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THE INTERACTION OF DISLOCATIONS WITH INTERFACES IN POLYCRYSTALLINE MATERIALS

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The process by which grain boundaries impede slip propagation has been a subject of renewed interest recently, with particular attention being given to the relationship of slip with macroscopic mechanical properties. This presentation will show that, by combining TEM observations of samples after deformation, in situ TEM deformation experiments, and fully anisotropic elastic calculations, it is possible to determine the effective stress, $\sigma^*$, necessary for slip transmission across individual boundaries. $\sigma^*$ varies greatly from boundary to boundary, and is a sensitive function of the misorientation and elastic properties. From these observations, a new criterion for predicting the favored system onto which dislocations crossing an interface will slip has been derived, and the mechanisms of slip transmission shown to be more complicated than previously realised. Systematic experiments on near $\Sigma 9$ and $\Sigma 13$ CSL boundaries in Si, after high temperature compression testing with selected interface orientations, have been combined with FEM modeling of the compression test, and provide additional insight into the the location of areas within the sample where the stress is maximum, and hence to favored nucleation sites for slip propagation or dislocation nucleation. The various experimental techniques, and their application, will be described in detail, and the contribution of each to understanding the deformation process outlined. The implications of these results for modeling slip in polycrystalline materials will be discussed.