FORTHCOMING PAPERS

Diffusion and related phenomena in bulk nanostructured materials

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The paper reviews results of experimental and theoretical studies of diffusion and related phenomena (grain growth, creep, superplasticity) in bulk nanostructured materials. The particular attention is paid to the following: (i) Recent developments in fabrication of bulk nanostructured materials. (ii) Microstructural characterization of bulk nanostructured materials and their evolution during heating. (iii) Experimental study of grain boundary diffusion in bulk nanostructured materials. (iv) Theoretical modeling of grain boundary diffusion in bulk nanostructured materials. (v) Related phenomena (grain growth, creep, superplasticity) in bulk nanostructured materials.

Acid-base properties of melts of the M_2O-GeO_2 system (M= Li, Na, K)

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In the article the problem of describing the acid-base properties of oxide melts is reviewed. Various versions of the acid-base equilibria description in terms of electroneutral particles, ion-molecular and oxygen components are considered.

Phase transformations in semiconductors under contact loading

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Phase transformations and amorphization that occur in many semiconductors under contact loading such as indentation with hard indenters, scratching or machining will be described. Contact loading is one of the most common mechanical impacts that materials can experience during processing or use. Examples are cutting, polishing, indentation testing, wear, friction and erosion. This kind of loading has a very significant nonhydrostatic component of stress that may lead to dramatic changes in the materials structure, such as amorphization and phase transformations. Simultaneously, processes of plastic deformation, fracture and interactions with the environment and/or counterbody can occur. The latter ones have been studied by mechanical engineers and tribologists, but the processes of phase transformations at the sharp contact have been investigated only for a very few materials and the data obtained so far can be only considered as preliminary. One of the reasons for the lack of information may be the fact that the problem is at the interface between at least three scientific fields, namely materials science, mechanics and solid state physics. Thus, an interdisciplinary approach is required to solve this problem and understand how and why a nonhydrostatic (shear) stress in the two-body contact can drive phase transformations in materials.

Misfit dislocation structures in single crystalline films

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Nucleation and development of misfit dislocation arrangements in thin-film single-crystalline structures are discussed. Various theories and recent experiments are reviewed with special atention being paid to the exact account for the influence of interphase boundaries. Other possibilities of strain accommodation in heteroepitaxial system (misfit dislocation walls and misfit disclinations) are also considered.

Disclinations in large-strain plastic deformation and work-hardening

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Large strain plastic deformation of f.c.c. metals at low homologous temperatures results in the subdivision of monocrystals or polycrystal grains into mesoscopic fragments and deformation bands. Since stage IV of single crystal work-hardening and the substructural contribution to the mechanical anisotropy emerge at about the same equivalent strain as the fragment structure, the latter is likely to be the reason for the new features in the macroscopic mechanical response. The present paper reviews some recent models which tackle the fragment structure development as well as its impact on the macroscopic mechanical response with the help of disclinations. Incidental or stress-induced formation of disclination dipoles and non-conservative propagation of disclinations are considered as «nucleation and growth» mechanisms for dislocation rotation boundaries. Propagating disclinations get immobilized in fragment boundaries to form new triple junctions with orientation mismatches and thus immobile disclinations with long-range stress fields. The substructure development is described in terms of dislocation and disclination density evolution equations; the immobile defect densities are coupled to flow or critical resolved shear stress contributions.

The first section presents a semi-phenomenological application to the cell and fragment structure development and their impact on the flow stress for either single crystals with symmetric orientation or polycrystals with constant average Taylor factor. The model is capable of reproducing stages III and IV of the work-hardening curve for copper. The second section presents an extension to a coupled substructure and texture development model. The substructure part is based on separate but coupled rate equations for dislocation and disclination densities in the 12 f.c.c. slip systems and for six cell wall and fragment boundary families. The texture part is based on a Taylor full constraints algorithm. This model is able to predict the cell and fragment structure development depending on the crystallite orientation. Coupling the immobile defect densities to critical resolved shear stress contributions reproduces the emerging substructural component of the mechanical anisotropy.