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Dislocation and grain boundary interaction in oxides: slip transmission or crack formation?

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Text of Abstract

Grain boundaries (GBs) play a critical role on the mechanical properties of polycrystalline materials. In ceramics, due to the limited independent slip systems and GBs acting as effective barriers for dislocation glide, the interaction between dislocations and most GBs impede plastic deformation. Hence, it is of great interest to identify GBs that allow dislocation transfer in ceramics. In this talk, we focus on the dislocation-GB interaction in a ceramic oxide $SrTiO_3$ at room temperature. Bi-crystal samples with a low-angle GB (4 degree tilting) and high-angle $\Sigma 5$ GB were fabricated. Large ball Brinell indentation was carried out close to the GBs to generate dislocations without cracks to ensure their interactions with the GBs. The dislocation structure was revealed by chemical etching, and the etch pits were characterized using scanning electron microscopy and laser confocal microscopy to reveal the dislocation-GB interaction. Depending on the GB type, we found both slip transmission across GB and GB cracking occurred. For low-angle GB, compelling evidence shows that dislocations propagate through the GB into the adjacent grain. Whereas for high-angle GB, intergranular cracking due to dislocation pileup dominates. The experimental results were validated using molecular dynamics (MD) simulations. Our findings provide insights for potential improvement of the plastic deformation of polycrystalline oxides.

Keywords: *slip transmission, grain boundary cracking, Brinell indentation, MD simulation, $SrTiO_3$*