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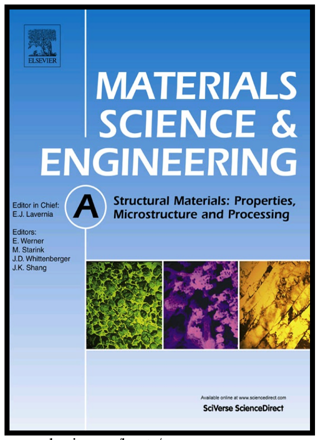

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A modified Taylor model for predicting yield strength anisotropy in age hardenable aluminium alloys

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Abstract

Coherent precipitates have long been known to alter the anisotropy in mechanical properties of rolled products with respect to rolling direction, which is manifested in terms of yield strength anisotropy (YSA) of age hardenable wrought aluminium alloys. The effect of anisotropy of matrix due to texture and of precipitate due to its morphology has been captured previously using elastic and plastic inclusion approaches with limited success. In the present investigation, yield strength of polycrystalline sheet specimen of Al-Mg-Si alloy in different ageing conditions was calculated by considering solid solution, grain boundary and shearable precipitate strengthening. Effect of coherent directional precipitates on yield strength anisotropy was analyzed using both elastic as well as plastic inclusion models. Additional elastic or plastic work required to deform the precipitates is taken into account along with work done in deforming the matrix to predict YSA. The concept of effective Taylor factor that accounts for anisotropic contribution from precipitates and crystallographic texture of matrix is proposed and incorporated in the existing strengthening models to predict YSA in aged samples. It is observed that modified plastic inclusion model that incorporates anisotropy in flow stress of precipitates is able to capture the experimental YSA in differently aged samples. Universal nature of modified plastic inclusion model is demonstrated by extending the concept to Al-Zn-Mg-Cu alloy.

Keywords: Polycrystal, Anisotropy, Strengthening mechanism, Yield strength

1. Introduction

Age hardenable Al alloys can show varying degree of yield strength anisotropy [1] as a function of different thermo-mechanical treatment and micro-chemistry states. Two key factors controlling anisotropy in mechanical properties are crystallographic texture of the matrix that develops during thermo-mechanical processing and complex precipitation