In-situ Observation of Irradiation Effects on High Entropy Alloys, 316H Stainless Steels and Nickel at 500-700°C

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High entropy alloys (HEAs) have attracted great interests in the field of nuclear materials because of its potential irradiation resistance from its high entropy effect, distorted lattice and sluggish diffusion kinetics. Many irradiation studies have shown that HEAs are resistant to swelling as compared with simpler modal alloys. However, other aspects such as the irradiation hardening and the embrittlement of HEAs are still not clear.

In order to evaluate the HEAs for nuclear applications, this study compared HEAs ($Al_{0.3}CoCrFeNi$ and CoCrFeMnNi) with 316H stainless steels and pure nickel under consistent irradiation conditions in the IVEM facility at Argonne National Laboratory. The four materials were *in-situ* irradiated with 1 MeV Kr ions at 500, 600 and 700°C. Previously, irradiation at 300°C to 1 dpa shows that the size and density of irradiation-induced dislocation loops as a function of dose were similar for HEAs and 316H. In contrast, at 500°C and 600°C to 1 dpa, the loop size in HEAs (20-25 nm) was evidently larger than 316H (10 nm), and pure nickel (14 nm). Vacancy migration energies of HEAs and 316H SS were measured with high voltage electron microscopy in Hokkaido University, and its implication to the observed defect microstructure will be discussed.

In this study, the irradiation effect at high temperatures from 500 to 700°C was further investigated. At high temperatures, the sink effect of TEM foil surface resulted in a surface layer with a high density of stacking fault tetrahedral, and with depletion of interstitial dislocation loops. In addition, depletion of dislocation loops in the vicinity of pre-existing dislocations was observed at 500 and 600°C. At 700°C the irradiation-induced defect clusters were found to be highly instable. *In-situ* observation shows that significant portion of the clusters disappear on-site quickly after formation without sliding to the foil surface. This indicates that at this temperature the disappearance of those defect clusters was due to dissociation or recombination, and was not due to surface sink.