PHYSICS OF MATERIALS

Physics School Autumn 2025

Series 8 **7 November 2025**

Exercise 1: Interaction force between two Shockley partial dislocations

Calculate the interaction force between two Shockley partials that glide on the (111) close-packed plane.

1) If the perfect dislocation $AB = \frac{a}{2}[\bar{1}10]$ is of screw type

2) If the perfect dislocation $AB = \frac{a}{2}[\bar{1}10]$ is of edge type.

The approach to solving this exercise is to make a schematic, calculate the Peach-Köhler forces between the partials (hint: at equilibrium, these correspond to the stacking fault energy), and show that the interaction reduces to screw-screw and edge-edge. This exercise aims to establish the equilibrium distance between partial dislocations as a function of the stacking fault energy (equation 7.38 in the textbook).

Exercise 2: Precipitation hardening

A precipitation-hardened alloy contains coherent spherical precipitates distributed uniformly (average distance between precipitates = ℓ). These precipitates grow when the alloy is annealed at a temperature T_A, and we observe variations in the electrical resistivity and hardness Hv, as reported in Figure 1.

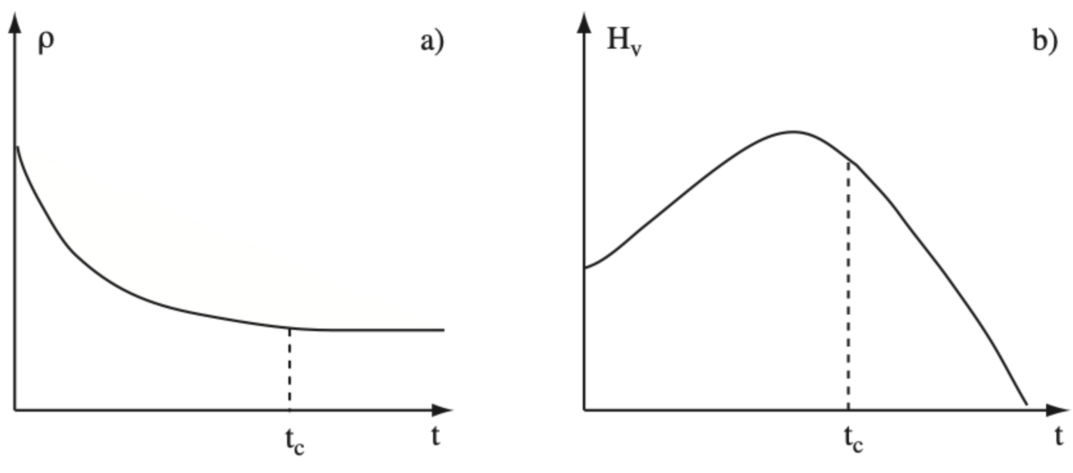

Figure 1 Annealing of a sample at constant temperature T_R. (a) Evolution of the electric resistivity. (b) Measurements of hardness after annealing are interrupted at consecutive time points.

a) Explain the observed maximum in hardness and calculate the precipitates' critical radius r_c leading to the maximum hardening.

b) After an annealing time t_c, the resistivity is constant, and the hardness decreases. Why?

Exercise 3: Reaction between dislocations

Show that, in an FCC crystal, the reaction $\frac{a}{2}[110]+\frac{a}{2}[1\bar{1}0]\rightarrow a[100]$ is favorable if the dislocation $a[100]$ is a pure screw and unfavorable if it is a pure edge.