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Emerging Trends in Applied Mathematics and Mechanics 2018

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MS10: Elastic/Plastic Materials with Micro Structural Defects: Mathematical and Mechanical Aspects

Multilevel Hierarchy of Shear Banding in Plastic Deformation of Solids

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Abstract: Plastic deformation of solids: polycrystalline metals, polymers, and amorphous materials is often produced as an effect of micro-shear banding. The micro-shear bands are observed as concentrated shear zones in the form of layers of the thickness of the order 0.1 μm , which form the clusters developing on multiple levels of observation. The identification and elucidation of physical mechanisms that are responsible for initiation, growth and evolution of micro-shear bands is of fundamental importance for understanding the macroscopic behaviour of many materials. Physical motivation and heuristic foundations of theoretical description are discussed with reference to known results in the literature. The difficulties with application of a direct multiscale integration scheme are discussed and an original idea of an extension of the representative volume element concept with use of the known theory of the propagation of the singular surfaces of microscopic velocity field is proposed. A new formulation of the description of rate of shear strain generated by multilevel hierarchy of shear bands is proposed and incorporated into theory of elastic/plastic or elastic/viscoplastic solids by means of the concepts of the instantaneous contribution function and volume fraction of shear banding.