ICSMA19 Metz, France, June 26 - July 1, 2022
International Conference on Strength of Materials

TEM Replica Analysis of Particles in a Tempered Martensite Ferritic Steel after Long Term Creep

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Tempered martensite ferritic steels (TMFSs) have been and are being used for critical components in high temperature plant operating in the 600°C range. They are expose to creep conditions for long time periods, exceeding 100 000h. In the present study we investigate a 12% Cr TMFS, after creep at 550°C at 120 MPa for 139 000 hours. We had previously investigated this material in the TEM using thin foils [1,2]. We now use an extraction replica technique to analyze four particle families: $M_{23}C_6$, MX, Laves-phase and Z-phase, considering statistically relevant numbers of particles (between 120 and 720). This not only allows the characterization of the morphology, crystallography and chemistry of particles in the absence of the magnetic matrix, but also allows special emphasis to be given on phases like Z-phase, which can be easily overlooked in thin foils. We show how EELS mapping can help in identifying Z-phase particles and use Cr-V-maps to differentiate between the four particle families [3]. The chemical evolution of particles in a unique set of specimens is investigated, allowing us to obtain new insights into how microstructure and especially particle populations evolve under the conditions of long term creep.

Keywords: Tempered martensite ferritic steels, transmission electron microscopy, particle phases, long term creep, computational thermodynamics.

References:

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