On the deformation and failure of polycrystalline materials

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ABSTRACT. Modeling of the inelastic response of metallic materials is of significant interest in numerous applications in the aerospace, automobile, and naval industries. These models must encompass very large inelastic deformations leading up to failure. While there are numerous investigations that postulate and implement micromechanical damage models such as the Gurson model to augment conventional strain-hardening plasticity in simulations, there are very few investigations that provide an experimental evaluation, both of the calibration of the models and of their use in predicting the deformation and failure in structural applications. In this presentation, a quantitative examination of the underlying deformation and failure mechanisms will be provided through a detailed, real-time, multiscale investigation of the deformation and failure processes in Al 6061-T6. Specifically, an in-situ loading stage in a scanning electron microscope is used to monitor both the macroscopic response and the local deformation and failure at high spatial resolution. Issues related to homogenization of strain, representation and calibration of phenomenological plasticity, and mechanisms of failure will be discussed.