Symposium | A. Advances in Materials Theory for Multiscale Modeling

[SY-A7]Symposium A-7

Chair: Michael Zaiser(FAU University of Erlangen-Nuremberg, Germany)
Wed. Oct 31, 2018 2:00 PM - 3:30 PM Room6

[SY-A7]**Dislocation multiplication in the discrete-continuum transition regime**

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The striving for advanced materials with well-defined microstructures has led to an increasing effort towards a physically based description of the motion of dislocations as the cause of plastic deformation. Several dislocation based continuum theories have been introduced, but only recently rigorous techniques have been developed for performing meaningful averages over systems of moving, curved dislocations, yielding evolution equations for a dislocation density tensor, see [1].

Regarding a self-consistent coarsening of dislocation modeling in order to construct an efficient numerical implementation, several issues have to be solved including calculation of the stress field of a system of dislocations, representation of dislocation interactions and reactions as well as boundary conditions. Accurate solutions have been found for one and two dimensional systems [2, 3]. However, the analysis and understanding of dislocation networks in three dimensions involves additional challenges such as the representation of dislocation multiplication.

In this presentation, we discuss the implications of a homogenization of dislocation interactions and reactions in the discrete-continuum transition regime. Based on the analysis of 3d discrete dislocation structures, we present a coarse-grained continuum formulation for dislocation multiplication due to cross-slip and glissile reaction events. The formulation is validated by the comparison with discrete dislocation dynamics simulations and discussed in the context of a continuum limit as lower application limit of a continuum approach.

[1]Hochrainer, T.; Sandfeld, S.; Zaiser, M.; Gumbsch, P.: Continuum dislocation dynamics: Towards a physical theory of crystal plasticity. *J. Mechan. Phys. Solids.* 63 (2014), p. 167-178.

[2] Schmitt, S., Gumbsch, P., Schulz, K.: Internal Stresses in a Homogenized Representation of Dislocation Microstructures. *J. Mechan. Phys. Solids*, 84 (2015), p. 528-544.

[3] Schulz, K., Sudmanns, M., Gumbsch, P.: Dislocation-Density based Description of the Deformation of a Composite Material. Modell. Simul. Mater. Sci. Eng., 25 (2017), 064003.