Elucidating the Role of 3D Deformation Twins on the Plasticity of Hexagonal Close-packed Metals

C.N. Tomé, D.A. Greeley, H. Vo, D. Bamney, K. Dang, R.J. McCabe, L. Capolungo

Materials Science and Technology Division, Los Alamos National Laboratory, USA

Abstract

Deformation twins play a key role in the strength, ductility, and hardness of technologically important hexagonal close-packed metals (e.g., Mg, Ti, Zr) and their alloys. In essence, nucleation, propagation, and interaction of deformation twins influence plastic strain accommodation in these materials. Thus, a comprehensive understanding of twin evolution is essential to unravel the microstructural basis of plasticity in hcp metals/alloys, with implications for optimizing their performance in various engineering applications.

It has been known for a long time that twins grow as 3D domains inside the grains and transmit across grain boundaries. However, until a few years ago the material's science community - our BES Program included - has mostly focused on characterizing twinning from 2D sections of the aggregate. The focus of this presentation is on our recent efforts in investigating the full 3D character of deformation twins and their associated networks. This presentation combines TEM and EBSD statistics with Molecular Dynamics and anisotropic Phase Field modeling to understand twin transmission across grain boundaries and formation of twin-twin junctions. Our 3D characterization reveals that twin transmission is much more complex than previously assumed from 2D characterization. We find that some criteria regarding twin nucleation and propagation need to be revised both, for better understanding of the mechanisms and for incorporating them into modeling frameworks.