CMM-SolMech 2022 conference

S08 Nanomaterials and nanocomposites, their properties and applications

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DEVELOPMENT OF CONSTITUTIVE RELATIONS OF VISCOPLASTICITY ACCOUNTING FOR SHEAR BANDING

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Two types of shear banding mechanisms control viscoplastic flow in solids.
The instantaneous multiscale shear banding system formed by micro-shear bands of the thickness of the order of 0.1 micrometer, the clusters of micro-shear bands producing the discontinuity of the microscopic velocity field vm and the macroscopic zone of shear strain localisation spreading through the representative volume element (RVE) of a polycrystalline metallic solid. A new concept of the RVE with strong singularity was introduced, and the instantaneous shear banding contribution function was defined [1].
The cumulative organisation of micro-shear bands is based on the accumulation of the particular contribution of micro-shear bands forming clusters in specific volumes contained in RVE. The micro-shear bands gradually contribute to the development and growth of micro-shear bands clusters. Finally, the clusters accumulate in the macroscopic localisation zone spreading across the macroscopic volume of considered material. Such deformation mechanism is observed in amorphous solids such as glassy metals or polymers, particularly epoxy resins. Micro-shear bands are growing from the local shear transformation zones (STZ). Finally, the phenomenological viscoplasticity model introduces the cumulative shear banding contribution function [1].

Both types of the mentioned shear banding mechanism appear with a variable contribution in the course of deformation processes. This situation may occur in polycrystalline metallic solids, subjected to the deformation characterising by a distinct change of deformation or loading paths. Also, materials that reveal the hybrid structure of amorphous, ultra-fine grained and nanostructural phases are prone to the mixed shear banding responsible for inelastic deformation. Finally, the description of the inelastic behaviour of epoxy resin composite doped with carbon-based nanoparticles was specified, modifying the viscoplastic flow law by determining the shear banding contribution function [2].

References

[1] R.B. Pęcherski (2022). Viscoplastic Flow In Solids Produced by Shear Banding, John Wiley & Sons Ltd. - in print.
[2] S. Wilczewski, Z. Nowak, R.B. Pęcherski, M. Giersig (2022). A new concept of epoxy resin composite doped with carbon-based nanoparticles: manufacturing, experiment and modeling, Abstract of CMM-SolMech 2022 Conference, Świnoujście.