TEM AND APT STUDIES OF LAVES PHASE PRECIPITATION DURING HIGH TEMPERATURE EXPOSURE OF A 12 % CR TEMPERED MARTENSITE FERRITIC STEEL

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Abstract

Tempered martensite ferritic steels (TMFSs) have been successfully applied in fossil fired power plants where they have to withstand mechanical loads at creep temperature. In the present study, we report the nucleation of Mo-rich Laves phase during high temperature creep of a TMFS containing 1 wt.% Mo. Interrupted creep tests were performed at 550°C, 120 MPa. The microstructural changes were characterized using analytical transmission electron microscopy (TEM) and atom probe tomography (APT). We show that during high temperature exposure, alloying elements (especially Mo, Si and P) segregate to micro grain boundaries forming a new local equilibrium that promotes the formation of the Laves phase. APT studies revealed that M23C6 carbides cannot dissolve Si, and hence, during the nucleation and growth they continuously push Si atoms into the ferritic matrix. We observe formation of a Si rich environment in ferritic matrix close to the M23C6 interface. Thermocalc calculations have been applied to evaluate the influence of Mo and Si on the nucleation of the Laves phase. Calculations showed that the enrichment of Mo and Si significantly enhance formation of Laves phase particles. Our results suggests that it is the combined effect of (i) segregation of Si from the matrix to micro grain boundaries and (ii) the enrichment of the matrix with Si around growing carbides which rationalizes the formation of Laves phase particles at micro grain boundaries next to carbides.

Keywords: tempered martensite ferritic steels, creep, Laves phase, transmission electron microscopy, atom probe tomography

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