Predicting plastic strain anisotropy of AA6016-T4 and DC05 by multiobjective parameter calibration of crystal plasticity models and coupling strategies with macroscopic models

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ABSTRACT

Recent research results showed that the anisotropic behaviour of commercial aluminium sheets at finite strains, limited to some inaccuracies depending on specific texture and alloy composition, are well mapped with crystal plasticity (CP) models [1]. Nevertheless, for macroscopic simulations beside stress mapping also the direction of plastic flow is of major importance. For this work, we focus on the AA6016-T4 aluminium alloy and the cold forming steel 1.0312 (DC05). Additional texture measurements by electron backscatter diffraction (EBSD) are performed for both materials to obtain more detailed data compared to previously [1] performed X-ray diffraction (XRD) tests. The obtained texture is used in a novel multiobjective calibration of the CP model based on uniaxial and equibiaxial mechanical tests. This method is applied because of the significant hardening difference under uniaxial an equibiaxial loading of 1.0312 [2]. Thus, multiple slip systems can be activated for materials with body-centred cubic unit cells and therefore, a wider range of deformation states can be considered in the model calibration. In the open-source environment of DAMASK [4] the boundary conditions can be described either by stress or by displacements, the impact of both formulations is investigated as well as the geometrical order of simulations (2D or 3D RVE).

Additionally, the CP simulations are used as virtual experiments to determine the model parameters of the well established macroscopic YLD2000-2d and the new FAY [3] yield locus. A comparison of the macroscopic model behaviour of both modelling strategies, the CP based and the classical approach, is done on the basis of prediction capabilities of selected experiments and a sensitivity analysis. For this purpose, prediction of strain distributions of Nakajima specimens as well as predicting the anisotropic behaviour based on R-values is discussed.

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