Interaction of mechanical twins across grain boundaries in polycrystalline magnesium

Hong Liu[1], Fengxiang Lin[2], Jonathan Lambrechts[3], and Laurent Delannay*[3]

[1]National Engineering Research Centre of Light Alloy Net Forming and State Key Laboratory of Metal Matrix Composite, Shanghai Jiao Tong University – China
[2]Department of Engineering and Physics, Karlstad University – Sweden
[3]Institute of Mechanics, Materials and Civil Engineering, Université Catholique de Louvain – Belgium

Abstract

Twinning is a common deformation mechanism in magnesium alloys, affecting both the mechanical properties and the evolution of texture and microstructure. The localized shear of the twin transformation induces internal stresses, which may promote thickening of the twin lamella and/or transmission across grain boundaries. The phenomenon is investigated here based on the combined use of a phase field model and a crystal plasticity based finite element model (CPFEM). The phase field model predicts the twin nucleation and growth (1) whereas CPFEM accounts for the redistribution of internal stresses due to (dislocation mediated) plastic accommodation (2). The model polycrystal consists of a 3D periodic Voronoi tessellation, aiming to provide insights into the influence of the twin inclination and the grain boundaries character. Simulation results are compared with experimental trends.
(1) Liu, H., Lin, F. X., Zhao, P., Moelans, N., Wang, Y., & Nie, J. F. (2018). Formation and autocatalytic nucleation of co-zone {101-2 } deformation twins in polycrystalline Mg: A phase field simulation study. Acta Materialia, 153, 86-107.
(2) Lin, F., Marteleur, M., Jacques, P. J., & Delannay, L. (2018). Transmission of {332}< 113> twins across grain boundaries in a metastable β-titanium alloy. International Journal of Plasticity, 105, 195-210.

Keywords: Crystal plasticity, Twinning, FEM, Phase field, anisotropy

*Speaker