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GRAIN STRUCTURE EVOLUTION DURING ANNEALING OF AA6xxx: A MODELING APPROACH

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AA6xxx are the alloys of choice for producing lightweight sheets for outer skin panel applications in automotive industry. Although suitable mechanical properties may be achieved through controlled precipitation, the alloy can benefit from further improvement in formability. One of the best techniques for optimizing formability of the sheets is controlling their grain structure. Grain structure of the sheets is mainly developed during the annealing treatment that follows cold rolling process. Tailoring grain structure, and in turn formability, requires precise control over the annealing process. In precipitate containing alloys, such as AA6xxx, annealing occurs through a complex interaction between recovery, recrystallization and precipitation. A modelling technique that accurately mimics these interactions can highly assist development of new annealing techniques for fabrications of light weigh, formable AA6xxx sheets.

In this research, a computational modelling technique is developed to simulate grain structure evolution during isothermal and non-isothermal annealing. The simulation is run on a digital microstructure, which is generated from an optical micrograph. Stored energy of deformation distribution is assigned to the digital microstructure considering deformation induced and pre-existing inhomogeneities. Assuming site-saturated nucleation, recrystallized nuclei are added to the deformed structure. Microstructural states are simulated based on a competition between recovery and recrystallization for reduction of stored energy. The effects of precipitates on the progress of recovery and recrystallization are included in the algorithm by considering precipitate pinning of grain boundaries and dislocations. The technique is implemented to simulate microstructural evolution during isothermal and non-isothermal annealing of AA6xxx sheets. The results of simulations are compared with quantified EBSD, DSC and microhardness measurement results. A good quantitative agreement is found between the model predictions and the results from the experimental investigations.