 7.2% on TEM FIB lift-outs using the ASTAR system showed similar magnitudes of both tensile and shear stresses at DC-GB interaction sites. Tensile bar samples were then strained in simulated boiling water reactor normal water chemistry at 288° C an additional plastic strain of 1.5%. A pseudo threshold in the grain boundary normal stress for crack initiation was observed in the Fe13Cr15Ni at 0.9 GPa. Below this value, no intergranular failure was observed. However, as the magnitude of the tensile stress acting at the DC-GB interaction site increased, so did the cracking susceptibility reaching a cracking fraction of 100% by 1.65 GPa. The DC-GB sites scanned in the Fe21Cr32Ni sample were observed to have similar levels of stress concentration, but no intergranular fracture was observed even though several measured tensile stresses eclipsed the 0.9 GPa threshold observed in the Fe13Cr15Ni sample. Results for both alloys will be presented and compared in the context of the stress required to initiate cracking in proton irradiated austenitic stainless steels.