INTERDISCIPLINARY CENTRE FOR
ADVANCED MATERIALS SIMULATION

Monday, 25th of October, 4:30 p.m.
ICAMS Seminar room UHW 11/1102

Dr. Daniel Weygand
IZBS, Karlsruhe Institute of Technology

Dislocation Modeling in Small Scale Structures: from elementary dislocations interactions to their collective behavior

Dislocation dynamics modeling has reached the maturity to address the question of plastic flow in small scale samples, which is governed by the particularity of the dislocation microstructure within the sample. Continuum modeling fails to predict the size dependency of the mechanical properties, as volume averaging over dislocation distributions one of the basic assumption of continuum description is no longer possible. On the other hand mesoscopic simulations as discrete dislocation dynamics simulations rely on a number of constitutive rules to be validated by experiments or more fundamental simulation techniques. Recent simulations in fcc materials on the the role of the chosen initial dislocation microstructure have revealed dislocation reactions leading to new sources [1] and to locally pinned points, which are a consequence of more complex dislocation reactions [2]. The latter reactions introduce rather stable Frank-Read or spiral sources. The role of those points on the overall stability of a dislocation population will be presented. The insights gained by discrete dislocation dynamics on the so called size effect and strain bursts are discussed [3,4,5].

[1] D. Weygand, P. Gumbsch, Study of dislocation reactions and rearrangements under different loading conditions, Mat. Sci. Eng A 400-401 (2005) 158.

[2] C. Motz, D. Weygand, J. Senger, P. Gumbsch, Initial dislocation structures in 3-D discrete dislocation dynamics and their influence on microscale plasticity, Acta Materialia 57 (2009) 1744.

[3] J. Senger , D. Weygand , P. Gumbsch, O. Kraft, Discrete dislocation simulations of the plasticity of micro-pillars under uniaxial loading, Scripta Materialia 58 (2008) 587.

[4] D. Weygand, M. Poignant, P. Gumbsch, O. Kraft, Three-dimensional dislocation dynamics simulation of the influence of sample size on the stress- strain behavior of fcc single-crystalline pillars, Mat. Sci. Eng A 483-484 (2008) 188.

[5] F.F. Csikor, C. Motz, D. Weygand, M. Zaiser, S. Zapperi, Dislocation Avalanches, Strain Bursts, and the Problem of Plastic Forming at the Micrometer Scale, Science 318 (2007) 251.