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Grain Growth in presence of mobile second phase particles – a microstructural simulation in Elle

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A numerical model is presented to simulate the interaction of migrating grain boundaries with mobile second-phase particles during grain growth. The model for mobile second-phase particles is integrated in the existing grain growth application of the microstructural simulation platform 'Elle'. When grain boundaries sweep past a particle, it is dragged along with a rate that depends on its mobility. A particle is dropped by the boundary when a critical drag angle is exceeded. The first set of simulations is run with constant starting geometry and particle fraction but with variations in the particle mobility to show the effect of the mobility ratio of particles and grain boundaries on grain size evolution. Particles with a high mobility are easily dragged by the migrating grain boundary, while low-mobility particles quickly detach. Medium-mobility particles have the greatest effect on grain growth, as these have the longest dwelling times on grain boundaries.
A major parameter controlling drag and drop is the critical drag angle, the angle under which the particle detaches from the grain boundary. We present an accompanying study, which focuses on the effect of variations of the critical drag angle on the evolving microstructure.
A third set of simulations shows the well-known effect of Zener pinning in this model, which is dependent on the number of particles per unit volume. Results here are in good agreement with theory.