Developing an integrated modeling framework for capturing orientation dependent precipitation strengthening in Al-Cu-Li alloys

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Abstract

A multi-scale modeling framework involving crystal plasticity simulations, Kampmann-Wagner numerical (KWN) method and dislocation line tension simulations is developed for simulating the orientation dependent precipitation strengthening in 3rd generation Al-Cu-Li alloys. Crystal plasticity simulations were performed using the visco-plastic self-consistent (VPSC) model to establish the heterogeneous distribution of dislocations in the individual grains after a given pre-strain amount. Subsequently, precipitation kinetics simulation using the KWN method was performed for each grain to understand the orientation dependent evolution of diameter and volume fraction of the T1 precipitates, which is the major strengthening phase in Al-Cu-Li alloys. Line tension simulations using the circle rolling procedure were then executed to assess the orientation dependent strengthening due to heterogeneous distribution of dislocations and T1 precipitates in the individual grains. The above modeling framework is also used to understand the effect of different ideal textures on strength evolution in Al-Cu-Li alloys and predict insights for developing suitable thermo-mechanical processing routes.

Keywords: Al, Cu, Li alloys, VPSC, Dislocations, Precipitates, Yield strength, Modeling

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