Abstract

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The implications of effective stacking fault energy and local microstructure on the monotonous and cyclic deformation of some medium/high-Mn steels

Stacking fault energy (SFE) is a very important parameter in determining the plastic accommodation behaviour of fcc metals/alloys. A comprehensive comparison of various experimental methods for estimating the SFE of a high-Mn steel is carried out under the framework of the dissertation. The corresponding deformation behaviour of some medium/high-Mn steels under monotonous and cyclic deformations are then interpreted using the local/global SFE of those steels. In case of monotonous deformation of medium-Mn austenitic steel, twinning nucleation was observed at low true strain ~ 0.02 and the local microstructures i.e. the occurrence of precipitates significantly influence the deformation mechanism. Unfaulting dislocation reaction is favored only near vicinity of the precipitates, while twinning is activated further from the precipitates. Twin nucleation follows a hybrid mechanism, involving creation of stacking faults through classical dislocation dissociation, while those stacking faults subsequently overlapped following a non-classical alternated stacking fault pair mechanism to create a three-layer twin nucleus. Additionally, the high-cycle bending fatigue deformation of coarse-grained (~ 25 μm) and graded-grained high-Mn austenitic steel reveals that in both cases the Vickers microhardness initially increased as a sign of cyclic hardening and almost saturated at prolonged cycling. Depending on the grain sizes the deformation mechanisms in graded-grained specimen varied widely; stacking faults were predominant in the fine grains, while interconnected dislocation cells were observed within the larger grains. Although the dislocation densities estimated from X-ray line profile analysis were relatively low ~ 10^{14} m^{-2} in both case, but the deformation microstructures of coarse-grained specimen are not similar to the graded-grained specimen and comprises of perfect dislocations, stacking faults, as well as shear bands at pre-saturation stage, while the formation of minor amount of ϵ-martensite was observed at intersections of shear bands at the saturation stage.

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