
Deciphering Acoustic Emission of Microsamples with Machine Learning

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Abstract

Plastic deformation in crystalline materials often exhibits significant inhomogeneity on the micron scale, presenting itself as a series of random local slip events of varying sizes. So far two robust techniques have been used independently to monitor this stochastic behaviour: microcompression for small-scale samples and acoustic emission (AE) for bulk specimens. While AE, with its high sampling rate (~2.5 MHz), yields a rich dataset, its interpretation remains challenging due to the complexity of the measurement process.

In this talk, results from coupling these two experimental techniques will be presented in order to gain a more comprehensive understanding of the meaning of the AE signals. The first part of the talk will focus on microcompression of Zn single crystal micropillars oriented for basal slip. These samples are mounted on an AE sensor and compressed in situ within an SEM using a specially designed device for this purpose. Our findings reveal a precise correlation between the acoustic events detected during compression and the stress drops measured by the micromechanical device, facilitating the interpretation of AE signals.

The second part will delve into uncovering additional insights that can be gleaned from the AE data. To achieve this, we will leverage machine learning to investigate the extent to which stress-strain curves and their finer details can be reconstructed from the AE signal.

Finally, experiments will be presented where the orientation of the Zn micropillars are varied in order to tune the dominant deformation mechanism between dislocation glide, twinning and fracture. This allows the more precise interpretation of the AE through different deformation mechanisms. The presentation will conclude with a glimpse into potential future applications of combining micromechanics and AE.

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