Microstructural Evolution of High-Dose Neutron Irradiated E97 at the Nano-Scale

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Eurofer97 (E97) is a reduced activation ferritic-martensitic (RAFM) steel that will be used in the future fusion reactors. One of its main problem is radiation hardening and embrittlement at temperatures below 350°C. Thus, understanding the mechanisms at the origin of this phenomenon is important in order to push RAFM steels to lower ductile-brittle transition temperatures after irradiation. To date, the radiation defects visible to the transmission electron microscope (voids and dislocation loops) have been insufficient to explain the hardening measured after tensile tests. However, nano-sized solute clusters (SC), detectable by atom probe tomography (APT), are suspected to significantly contribute to the total hardening. In order to investigate the formation of such SC at low-temperature (300-330°C), the microstructure of E97 neutron irradiated in ARBOR-I (32 dpa, dose rate 8.04 10^{-7} dpa/s, fast neutrons), WTZ (15 dpa, dose rate 8.04 10^{-7} dpa/s, fast neutrons) and SPICE (15 dpa, dose rate 2.25 10^{-7} dpa/s, fast and thermal neutrons) campaigns has been characterized with APT. The re-arrangement of some elements such as Cr, Ni, Si, Mn and P is found to be major after such doses. A detailed description of the bulk microstructure will be presented in this work.

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