Microstructural characterization of single and simultaneous triple ion implanted ODS Fe-(12-14)Cr steels

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Oxide dispersion strengthened reduced activation ferritic/martensitic steels having Cr contents of ~ 12 – 14 wt% (ODS-RAFMS) are promising candidates for demanding structural components of future fusion reactors. These steels have enhanced creep and mechanical resistance allowing increasing their operating temperature as compared with conventional RAFMS. Moreover, stable Y-rich oxide nanoparticles homogeneously dispersed in the steel could be efficient trapping sites for He atoms and point defects, thus reducing swelling and hardening effects under irradiation. In order to prove the efficiency of these materials for fusion applications it is vital to analyse their microstructures after irradiation. There are no irradiation sources which adequately reproduce the extreme conditions taking place in a fusion reactor. However, some aspects of fusion damage can be simulated using ion irradiation.

In this work, single and simultaneous triple ion implanted ODS Fe(12-14)Cr (2W-0.3Ti) steels were investigated by Transmission Electron Microscopy (TEM) and slow positron annihilation spectroscopy (PAS). The ODS steels were implanted with Fe or (Fe + He + H) at the JANNUS facility. The single ion irradiation was carried out at RT up to a damage of 10 dpa, while the triple ion irradiation was accomplished at 600ºC up to a damage of 30 dpa. Small irradiation induced defects were present in the single ion implanted steel, while no defects were detected in the matrix after the triple implantation. The ODS nanoparticles appear to be stable under these irradiation conditions, but slow PAS results suggest that there could be some irradiation-induced chemical evolutions.

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