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Effect of Dose Rate on Microstructural Evolution in Austenitic Stainless Steels under Electron irradiation

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Depending on reactor design and component location, structure materials may experience different irradiation dose rates in the same reactor. In order to investigate the effect of dose rate on microstructural evolution in austenite stainless steels, in-situ observation using a high voltage electron microscope was performed on a Fe-Cr-Ni model alloy. Electron irradiation was carried out at various dose rate (1x10^{-4}~2x10^{-3} dpa/sec) in temperature range between 200 and 500°C. Grain boundary segregation, void density, and dislocation loop density were measured after the in-situ observation. Radiation-induced segregation, i.e. Ni enrichment and Cr depletion, occurred at grain boundaries in all irradiation conditions. Both swelling and RIS appear to be affected by dose rate, the irradiation at medium dose rate resulted in the maximum segregation with maximum dislocation loop density, while the irradiation at the lowest dose rate did the maximum void swelling. On the other hand, the peak temperature of segregation and void swelling increased with increasing in damage rate. This dose rate dependence on microstructural evolution can be explained by the rate-theory with considering recombination of point defects at sinks, such as dislocation loops.

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