

Topics of „Lattice defects II.” course

Interaction between dislocations and secondary phase particles

Processing of microstructures with secondary phase particles. Coherent, semi-coherent and incoherent phase boundaries. Dispersion strengthening. Orowan mechanism. Dipole criterion. Effect of size and spacing between precipitates on yield strength. Cutting mechanism. Dependence of yield strength on precipitate radius for Orowan and cutting mechanisms.

Geometric models of grain boundaries

Characterization of misorientation. Macroscopic and microscopic degrees of freedom for grain boundaries. Coincidence site lattice (CSL). Twist and tilt boundaries. Symmetrical tilt boundary. Displacement shift complete lattice (DSCL). Bollmann-type zero lattice (OL). Correlation between CSL, DSCL and OL. Grain boundary engineering. Brandon and Palumbo-Aust criteria. Marcinkowski-type grain boundary model.

Physical models of grain boundaries

Dislocation model of low-angle grain boundaries (GBs). Dependence of GB energy on misorientation. Liquid model of GBs. Temperature dependence of GB energy at high temperatures.

Grain boundary segregation

Determination of impurity excess concentration segregated at GBs using the Gibbs equation. Langmuir-McLean adsorption theory for grain boundary segregation. Grain boundary coverage as a function of impurity concentration.

Vacancy condensation

Formation of vacancy clusters. Dislocation loops formed by vacancy condensation: Frank-type sessile loops, prismatic loops. Transformation of Frank-type loop to prismatic loop. Stacking fault tetrahedron. „Stair-rod” dislocation. Formation of stacking fault tetrahedron from Frank-type loop. Variation of the size of stacking fault tetrahedron as a function of the distance from the free surface.

Crack propagation and fracture

Brittle and ductile fracture. Theoretical fracture strength. Griffith theory of brittle fracture. Stress intensity theory. Stress intensity factor. Fracture toughness: definition, measurement. Charpy-type impact test. Dependence of fracture toughness on temperature and strain rate. Brittle-ductile transition.