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DISCRETE-TO-CONTINUUM COUPLING IN PLASTICITY

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ABSTRACT

A faithful description of the intrinsic plastic behaviour of the material is at the heart of any computational approach to macroscopic plasticity. On the continuum level, the main workhorses are the constitutive relations for the stress and the plastic strain-rate, in terms of macroscopic quantities. While this does close the complete plasticity model in purely macroscopic terms, it is often difficult to incorporate one’s knowledge about the underlying microscopic characteristic features which give rise to the macroscopic behaviour. Nowadays, advanced experimental techniques provide us with a wealth of information as regards the microstructure itself, as well as how the dynamics of the microstructure gives rise to plasticity. The models and computational approaches must be synchronized with these advances, i.e., provide frameworks to incorporate this microstructural information concretely in a manner that renders the entire approach still computationally tractable.

The main goal of this invited session is to provide a comprehensive review about how experimental evidence and microscopic modelling in the form of static and dynamic information can be used concretely towards improving the computational approach to plasticity. For example, a key ingredient is how the macroscopic constitutive relation for the material behaviour is to be replaced by a multiscale or coarse-graining approach that explicitly takes microstructural degrees of freedom into account. By multiscale modelling we mean the concurrent coupling of different levels of description in dynamic situations, while coarse graining implies the elimination of a large amount of fine-scale degrees of freedom in order to arrive at a coarse-grained description with just a few variables. It is also interesting to examine the notable differences between various classes of solids. While the concept of dislocations is well established and the basis of multiscale models of crystal plasticity, the carriers of plastic deformation in the case of amorphous solids have not yet been identified to similar clarity.