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INELASTIC PROCESSES IN HETEROGENEOUS MATERIALS:MULTI-SCALE FORMULATION, HOMOGENISATION AND UPSCALING, UNCERTAINTY QUANTIFICATION AND COMPUTATION

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ABSTRACT

Many natural materials like rock, soil, ice, wood, bone, etc., are heterogeneous, as are important man-made materials like concrete, fibre-reinforced materials, as well as many others. Often the elastic range of these materials is very small, inelastic/irreversible processes occur-ing already at “normal” use, and of course such irreversible processes occur at extreme loadings ranging from plate tectonics to micro-indentation tests for material investigation. The heterogeneity present in many instances extends over a large range of scales, frequently to scales much smaller than those of interest for particular investigation. The inhomogeneity at sub-resolution scales often leads to incomplete knowledge and hence uncertainty and randomness at the scale of interest.

Various approaches have been investigated to deal with the aforementioned situations computationally, and will be the focus of this session. For some phenomena, the heterogeneity averages out at larger scales, leading to the by now well-known homogenisation approaches. In other cases heterogeneities at small scales directly initiate some large-scale behaviour, so that the result is an amplification of the heterogeneity in inelastic/irreversible behaviour.

Hence the main topics of the mini-symposium will include - but will not be limited - to:

- Mathematical formulations for heterogeneous materials and irreversible processes
- Upscaling and Homogenisation
- Multi-scale formulations
- Computational multi-scale procedures for inelastic processes like FE² and element-in-element (MIEL) methods
- Uncertainty quantification for heterogeneous inelastic materials
- Identification of heterogeneous materials

- Non-local constitutive material laws