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An efficient continuum model for the slip–twinning interaction in Magnesium

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ABSTRACT

Owing to its HCP crystallography, deformation mechanisms of magnesium involve both plastic slip and deformation twinning. In order to understand and ultimately to predict the mechanical response of Mg and Mg alloys, any effective continuum model should not only describe the intricate interaction mechanisms between plastic slip and twinning, but also be able to capture the different length scales at which slip and twinning occur. We will discuss a theoretical–computational framework to model slip and twinning interactions in HCP materials with a focus on pure Mg. Plastic slip is incorporated through crystal plasticity theory which explicitly takes accounts for interactions between the different slip systems. Twinning is modeled through a relaxation-based approach, that allows capturing twinning at lower length scales. Model parameters are identified by experimental data through plane–strain compression tests. The influence of multiple active slip and twinning system will be discussed together with challenges of the numerical implementation. The effective response of polycrystalline Mg will be simulated using both exact finite element calculations and the Taylor assumption, and we will compare the simulated response to experimental results.