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Marc Geers

"High-resolution micro-plasticity in advanced high-strength steels"

The persistent demand for green, strong and ductile advanced high strength steels, with a reduced climate footprint, calls for novel and improved multi-phase microstructures. The development of these new steels requires an in-depth understanding of the governing plasticity mechanisms at the micron scale. In order to address this challenge, novel numerical-experimental methods are called for that account for the discreteness, statistics and the intrinsic role of interfaces. This lecture sheds light on recent and innovative developments unravelling metal plasticity at the micron scale.
Multi-phase through-thickness samples allow for a full characterization of the underlying microstructure. Using computational crystallographic insights, a slip system based local identification method has been developed, which provides full-field crystallographic slip system activity maps. The resulting deformation maps are directly used to assess the model predictions. Heterogeneous spatial variations are introduced by sampling the slip system properties of individual atomic slip planes from a probability density function. This allows to recover naturally localized slip patterns with a high resolution. It is demonstrated that this discrete slip plane model adequately replicates the diversity of active slip systems in the corresponding experiment, which cannot be achieved with standard crystal plasticity models. Recent experimental observations on dual-phase steels demonstrate substructure boundary sliding parallel to the habit plane in lath martensite, for which a habit-plane slip enriched laminate model is developed. This model adequately captures the role of the substructure boundary sliding on the deformation of the martensite aggregate.

Marc Geers is full professor in Mechanics of Materials at the Eindhoven University of Technology in the Netherlands since 2000. His research interests are in the field of micromechanics, multi-scale mechanics, damage mechanics and mechanics in miniaturization. His research group aims to understand, describe, predict and optimise the mechanical response of engineering materials as a function of their underlying microstructure, processing and evolution, through focused and coordinated experimental, theoretical and computational efforts at a wide range of length scales. Particular research topics are: strain gradient crystal and dislocation plasticity, ductile damage, interface mechanics, computational homogenization and metamaterials. He published more than 300 journal papers with a significant citation impact. At present, he is the Editor-in-Chief of the European Journal of Mechanics A/Solids, and he serves on the editorial boards of several other journals. He serves the Dutch scientific community and organizations in various responsible roles. He is a Fellow of the European Mechanics Society, Fellow of the International Association for Computational Mechanics and member of the Royal Netherlands Academy of Arts and Sciences. He received an ERC Advanced Grant for his research on homogenization and metamaterials. He is the President of the European Mechanics Society EUROMECH.