Methodology

- Nuclear grade AISI 304L austenitic stainless steel was examined as-received (AR) and after grain boundary engineering (GBE).
- GBE samples were cold rolled to a 50% reduction, followed by a 2hr anneal at 960°C.
- GBE increased CSL grain boundary fraction. Σ3 boundaries increased from 5.1% in the AR to 17.6% in the GBE.
- 304 and 316 steels, both AR and GBE, were electro-discharge machined (EDM) into tensile bars for in-situ TEM.
- After being jet polished, in-situ transmission electron microscopy (TEM) was used to heat the samples to 160°C, irradiate to 0.4 dpa at temperature, and then strain.
- Post-fracture the fracture morphology was correlated to the microstructure using EBSD, and chemical analysis was performed using STEM/EDS.

- We observe the formation of dislocation loops under irradiation, however STEM/EDS did not reveal significant segregation.
- Fractures of both irradiated and non-irradiated samples show "lightning" fracture paths, but irradiated samples show slightly lower ductility during fracture.
- EBSD shows the fractures occur transgranularly along slip planes. No preference is seen for grain boundary character.

Future work will continue on two fronts. The first will use this experimental procedure with improved GBE and observation techniques. The second will use in-situ TEM techniques coupled with atom probe to attempt to isolate specific mechanisms behind RIS and the effect of grain boundary character in model alloys.
It has been shown that grain alignment of coincident site lattice (CSL) grain boundaries may reduce the effect of RIS in austenitic stainless steels.