EFFECT OF 16.3 DPA NEUTRON IRRADIATION ON FATIGUE LIFETIME OF THE RAFM-STEEL EUROFER97

E. Materna-Morris, A. Möslang, R. Rolli, and H.-C. Schneider

KIT (Karlsruher Institut für Technologie) Campus Nord, Institut for Materials Reseach, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen

Corresponding author: Edeltraud.Materna-Morris@kit.edu

The fatigue behavior of structural material is an important and basic property for the design of components for future Fusion reactors. By this background, characteristic tests were performed as strain controlled isothermal fatigue experiments of neutron irradiated reduced-activation martensitic-ferritic (RAFM) 8-10Cr-WTaV steels so called EUROFER97 [1].

This irradiation program was coordinated within the framework of the European steel developing program. Series of small fatigue specimens, aside tensile and Charpy specimens, were irradiated in the Petten High Flux Reactor (Netherlands) during 771 full power days up to an accumulated dose of 16.3 dpa. The irradiation temperature ranged from 250 to 450 °C. All post-LCF (Low Cycle Fatigue) tests were carried out at the irradiation temperature at the Fusion Material Laboratory of KIT. The tests at the lowest and highest irradiation temperature as 250 and 450 °C were a matter of particular interest. By post-irradiation tensile and impact tests, the irradiation induced strengthening and reduction of ductility could be observed. Microstructural investigations could document the hardening of the material by a high density of dislocation loops, which generated the increase of strength [2].

The results of the LCF experiments revealed a pronounced increase of fatigue life of up to almost one order of magnitude at 250 °C irradiation temperature, as shown in figure 1, but no obvious irradiation effect at 450 °C. This relevant increase of fatigue life at 250 °C is the highest one ever observed after irradiation.

The presentation of the mechanical behavior of EUROFER97 will be correlated with their fracture behavior and observed irradiation induced microstructural development.

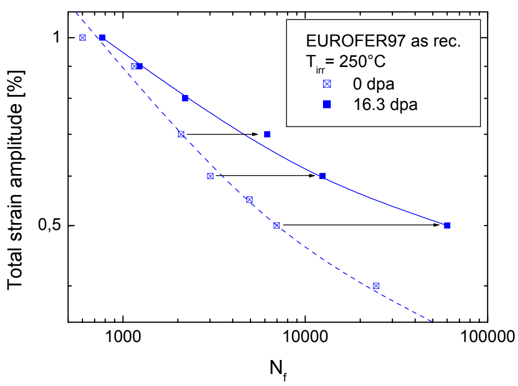

Figure 1: Effect of low temperature irradiation on fatigue lifetime N_f at $T_{irr} = T_{test} = 250$ °C.

[1] A. Möslang, Ch. Adelhelm, R. Heidinger: Innovative materials for energy technology. Int. J. Mat. Res. 99 (2008) 10, p. 1045-1054.

[2] E. Materna-Morris, A. Möslang, R. Rolli, H.-C., Schneider: Effect of Helium on Tensile Properties and Microstructure in 9%Cr-WVTa-Steel after Neutron Irradiation up to 15 dpa between 250 and 450 °C. J. of Nucl. Mat.. 386-388 (2009) 422-425.