Radiation induced recrystallization mechanism revealed by PED analysis in CrFeCoNiCu high entroy alloy

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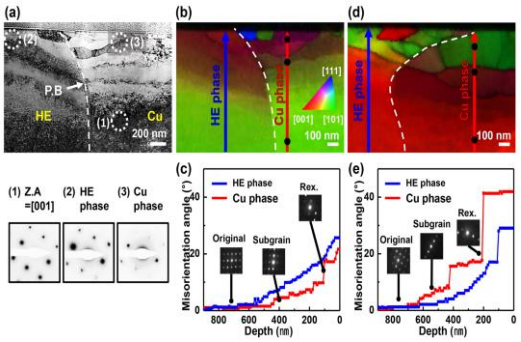
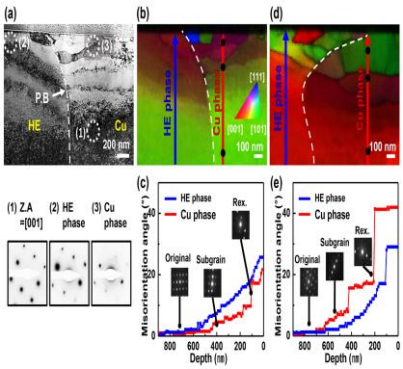
Under irradiation, defects such as dislocation loops and voids are created, resulting in property and microstructure degradation. Due to correlation between microstructure and property, it is necessary to analyze the microstructure to determine radiation tolerance of the materials. High entropy alloys (HEAs), characterized by alloy design with similar atomic percentages lead to relatively stable solid solution with lattice distortion and as a result, diffusion and dislocation movement are difficult. The radiation tolerance of the HEAs was evaluated by quantifying the microstructure change upon irradiation.

As-cast CrFeCoNiCu high entropy alloy, selected in this research, is composed of CrFeCoNi high entropy phase and Cu-rich phase, showing both phases have FCC structure. Therefore, it has a merit that the irradiation damage behavior on the Cu-rich FCC phase and the high entropy FCC can be compared at one time. Heavy ion irradiation was performed using a 2 MeV tandem accelerator in Korea Institute of Science and Technology (KIST) at room temperature and at 400 ° C at 1 dpa and 10 dpa. TEM samples of irradiated CrFeCoNiCu were fabricated using dual-beam FIB (FEI, Helios Nanolab 600). Irradiation induced microstructure degradation was analyzed with bright field image (BF image) and selected area diffraction pattern (SADP) using TEM (FEI, Tecnai F20, FEI Talos F200X). Especially, microstructural evolution like the recrystallization was quantitatively analyzed by TEM-orientation mapping technique based on precession electron diffraction (PED).

With the help of nanoscale quantitative crystal orientation mapping in a cross-sectional transmission electron microscopy sample, we found that continuous dynamic recrystallization occurred at the surface area under ion irradiation. The effect of radiation dose, temperature, and alloy composition on subgrain formation and recrystallization was systematically investigated. This study thus provides insight and guidance to study the radiation-induced recrystallization mechanism and evaluate the radiation resistance of the materials in terms of microstructural analysis.





This research was supported by the National Nuclear R&D Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2013M2A8A1042255) and the KIST Institutional Program (2V05210).