
Strain localization phenomena in austenitic FeMnAlC low-density steels: Mechanisms and contribution to plasticity

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Abstract

The inhomogeneous plastic deformation associated with strain localization phenomena has received much attention due to its influence on the deformation behavior of novel austenitic (fcc, face-centered cubic) multicomponent alloys such as FeMnAlC low-density steels (1). Strain localization phenomena are associated with local shear instabilities on the deformation structure resulting in the formation of characteristic deformation structures such as microbands (MBs) and shear bands (SBs) that propagate through the material. These phenomena play a relevant role in mechanical properties such as ductility and mechanical anisotropy upon strain path changes. In this presentation, we show the analysis performed on the influence of the deformation temperature from room temperature to cryogenic deformation temperatures on the deformation structures associated with strain localization phenomena, such as microbands and deformation bands, in an austenitic Fe-30Mn-6.5Al-0.3C low-density steel by EBSD, ECCI, t-FSEI, and TEM (2,3). The underlying dislocation-based processes controlling the nucleation mechanisms of microbands at the analyzed range of deformation temperature were investigated through the analysis of the MB structure on the main texture components. We find that the MB nucleation mechanisms evolve from a dislocation cross-slip-assisted mechanism (room temperature) to a slip-band localization mechanism (cryogenic temperatures). This effect has a profound influence on the grain orientation dependence of the MB structure but not on its crystallographic alignment. The contribution of MBs to polycrystalline plasticity (Microband-Induced Plasticity effect) was evaluated through the analysis of the interactions of MBs with the evolving dislocation and twin structures. We find that MBs have a small contribution to strain-hardening and ductility, which is mainly attributed to their small mechanical resistance.

References

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