In-situ transmission kikuchi diffraction during tensile testing for assessing deformation mechanism at the nanoscale in SEM

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Abstract

We have developed the capability to perform in-situ Transmission Kikuchi Diffraction (TKD) during tensile testing in SEM, enabling nanoscale characterization of the evolution of complex plasticity mechanisms. This was achieved by integrating a modified in-situ nanoindenter with a microscale push-to-pull (PTP) device, a conventional EBSD detector and a STEM detector in the SEM. A dedicated Focused Ion Beam (FIB) procedure was developed for site-specific specimen fabrication, including lift-out, thinning, and shaping into a dog-bone geometry. We will show the application of this methodology for several case studies: (i) To understand the initiation and evolution of nanoscale twinning and stress-induced martensitic transformation on a β-Ti single crystal, (ii) investigate strain localization and defect evolution in metal/ceramic nanolaminates, and (iii) investigate twin initiation and propagation in Re single crystals loaded along the c-axis direction. Overall, the in-situ TKD approach provides a robust alternative to in-situ EBSD and TEM testing, facilitating detailed analysis of deformation mechanisms at the nanoscale.

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