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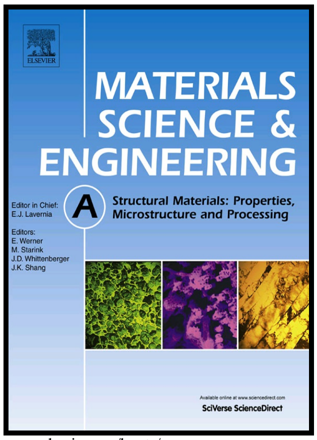

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Precipitation and clustering in a Ti-Mo steel investigated using atom probe tomography and small-angle neutron scattering

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Abstract

The isothermal evolution of nanometer-sized precipitates formed in a Ti-Mo microalloyed steel through interphase precipitation has been investigated using atom probe tomography and small-angle neutron scattering. The coiling time and applied strain have been varied to observe the precipitate evolution at a constant coiling temperature of 650 °C, where various evolution parameters such as particle radius, number density, volume fraction and chemical composition have been evaluated and compared. The possibility of early stage solute clustering and its effect on precipitate formation have also been investigated. Clustering of Ti, Mo and C atoms as Ti-C and Mo-C has been observed at the shortest coiling time of 5 min. These clusters are assumed to be precursors to the carbide precipitates observed in the system, which exhibit a metastable composition, containing a carbon fraction (C/Ti+Mo ratio) in the range of 0.2 to 1. In particles having a Guinier radius > 3 nm, however, the average chemical composition approached the stable MC carbide stoichiometry with Ti/Mo ratio ~2.5 and C/(Ti+Mo) ratio ~0.55. This study reveals that the precipitate coarsening kinetics are very slow, with average particle diameter < 5 nm even at longer coiling times (> 10 h) in both the undeformed and deformed conditions. This is believed to be due to the reduction in equilibrium Ti content in the matrix as a result of partial replacement of Ti by Mo (Ti/Mo ratio > 2) in the precipitate lattice, in the presence of excess C in the system.

Keywords: Precipitation, Steel, Atom probe tomography, Small-angle neutron scattering, Transmission Electron Microscopy

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