

Turbulent mixing of stacked solid state multilayers by high pressure torsion

Initiative: Trilaterale Partnerschaften – Kooperationsvorhaben zwischen Wissenschaftler(inne)n aus der Ukraine, Russland und Deutschland

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The notion of turbulent mixing implies mixing of various substances through stochastic flows of gases or fluids. This project aims at providing a first comprehensive and detailed study of stochastic mixing in solid state. This interesting physical phenomenon was recently discovered for the case of high pressure torsion (HPT) of lamellar metallic materials. Preliminary experiments demonstrated that mixing in a deforming material occurs by virtue of multiple faults and vortices forming randomly in a way resembling turbulence in fluids. This apparent similarity gave rise to publications where the underlying mechanism was associated with a Kelvin-Helmholtz instability at the interface between viscous fluids. The project consortium demonstrated that this is a misconception and that turbulent mixing in solid state has a different physical nature. The hypothesis that the root cause of random vortex flow in deforming solids is blocking of simple shear will be a starting point for the proposed project. The investigation which is to be carried out at macro and micro scale will unravel the possible mechanisms of loss of stability of a multi-layer metallic assembly under simple shear. A criterion for stability of such systems under HPT will be proposed and verified. It is planned to investigate the fundamental features of mixing by HPT at micro scale and to introduce a quantitative measure of the degree of mixing. This new characteristic will be related to the HPT processing conditions. The new experimental data and theoretical insights in the HPT-induced blending of multilayered materials will be of great significance for understanding of solid state mixing. This will constitute the fundamental science aspect of the expected project outcomes. The project will also provide valuable information about the practical utilisation of deformation-induced solid state synthesis of advanced materials and nascent manufacturing technologies based on HPT.

Projektbeteiligte

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Simulation of layered structure instability under high-pressure torsion

Some Unresolved Problems of High-Pressure Torsion

Gripping Prospective of Non-Shear Flows under High-Pressure Torsion

Mechanisms of structural evolution of laminates with immiscible components under high-pressure torsion