Yield Surface Prediction by Virtual Microstructure and Testing

Junhe Lian[1, 2, 3, a)], Wenqi Liu[2], Fuhui Shen[2] and Sebastian Münstermann[2]

[1]Department of Mechanical Engineering, Aalto University, Otakaari 4, 02150 Espoo, Finland
[2]Steel Institute, RWTH Aachen University, Intzestraße 1, 52072 Aachen, Germany
[3]Impact and Crashworthiness Lab, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA

[a)]*Corresponding author: junhe.lian@aalto.fi*

Abstract. In the integrated computational materials engineering (ICME) roadmap, quantitative correlation of the material microstructure and its mechanical deformation properties by using a multiscale modelling approach is of high interestfomaterial production and component forming industry. The powerful mechanism of the multiscale modelling lies in the construction of a representative virtual microstructure model allowing consideration of the relevant material parameters and a virtual testing scheme bridging the equivalent quantities from microstructure to macroscopic level by incorporating the microdeformation mechanism-descriptive material models. Therefore, in this study, we firstly aim to give an overview of various possible generated virtual microstructures with respects to application of metals. The capability and limitation of these virtual microstructure models to describe the comprehensive microstructure features are discussed. In the second part, we aim to give application examples incorporating such a multiscale modelling approach relying on the virtual microstructure and testing to correlate the material microstructure to the yield surface for various metals including a single-phase steel, a dual-phase steel and an aluminum alloy. Specific attention is paid to i) the construction a specific virtual testing scheme for a robust prediction and upscaling of the microstructural-level data to the macroscopic phenomenological yield criteria, ii) the texture evolution induced anisotropic hardening and r-value evolution and iii) the viscoplastic behavior of materials and the prediction of it by crystal plasticity models.