MICROMECHANICAL MODELLING OF METALS AND ALLOYS OF HIGH SPECIFIC STRENGTH: MECHANICAL RESPONSE AND MICROSTRUCTURE EVOLUTION

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ABSTRACT

The micromechanical models will be discussed, devoted to the prediction of the effective mechanical response of polycrystalline metals and microstructure evolution in the large deformation processes. Microstructure evolution in polycrystalline metals, apart from texture evolution, is related to the development of dislocation substructure and creation of laminates due to mechanical twinning. Own results for hcp metals of high specific strength such as magnesium alloy AZ31B and Ti, obtained using the proposed crystal plasticity model accounting for twinning will be reported.
Next, the three-scale model of grain refinement will be presented. In the model a single grain within the polycrystalline representative volume element is initially subdivided into multiple subdomains with the orientations slightly mis-oriented with respect to the nominal orientation of the crystallite. The model has been applied to simulate substructure evolution in fcc and hcp metals.

Finally, the 3D finite element method implementation of the rate-independent crystal plasticity theory with a single yield surface will be shown. This full-field approach provides computationally efficient tool for simulating microstructure evolution and particularly grain refinement in the severe plastic deformation ECAP process. The predictions of the CPFEM formulation for different degrees of discretization and different shapes of grains will be compared and the reasons why some grains subdivide, while others do not, will be enlighten. Grain refinement is analyzed by means of histograms of grain size and misorientation angle distributions as well as presented fields of the mean misorientation angle in the element with respect to its average orientation and the average orientation of the initial grain domain encompassing a number of elements. These fields correspond to the kernel average misorientation (KAM) and intragranular misorientation (IGM) plots, respectively, obtained by EBSD measurements. KAM correlates with local orientation gradients and high value indicates domains of high density of geometrically necessary dislocations, while IGM plots are known to indicate long-range orientation gradients.

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She graduated from the Warsaw University of Technology, Faculty of Civil Engineering in 1996. She received her PhD (2001) and habilitation (2012) at IPPT in Mechanics, both with distinction.

She specializes in micromechanics of composites and polycrystalline metals and alloys, microstructure evolution, as well as analytical methods of description of material anisotropy.

She is the author or co-author of three monographs and over 35 papers in leading international journals (e.g.: Int. J. Plasticity, Int. J. Engineering Sciences, Materials Science and Engineering A, European Journal of Mechanics, Composites: Part B), participant in international and national research projects of which three was coordinated by her. Currently she is an IPPT representative in H2020 MSCA-RISE project QUANTIFY.

She delivered 7 invited lectures (1 general) at international conferences (e.g.: at Plasticity, Nano SPD or ECCOMASS conference series). She is the Editor-in-Chief of the journal Engineering Transactions.

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