Seminar

Under the aegis of the Medicis programme

MEDICIS
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to Conquer Industrial and technological Sovereignty

Recent Progress in FFT-Based Modelling of Microstructure / Property Relationships of Polycrystalline Materials

Dr. Ricardo A. Lebensohn

Ricardo Lebensohn is an expert in structure / property relationship of materials and crystal plasticity modelling. His pioneer contributions include the main-field viscoplastic selfconsistent (VPSC) formulation and associated code, a homogenization-based simulation tool for the prediction of mechanical response and microstructure evolution of polycrystalline metals, minerals and polymers. He also developed the specialization to polycrystals of the full-field Fast Fourier Transform (FFT)-based formulation and associated codes. FFT-based formulations are ideally suited for micromechanical simulations with direct input from microstructural images, e.g. collected by emerging 3-D characterization methods in Experimental Mechanics.

Dr. Lebensohn has extensive experience in the following fields, applications and techniques: Mechanics of Materials, Computational Mechanics; Solid Mechanics; Micromechanics; Polycrystal Plasticity; Dilatational Plasticity; Strain-Gradient Plasticity; Homogenization; Spectral Methods; Multiscale Material Modelling; Texture, Anisotropy, Microstructure and Damage Evolution of Metals, Minerals and Polymers; X-Ray and Neutron Diffraction; Residual Stresses; Finite Element Analysis; Metal Forming; Dynamic Properties of Materials.

Resume

Crystal plasticity (CP) models are increasingly used in scale-bridging applications to obtain microstructure-sensitive mechanical response of polycrystalline materials. These models require a proper consideration of the single crystal deformation mechanisms, a representative description of the microstructure, and an appropriate scheme to connect the microstates with the macroscopic response. Fast Fourier Transform (FFT)-based methods, originally proposed by Moulinec and Suquet at the turn of the century for composites (1) and extended to polycrystals (2) (the most recent formulation, including non-local large-strain elasto-viscoplasticity reported in (3)) are attractive due their higher efficiency compared with CP-Finite Elements, and their direct use of voxelized microstructural images. In this talk, we will report recent progress on FFT-based polycrystal plasticity, with emphasis in novel implementations, including thermo-elasto-visco-plasticity, strain-gradient plasticity, creep, thermal conductivity, and dynamic effects. We will show applications of these methods to: micromechanics of nano-metallic laminates, multiscale coupling with a Lagrangian hydrocode, creep of steels, integration with 3-D characterization methods, and use for training and validation of machine-learning methods.

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