

Topics of „Lattice defects I.” course

Point defects, diffusion

Types of point defects. Vacancy concentration in thermal equilibrium. Measurement of vacancy concentration (differential dilatometry, electric resistance measurement, positron annihilation spectroscopy). Point defect pairs. Diffusion mechanisms. Fick I. law. Kirkendall effect. Diffusion in the presence of lattice defects. Fick II. law.

Dislocations and plastic deformation

General definition of dislocation (cut surface). Burgers vector. Edge and screw dislocations. Stress field of edge and screw dislocations. Energy of dislocation. Burgers vectors in cubic crystals. The force acting on a dislocation. Interaction between dislocations. Frank-Read source. Dislocation reactions. Lomer-Cottrell lock. Cross-slip of screw dislocation, climb of edge dislocation. Slip systems in hexagonal close packed structure.

Mechanical properties

Uniaxial tensile test. Schmid factor. Thompson tetrahedron. Single slip, multiple slip. Stages of deformation in single- and polycrystals. Yield strength, ultimate tensile strength, fracture strength, uniform and total elongations. Taylor equation. Hall-Petch equation.

Stacking and twin faults in face-centered and body-centered cubic crystals

Intrinsic and extrinsic stacking faults in fcc lattice. Coherent twin boundary. Partial dislocations in fcc lattice: Shockley partial, negative and positive Frank partial dislocations. Dissociated dislocations. Equilibrium splitting distance between partials in dissociated dislocations. The effect of stress on dissociated dislocations. Deformation twinning. The effect of grain size on the splitting distance between partials in dissociated dislocations. Twinning in bcc crystals.

Twinning in hexagonal crystals

General description of twinning: invariant plane of shear, shear direction, conjugate plane, conjugate shear direction. Extension and contraction twinning in magnesium. Schmid factors for extension twinning. The orientation change of crystallographic c-axis due to extension twinning in Mg during tension and compression. „Double” twinning. The dislocation model of extension twinning in Mg. Monitoring of extension twinning activity by neutron diffraction and acoustic emission. Effect of grain size and deformation temperature on twinning activity in hcp crystals

Solid solution hardening

Interaction between dislocations and solute atoms: size effect, modulus effect. The effect of solute concentration on yield strength. The influence of temperature and difference in atomic sizes on yield strength increment.

Recovery and recrystallization

Driving force of recovery and recrystallization. Annihilation processes of lattice defects as a function of temperature: reduction of point defect concentration, dislocation annihilation, polygonization, primary and secondary recrystallization. Change of physical properties. Kinetics of recovery and recrystallization.