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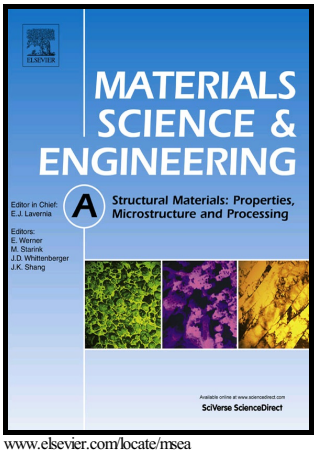

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The sequential twinning-transformation induced plasticity effects in a thermomechanically processed high Mn austenitic steel

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Abstract

Different initial microstructures with various bimodal grain size distributions (BGSD) were produced in a high Mn austenitic steel through applying a predetermined set of thermomechanical processing cycles. The corresponding room temperature mechanical properties and the related strain hardening behaviors were assessed using tensile testing method. The results indicated that in the microstructure with high grain size bimodality, the length and amplitude of rapid hardening region was well higher than the others. This was attributed to its higher capability to α'-martensite formation. In addition, the threshold strain to initiate martensitic transformation was shifted to the lower one in the microstructure with higher bimodal grain size distribution. The latter was related to the lower arisen back stresses in the interior regions of the coarser grains. Furthermore, different transformation paths were identified as the BGSD changed. The austenite could directly transform to α'-martensite ($\gamma \rightarrow \alpha'$) in the microstructure with lower BGSD; in this case the α'-martensite mainly appeared at the intersections of deformation twins. In contrast, in microstructures with higher BGSD, the nucleation occurred at the intersections of ε-martensite platelets. The co-existence of these transformation paths provided an extended transformation induced plasticity effect ending to a higher elongation to fracture in the course of deformation. In order to summarize the contribution of various strain hardening mechanisms, a deformation map was also constructed. Accordingly, the enhanced ductility/strength properties were attributed to the sequential operation of extended transformation induced plasticity and twinning induced plasticity effects.

Keywords: Transformation-twinning induced plasticity steel; Strain hardening rate; Deformation twins; Martensitic transformation; α'-martensite

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