Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Slip Dynamics in Small Scale Crystals ROBERT MAASS, University of Göttingen, University of Illinois at Urbana-Champaign, PETER DERLET, Paul Scherrer Institute, Condensed Matter Physics, JULIA GREER, California Institute of Technology, CYNTHIA VOLKERT, University of Göttingen — Classical work showed that dislocation velocities are strongly dependent on applied stress. Numerous experiments have validated this for individual or groups of dislocations in macroscopic crystals by using imaging techniques combined with either mechanical data or time resolved topological data. Developments in small scale mechanical testing allow to correlate the intermittency of collective dislocation motion with the mechanical response. Discrete forward surges in displacement can be related to dislocation avalanches, which are triggered by the evolving dislocation sub-structure. We study the spatiotemporal characteristics of intermittent plastic flow in quasi-statically sheared single crystalline Au crystals with diameters between 300 nm and 10000 nm, whose displacement bursts were recorded at several kHz (Scripta Mater. 2013, 69, 586; Small, available online). Both the crystallographic slip magnitude, as well as the velocity of the slip events are exhibiting power-law scaling as. The obtained slip velocity distribution has a cubic decay at high values, and a saturated flat shoulder at lower velocities. No correlation between the slip velocity and the applied stress or plastic strain is found. Further, we present DD-simulations that are supportive of our experimental findings. The simulations suggest that the dynamics of the internal stress fields dominate the evolving dislocation structure leading to velocities that are insensitive to the applied stress – a regime indicative of microplasticity.

Robert Maass
University of Göttingen, University of Illinois at Urbana-Champaign

Date submitted: 14 Nov 2014 Electronic form version 1.4