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STRESSES WITHIN DISLOCATION CELL STRUCTURES: SIZE EFFECTS VERSUS STOCHASTIC PROCESSES

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Abstract

We have used depth-resolved, submicrometer X-ray beams to directly measure the axial elastic strains within individual dislocation cell walls and adjacent cell interiors in plastically deformed copper single crystals. These studies have settled long-standing questions about the existence and nature of long-range stresses in heavily deformed metals. However, it is equally important to determine what underlying processes drive the evolution of the measured broad distributions of elastic strain. Two viable mechanisms have been identified that are consistent with the experimental results: size effects arising from the dipolar nature of the stress field and stochastic processes operating during the evolution of individual dislocation walls. Analytic models for both processes will be presented and compared with the measured stresses.

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