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CRYSTAL PLASTICITY MODELLING OF MICROSTRUCTURE/PROPERTY RELATIONSHIPS OF POLYCRYSTALLINE MATERIALS

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Abstract. Crystal plasticity (CP) models are increasingly used in engineering applications to obtain microstructure/property relationships of polycrystalline materials. These models require a proper consideration of the single crystal plastic deformation mechanisms, a representative description of the microstructure, and an appropriate scheme to connect the microstates with the macroscopic response. The latter can be based on homogenization, e.g. self-consistent methods, which relies on a statistical description of the microstructure, or on full-field solutions, requiring a space-resolved description of the microstructure, e.g. Fast Fourier Transform-based methods, which are attractive due their relative higher efficiency compared with CP Finite Elements and their direct use of voxelized microstructural images. In general, full-field models are numerically intensive, making their direct embedding in multiscale calculations computationally demanding. Alternatively, they can be used to generate reference solutions for assessment and calibration of approaches based on homogenization or semi-analytical expressions. In this talk, we will review the state-of-the-art of polycrystal plasticity models, along with their integration with emerging characterization methods in Experimental Mechanics, and their embedding in Finite Elements formulations to solve problems involving complex geometries and boundary conditions with microstructure-sensitive material response.

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