Microstructure-Sensitive Investigation of Fracture using Acoustic Emission Coupled with Electron Microscopy

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Abstract

A novel technique using Scanning Electron Microscopy (SEM) in conjunction with Acoustic Emission (AE) monitoring is proposed to investigate microstructure-sensitive fatigue and fracture of metals. The coupling between quasi in situ microscopy with actual in situ nondestructive evaluation falls into the ICME framework and the idea of quantitative data-driven characterization of material behavior. To validate the use of AE monitoring inside the SEM chamber, Aluminum 2024-T3 sharp notch specimen were tested both inside and outside the microscope using a small scale mechanical testing device. Subsequently, the same type of specimen was tested inside the SEM chamber. Load data were correlated with both AE information and observations of microcracks around grain boundaries as well as secondary cracks, voids, and slip bands. The preliminary results are in excellent agreement with similar findings at the mesoscale. Extensions of the application of this novel technique are discussed.