Tfy-3.4311 Materials Physics II Second midterm exam, 16.12.2011

Answer preferably in English (Answers in Finnish, Swedish, and German are also understood).

1. Describe briefly the following concepts/phenomena:
   (a) Describe the processes of quenching and annealing. How are they used to study defect properties in solids? (2 p)
   (b) Figure 1 describes hydrogen diffusion in some transition metals. Explain the dependencies and phenomena seen! (2 p)
   (c) What is the significance of the Kramers-Kronig relations? (2 p)
   (d) Interpret the results shown in Figure 2. (2 p)
   (e) Figure 3 shows reflectivities of different n-doped InSb samples. Interpret the results. (2 p)
   (f) What is a polariton? (2 p)
   (g) Explain the behaviour of entropy in the superconducting transition! (2 p)
2. Why do point defects exist in thermal equilibrium at a finite temperature but extended defects do not exist? Derive OR explain how you would derive the equation for the number of Frenkel pairs in thermal equilibrium. (4p)
3. Long wave length optical phonons in ionic solids. Why cannot they be described like those in metals or covalent solids? How can they be described? Which are the main features in their dispersion relations? Can you explain the origin of these features? (4 p)
4. Explain the ingredients used to describe the superconducting state in the BCS theory: attraction between electrons, character of Cooper pairs, and that of the BCS many-body wave function. (4 p)
5. Describe the penetration of the magnetic field into type-II superconductor: Why is the vortex lattice stable? When does the first vortex nucleate? When does the magnetic field destroy the superconducting state? (4 p)

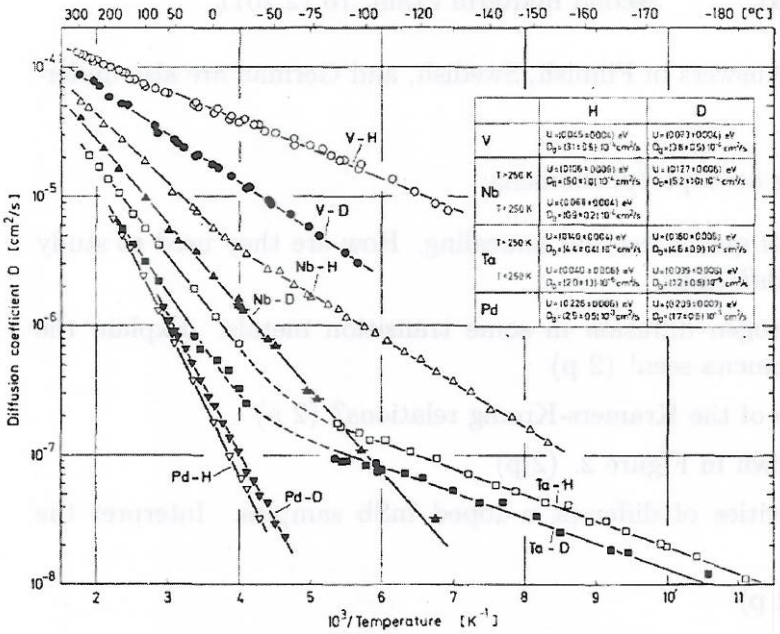

Fig. 1. Hydrogen diffusion in transition metals

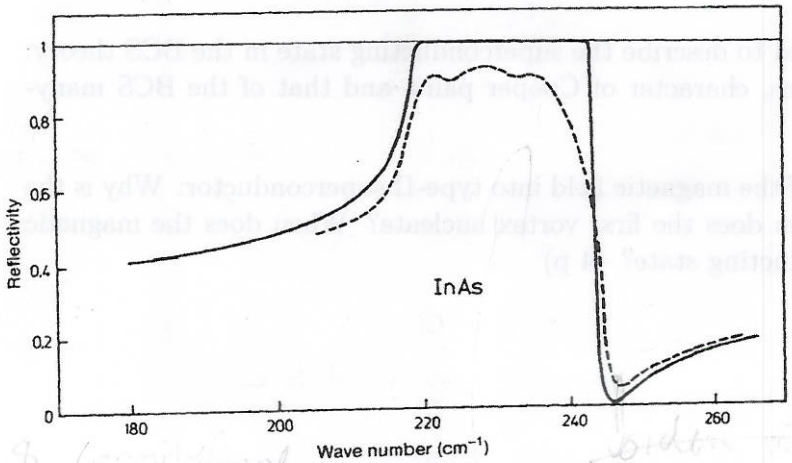

Fig. 11.8. Reflectivity for the undamped case (theoretical). The dashed line is the experimentally measured curve for a real ionic crystal (InAs). (After [11.4])

Fig. 2.

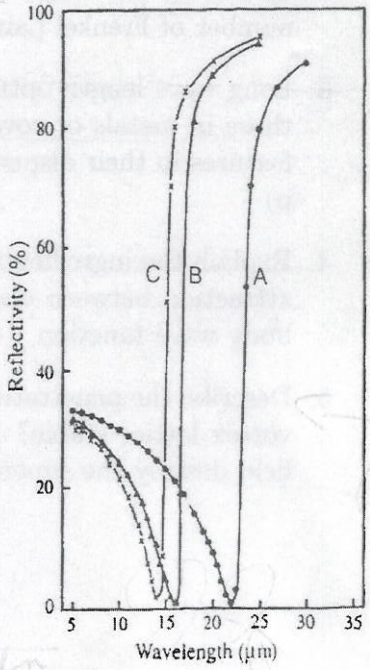

Fig. 3. Reflectivity of different n-doped InSb samples