

PROCEEDINGS

Phase Stability of ODS Ferritic Steels Under Ion-Irradiation: For Oxides and Carbides

Peng Song^{1,2,*}

¹Future Energy Acceleration & Translation, Agency for Science, Technology and Research (A*STAR), 138634, Singapore

²Institute for Materials Research, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi, 980-8577, Japan

*Corresponding Author: Peng Song. Email: Song_Peng@a-star.edu.sg

ABSTRACT

An ultrahigh density of oxide particles and fine grains provide ODS ferritic steels with high tensile, creep and fatigue strength at elevated temperatures, as well as excellent radiation tolerance. The Ti-addition to FeCr-ODS steels refined oxide particles by forming the nano-sized (Y, Ti, O) particles, which were dominated by $Y_2Ti_2O_7$ pyrochlore and Y_2TiO_5 . However, the Al-addition to FeCr(Y, Ti)-ODS steels altered the dominated particles from fine (Y, Ti) oxide particles to larger $YAlO_3$ (YAH and YAP) or $Y_4Al_2O_9$ (YAM) in FeCrAl-(Y, Ti)-ODS steels, and a small addition of Zr to FeCrAl-(Y, Ti)-ODS steels altered the majority of oxide particles from (Y, Al) ones to (Y, Zr) ones, e.g. $Y_4Zr_3O_{12}$, where the latter oxide particles have smaller size and higher number density. In addition, carbides like Ti_xCy were usually produced inside the ODS ferritic steels during the hot-extruding or sintering.

Considering the difference in chemical compositions and structures of these second phases, we have investigated their stabilities in ODS ferritic steels by means of ion irradiations at different temperatures and damage levels. After ion-irradiation, radiation defects and second phase oxide particles and carbides were observed by transmission electron microscope (TEM). The lattice structure and chemical compositions of second-phase particles were characterized accordingly and their stabilities under irradiation were compared for each other. Accompanied by the evolution of second phases, such as re-nucleation of new phases, the materials displayed the significant post-irradiation hardening. The hardening mechanism has been well discussed.

KEYWORDS

Phase stability; oxide particle; carbides; ODS steels; ion irradiation

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