In situ monitoring crack growth in nanostructured materials

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Abstract

While nanostructured materials excel in strength, they commonly exhibit deficiencies in terms of ductility and fracture toughness. In order to better understand the processes governing local fracture processes and consecutively enhance the material performance, it is essential to identify the local energy dissipation mechanisms. Here we propose the use of miniaturized *in situ* fracture experiments conducted inside electron microscopes. This approach enables us to combine mechanical data, such as far field loading and local stress intensities, in analogy to macroscopic experiments. Furthermore, the actual crack length can be determined from continuous stiffness measurements, while local crack tip descriptors, such as the crack tip strain field or crack tip opening displacement, are assessable by employing digital image correlation of the recorded high resolution electron microscopy images. In harnessing these possibilities, we are able to establish correlations between common macroscopic static and cyclic failure characteristics and the herein assessed local crack tip processes. These insights contribute to enhancing our understanding of failure processes in nanostructured materials, and subsequently increase the respective contributions to further toughen these attractive class of materials.

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