Insights into plasticity by combining nanomechanics, high-resolution characterization and simulation

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Mechanical behavior of metals strongly depends on the microstructure and its evolution at different length scales, which is governed by, e.g., crystallography, the distribution of defects, grain morphology, or texture. Understanding and predicting macroscopic mechanical behaviors requires appropriate descriptions of the micro- and nanoscale response and the evolution of the underlying microstructure or intra- and inter-granular stresses. Following the advancement of experimental techniques, it is becoming possible to link computational models with direct observations of deformation and failure.

In this presentation, an overview of current approaches integrating advanced experimental methods with high-resolution characterization and modeling will be discussed in the context of dislocation plasticity. In-situ micromechanical experiments, electron diffraction methods, and high-resolution digital image correlation allow the determination of local strains and identification of activated slip bands. In combination with transmission electron microscopy, theory and computational analysis, the formation of dislocation structures and the interaction of dislocations with grain boundaries can be analyzed. With those methods, experiment and simulation move closer together facilitating an understanding of relevant mechanisms in plasticity and fracture.