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]Mathematical challenges for a mesoscale theory of dislocations

Invited

○Thomas Hochrainer (TU Graz, Austria)

During the last two decades, dislocation research saw a revival driven by new experimental techniques for small scale testing, high resolution characterization and the rise of large scale discrete dislocation simulations. This also stimulated intensive research in mesoscale theories of dislocations. Great advances were achieved on continuum models of dislocation interactions for strongly simplified straight-dislocation systems and continuum dislocation dynamics of single slip deformation. However, a transfer of the employed averaging methods to fully three-dimensional multiple slip deformation remains a challenge for various reasons.

In the current talk we shall highlight some challenges appearing on different levels of continuum dislocation modelling. At the most fundamental level it is yet unclear what continuum measures are suited for characterizing 3D networks of dislocations. The alignment tensors successfully used for dislocation distributions in single slip seem to be of limited value in networks consisting mostly of junctions and reaction products. It is likewise an open question how to describe the kinematics of dislocation networks, where reactions and junction formation or break-up imply permanent changes in the topology of the network and the characteristics of dislocations. Closely related is the challenge of capturing the averaged energetics, kinematics and dissipation of these dislocation interactions.

To overcome the named challenges possibly requires new mathematical tools or at least the adoption of concepts from other areas of physics and mathematics which were not yet (fully) exploited in dislocation theory. We shall discuss several ideas where we might find new impulses and promising tools for further successes in developing a mesoscale theory of dislocations. Expected key areas include discrete and differential topology, gradient flows, rough energy landscapes, and temporal and spatial statistics.