Dislocation Mechanics and Metal Plasticity

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1. Experimental basis of plasticity and dislocation mechanics.
   (a) The elastic limit and yield phenomena.
   (b) Loading-unloading hysteresis and Bauschinger effect.
   (c) Rate and temperature dependence of yield.
   (d) Work hardening of metals.
   (e) Direct observations of dislocations.
   (f) Measurements of dislocation mobility.
   (g) Scaling laws: Taylor, Hall-Petch.
   (h) Dislocation structures.
2. Linear-elastic theory of dislocations.
   (a) The cut-surface problem of linear elasticity.
   (b) Geometrical representation of slip and dislocations.
   (c) Stored energy and the Peach-Koehler force.
   (d) Dislocation fluxes and plastic deformation.
   (e) Extensions to finite kinematics.
3. Microscopic theories of dislocations and the passage to continuum.
   (a) Geometrical representation of discrete dislocations (DD).
   (b) Core energies and core relaxation.
   (c) The DD dilute limit and the line tension approximation.
   (d) The Peierls-Nabarro (PN) theory of the dislocation core.
   (e) The PN dilute limit and the line tension approximation.
   (f) Application to Kocks theory of forest hardening.
4. Mesoscopic theories of plasticity and the micro-macro transition.
   (a) Continuum theories of crystal plasticity.
   (b) The rate-independent theory: Minimum principles.
   (c) Minimum principles obtained by time discretization.
   (d) Dislocation microstructures and relaxation.
   (e) Dislocation microstructures and optimal scaling.
   (f) Application to multiscale modeling of metals.