

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

Other Conference Item**Author(s):**

Hirsiger, Sebastian; [Berisha, Bekim](#) ; Hippke, Holger; Hora, Pavel

Publication date:

2019-09

Permanent link:

<https://doi.org/10.3929/ethz-b-000386362>

Rights / license:

In Copyright - Non-Commercial Use Permitted

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

S. Hirsiger^{1,*}, B. Berisha², H. Hippke¹ and P. Hora¹

¹ Institute for Virtual Manufacturing (IvP)
ETH Zürich
Tannenstrasse 3, 8092 Zürich, Switzerland

* e-mail: hirsiger@ivp.mavt.ethz.ch, web page: <http://www.ivp.ethz.ch>

² Institute for Virtual Manufacturing (inspire-ivp)
inspire AG
Tannenstrasse 3, 8092 Zürich, Switzerland

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.

REFERENCES

- [1] S. Hirsiger, B. Berisha, C. Raemy, & P. Hora. On the prediction of yield loci based on crystal plasticity models and the spectral solver framework. *Journal of Physics: Conference Series*, 1063(1), 012056. (2018)
- [2] P. Peters. Yield Functions taking into account anisotropic hardening effects for an improved virtual representation of deep drawing processes, *PhD-Thesis, ETH No. 22707*. (2015)
- [3] C. Raemy, N. Manopulo & P. Hora. On the modelling of plastic anisotropy, asymmetry and directional hardening of commercially pure titanium: A planar Fourier series based approach. *International Journal of Plasticity*, 91, 182–204.(2017)
- [4] F. Roters, M. Diehl, P. Shanthraj, P. Eisenlohr, C. Reuber, S: L. Wong, ..., & D. Raabe. DAMASK - The Düsseldorf Advanced Material Simulation Kit for modeling multi-physics crystal plasticity, thermal, and damage phenomena from the single crystal up to the component scale. *Computational Materials Science*, 158, 420–478. (2019).