Numerical assessment of substructure evolution and kinetics of recrystallization in aluminum alloys

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Abstract

The evolution of substructure and kinetics of recrystallization in technically pure aluminum alloy are analyzed in this contribution by means of experimental evidence and numerical approaches. Investigating the recrystallization phenomena requires detailed information about the deformed state. The relationship between the deformed and annealed states is done via orientation imaging microscopy, indentation techniques and implementation of numerical techniques. Various experimental approaches such as microindentation, XRD line profile analysis and electron backscattering diffraction were employed to quantify the dislocation density in the cold rolled sheets and the release of stored energy during annealing. The experimental techniques enabled to reveal the substructural aspects of microstructure evolution and the assessment of recrystallization kinetics. Numerical approximations successfully reproduced the experimentally observed evolution of dislocation density. Both experimental findings, numerical analysis of substructure evolution as well as the results of crystal plasticity simulations allowed the determination of the driving force of recrystallization, nucleation rate and other model parameters, which are essential for the simulation of kinetics of recrystallization. It is shown that the model parameters of the well-known JMAK theory can be determined by physically sound modeling approaches. The employed flow line model supported the explanation of the heterogeneous nature of microstructure evolution across the thickness of rolled sheets.

Keywords: modeling, substructure, deformation, recrystallization

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