Irradiation Response and Mechanical Property Changes of Conventionally and Additively Manufactured 316L Stainless Steels

Lin Shao

Department of Nuclear Engineering, Texas A&M University, College Station, TX 77843

lshao@tamu.edu

Abstract:

Our recent studies on irradiation responses and mechanical properties of AM 316L stainless steels, were reviewed. The major findings include: (1) printing-introduced large pores contain amorphous cores. The pore edges develop either island-like segregation or layered shell-like structures; (2) residual stress can be effectively removed by applying annealing; (3) proton irradiation induces complicated dislocation networks and short-range ordering around dislocations; (4) deformation has a transition from dislocation gliding to twinning as a function of damage levels; (5) the deformation mechanism change is caused by irradiation hardening which allows the yielding stress high enough to exceed the required shear stress for twinning nucleation and activation; (6) twinning benefits the homogeneity in plasticity flow; (7) both high angle grain boundaries and cell walls exhibit defect sink property, but high angle grain boundaries are more efficient; (8) the irradiation-induced swelling in AM variants is systematically less than the wrought counterpart. These findings show that, in comparison with conventionally manufactured 316L SS, AM 316L SS behaves differently under extreme conditions involving irradiation and severe deformation. These behaviors can be interpreted as characteristics of AM variants. The study also shows that A