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Modelling of microstructure development during hot deformation and subsequent annealing of precipitates containing AA6016

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Microstructure and microchemistry evolution during hot deformation and subsequent annealing of a commercial Al-Mg-Si alloy were experimentally investigated using EBSD, SEM as well as TEM. Based on the experimental observations a new model for the recrystallization driving force in particular after hot deformation and its evolution during subsequent annealing is proposed. Unlike a driving force model for cold deformed materials proposed recently, the geometrically necessary dislocations (GNDs) are taken into account in the new model for hot deformed materials, in which the deformation stored energy is normally very low. Furthermore, the static recovery of statistical stored dislocations, which decreases the recrystallization driving force, is terminated in the new model at a certain level. This is based on the fact that after evolving into subgrain boundaries, dislocation cell walls will no longer change (apart from very slow subgrain growth). Fine precipitates exhibit back-driving forces on the moving grain boundary, namely the Zener drag force, thus diminish the effective driving force for recrystallization in the deformed grains. Implementing these aspects into the recrystallization model CORe, the partial recrystallization in materials deformed at two variant conditions could be modelled. The predicted microstructural results are consistent with the experimental observation in terms of recrystallization kinetics, recrystallized grain structure and size, and recrystallized volume fraction.