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SURFACE LAYER EFFECT IN POLYCRYSTALLINE AGGREGATES

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In this work we perform numerical simulations with a polycrystalline model based on copper microstructure. Inside grains anisotropic viscoplastic material model with random crystal lattice orientation is used. Due to high heterogeneity redistribution of stresses and strains in a polycrystal is observed during loading and unloading. In bulk region of the structure such redistribution can be analyzed with a unit cell model applying periodic boundary conditions. For the analysis of surface layer free boundary condition should be assigned. Simulation of structure with free surfaces and large number of grains can illustrate an influence of geometry at microscale. Since stress distribution in a polycrystal is heterogeneous an averaging technique is developed. To obtain smooth fields of stresses and strains a set of statistically randomized realizations of microstructure within the same geometry and loading conditions is calculated. The fields were processed through developed interpolation algorithm and point-wise averaging. This algorithm is based on interpolation using shape functions of finite elements. In this way models of 3D rectangular plate and cylindrical bar are investigated within cyclic viscoplasticity. Both models clearly show the presence of surface layer effect. The model of rectangular plate with a central circular hole is calculated in tensile conditions. Influence of grain size effect and loading rate on thickness of the surface layer is considered.