Effect of Friction Stir Welding on Microstructure Evolution on -Ion Irradiated MA956 up to 200 dpa

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Determining the microstructure evolution of oxide dispersion-strengthened (ODS) alloys is important for predicting the safety and structural integrity of fast reactors. Furthermore, understanding of the detrimental effect of joining techniques such as friction stir welding on microstructural evolution remains an outstanding question for future reactor designs. In order to understand the effect of displacement damage on microstructural stability, rastered ion irradiations were performed on ODS MA956 with 5 MeV Fe^{++} ions utilizing a 6 MV Tandem accelerator at Sandia National Laboratories or a 1.7 MV Tandem at the Michigan Ion Beam Laboratory from 400 to 500°C at doses ranging from 1 to 200 dpa. For *ex situ* samples, the precipitate and void behavior was analyzed using scanning transmission electron microscopy (STEM) in bright field (BF) and high angle annular dark field (HAADF), respectively, while dislocation loops and network dislocations were analyzed with BF imaging. Re-precipitation of the welded MA956 was observed at low dose and was confirmed by energy dispersive x-ray spectroscopy (EDS). Dislocation loops formed by 1 dpa and had a constant diameter from 25 to 200 dpa, regardless of welding condition. Coarsening of the Y-Al-O dispersoids was observed up to 200 dpa. Although initial re-precipitation of dispersoids in the welded samples indicated recovered strength, the radiation tolerance at high dose was much worse in the welded condition at 50 dpa and above measured by the appearance of new phases. The implications of the relative radiation tolerance of welded samples are significant for future reactor designs.