5^{th} Structural Materials Seminar Jointly with iSM

Analysis of microstructural evolutions in tempered martensite ferritic steels using EBSD

by

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Place: 2^{nd} conference room

Ferritic steels with tempered lath martensite microstructures are important high-temperature materials for steam power plant. The diffusionless formation of lath martensite from austenite during fabrication of these alloys leads to a high density of internal interfaces and of dislocations. These features, together with the fine distribution of alloy carbonitrides formed during controlled tempering, provide acceptable resistance to creep deformation over service lives of up to several decades at steam temperatures in the 600°C range. However, prolonged exposure to high temperatures and stresses leads to microstructural changes with deleterious effects on creep resistance, such as coarsening of the grain substructure, reduction in the dislocation density and dissolution or coarsening of the precipitate distribution.

Martensite has a fixed orientation relationship (OR) with its parent austenite, and crystal symmetry gives a number of equivalent variants of this relationship. The spatial arrangement of variants in a former austenite grain forms a characteristic hierarchical substructure. The OR and spatial arrangement of variants are modified little by typical tempering treatments but begin to change on long-term creep exposure and break down in regions of stress concentration, such as those encountered in uniaxial tensile creep test and crack growth test specimens. These crystallographic changes can usefully be followed using electron backscatter diffraction (EBSD) in the scanning electron microscope. Special analysis techniques for this family of steels have been developed, making use of the OR. Firstly, former austenite grains and smaller units in the substructural hierarchy can be identified and their sizes and orientations determined. This enables us to determine the types of sites most prone to crack and cavity formation. In the case where cracks are found on former austenite grain boundaries, the misorientations of these boundaries can be calculated to investigate whether tendency to cracking has any dependence on the properties of these grain boundaries. Secondly, determination of the orientation relationship and the scatter in this allow us to observe microstructural changes such as plastic deformation, recovery and recrystallization either in the bulk or in localized regions. These observations, coupled with TEM studies of lath sizes, dislocation densities and precipitate types and sizes, should give insight into microstructure/property relationships in these technologically important materials.

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