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Title: Characterization of Mechanical Behavior of Metallic Materials at the Mesoscale Using Orientation Imaging Microscopy (OIM).

The mechanical behavior of materials at the mesoscale, i.e., for individual grains in a polycrystalline material, can have a significant impact on their behavior at the macroscale, particularly on damage and failure under loading. The heterogeneity of the microstructure and the local anisotropic behavior resulting from considering grains as individual single crystals result in heterogeneous stress and strain fields that, in turn, can lead to significant scatter on the nucleation and growth of defects. Orientation Imaging Microscopy (OIM) is well suited to provide information on both geometry and crystallography of individual grains over relatively large areas of a sample. This allows for direct evaluation of the effect of local heterogeneity on mechanical behavior at the grain level. The strengths and weaknesses of OIM as a tool to evaluate mechanical behavior at this length scale will be discussed based on two case studies: fatigue crack propagation in polycrystalline nickel and shock loading of NiAl samples. In these two pieces of work, OIM was used to evaluate samples before and after testing and techniques were developed to evaluate the local strains based on the information collected. This information was correlated with data obtained from other techniques, e.g., Digital Image Correlation (DIC) and Transmission Electron Microscopy (TEM), to provide a more complete picture of the material response at the mesoscale. Current trends on the use of OIM for study of mechanical behavior and microstructure of materials will also be briefly discussed.