PHYSICS OF MATERIALS

Physics School Autumn 2024

Series 8 **15 November 2024**

Exercise 1 Interaction force between two Shockley partial dislocations

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

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

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

The approach for solving this exercise is to make a schematic, calculate the Peach and Köhler force between the partials (hint: at equilibrium, this corresponds to the stacking fault energy), and show that the interaction is reduced 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 of Chapter 7 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 the variations in the electric resistivity and hardness Hv reported in Figure 1.

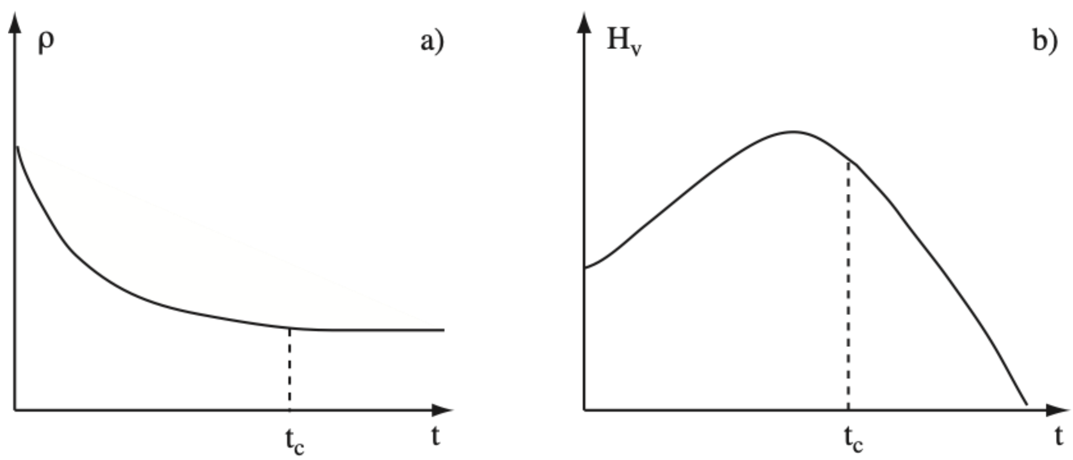

Figure 1 Annealing of a sample at constant temperature T_R. (a) Evolution of the electric resistivity. (b) Measurements of the hardness after annealing are interrupted after consecutive times.

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.