Thematic Issue:

Microstructural Interactions in Inelastic Solids

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When Ludwig Prandtl and Richard von Mises founded the "Gesellschaft für Angewandte Mathematik und Mechanik" (engl.: "International Association of Applied Mathematics and Mechanics") abbreviated "GAMM" in 1922, they obviously saw the necessity for a strong interaction between researchers from both fields. During the 20th century and until today, they have definitely been proven right. Furthermore, recent problems in engineering require sophisticated experimental studies which build the foundation for the development of material models and computer based simulations. Thus, mathematics, mechanics and materials science may be considered as a "magic triangle".

This special issue stems from presentations at a minisymposium held at the 81st Annual GAMM meeting in Karlsruhe (Germany) in 2010. The intention of this symposium was the same as it is for this special issue: to bring together researchers from the fields mentioned above in order to find intersections of interesting topics and to try to establish and tighten the bonds of this "magic triangle".

The articles presented in this special issue cover studies of a wide range of modern materials with complex behaviour due to certain microstructural phenomena. The two contributions from materials science emphasize the influence of the Bauschinger effect on the behaviour of 42CrMo4 steel and the role of austenitization treatment on a subsequent phase transformation in 51CrV4 steel. The three articles from mechanics provide sophisticated methods for the modelling of twin formation in magnesium, the origin of heterogeneous phase distributions in macroscopic shape memory alloy specimens and the interaction between martensitic phase transformations and plasticity which is essential for the modelling of shape memory alloys and TRIP steels. Finally, the mathematical contribution shows that a limit process from a highly oscillating stochastic microstructure to an effective macroscopic material can be performed rigorously by using the technique of homogenization.

With this special issue we aim at highlighting the challenges in the field of the modelling and simulation across the relevant material's scales of Chromium based alloys, magnesium, shape memory alloys and TRIP steels – from the experimental, mechanical and mathematical point of view.

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