# Three-level Model of Metal Inelastic Deformation with the Description of Structural Superplasticity Regime

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## ABSTRACT

Thermomechanical processing of metal by using superplastic deformation allows to reduce energy consumption and improve product quality (due to residual stresses decreasing and surface purity increasing). To develop these technologies it is necessary to develop constitutive models, which can describe material structure evolution during all available deformation regimes, transition to superplasticity regime and transition from it.

In frameworks of crystal plasticity geometrically and physically nonlinear three-level model of polycrystalline metals and alloys proposed. The model is largely universal and intended for study of material deformation in a wide range of thermomechanical influences. It desribe significant mechanisms of inelastic deformation: intragranular dislocation sliding, crystallite lattice rotation (including consideration of dislocation motion incompatibility in neighboring grains), grain-boundary sliding (predominant deformation mechanism in superplasticity regime). Interaction between grain-boundary sliding and intragranular dislocation sliding (inflow of intragranular dislocations into the boundary makes it more non-equilibrium, boundary energy increases, which is facilitate grain-boundary sliding) and grain boundary diffusion are taken into account. The model includes description of grain growth due to dynamic recrystallization, also dynamic recovery and diffusion in relations for intragranular hardening. Corotational rate of stress in mesolevel relations introduced taking into account the symmetry axes and planes of crystallites [1].

The simulation results for tensile tests of aluminum alloy with transition to superplasticity regime are consistent with known experimental data at various temperatures and strain rates (for example, [2], a brief review is presented in [3]), including structure evolution and realization of deformation mechanisms. The technique for estimating model sensitivity to parameter perturbations is proposed, results indicate the stability of model to parameters and influences perturbations. The simulation results of metal processing with proposed constitutive model are obtained with the developed software for boundary value problem solving based on FEM.

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## REFERENCES

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