Acoustic Signatures of Dislocation Avalanches During Microsample Deformation

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Two decades ago, it was revealed by compression tests on micron-scale specimens and acoustic emission (AE) measurements performed on bulk samples that the motion of dislocations resembles a stick-slip process. As a result, deformation proceeds in a series of unpredictable local strain bursts with a scale-free size distribution. Here we use a unique, highly sensitive experimental set-up, which allows us to detect weak AE waves of dislocation slip during the compression of micron-sized Zn pillars. Profound correlation is observed between the size of the deformation events and the total energy of the emitted signals that, as we conclude, are induced by the collective dissipative motion of dislocations. The AE data also reveal an interesting two-level structure of plastic events, which otherwise appear as a single stress drop. Moreover, we show by statistical analyses of the acoustic event sequences that dislocation avalanches and earthquakes are essentially alike despite the fundamental differences in the deformation mechanism and the huge gap in the involved length and time scales. Our experimental and simulation results not only unveil the complex spatiotemporal structure of strain bursts but also exhibit technological importance by unraveling the missing relationship between the properties of acoustic signals and the corresponding local deformation events.

Keywords: *micropillar; deformation; acoustic emission; earthquake; simulation.*