UNIVERSITÄT LEIPZIG

Fakultät für Physik und Geowissenschaften

Tasks
Semiconductor Physics I WS 2016/17

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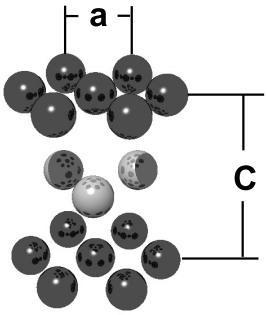
These tasks are for the preparation of the exam. In order to get the additional points, please hand in your solution on Monday, 23. January, after the lecture (SR532).

Z1. (a) Name three semiconductors which crystallize in wurtzite structure and order them according to their bandgap in ascending order.

(b) **Calculate** two orthogonal directions, which are perpendicular to [2 -1 0] in a diamond-structure semiconductor.

(c) The lattice parameters of a hexagonal closed-packed (hcp) structure a and c are defined as shown in the figure below. Name the base vectors. Calculate the ratio c/a of the hcp lattice.

(d) Name 3 different types of scattering in semiconductors and the corresponding temperature dependence.



[12 points]

Z2. **Occupation** In Fig. Z2.1 an inhomogeneous band structure is given.

(a) Draw the intrinsic level!

(b) Order the electrons by their kinetic energy (start with the lowest one). Give a short explanation for your order!

(c) Order the electrons by their occupation probability in the thermal equilibrium (start with the lowest one). Give a short explanation for your order!

(d) Name the type of the semiconductor (n-HL, p-HL, intrinsic) of the area I, II und III!

[7 points]

Z3. Consider an n - doped silicon thin film of thickness $1\,\mu$m. The doping and hence the electron concentration shall have a linear gradient, such that $n(x = 0\,\mu\text{m}) = 10^{17}\,\text{cm}^{-3}$ and $n(x = 1\,\mu\text{m}) = 10^{16}\,\text{cm}^{-3}$.
Determine the neccessary electric field in the center of the film, such that the current density is equal to zero (i.e. diffusion and drift current cancel each other). The sample's temperature is 300 K and the electron mobiblity $\mu_\text{n} = -1000\frac{\text{cm}^2}{Vs}$.

[6 points]

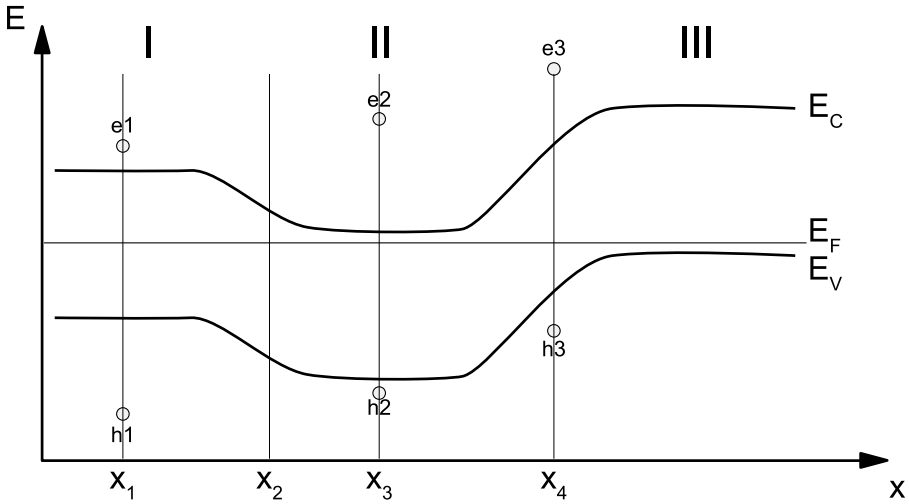


Figure Z2.1: Inhomogeneous band structure of a semiconductor.

Z4. Consider an n - doped silicon thin film of thickness $1\,\mu$m. The doping and hence the electron concentration shall have a linear gradient, such that $n(x = 0\,\mu\text{m}) = 10^{17}\,\text{cm}^{-3}$ and $n(x = 1\,\mu\text{m}) = 10^{16}\,\text{cm}^{-3}$.
Determine the neccessary electric field in the center of the film, such that the current density is equal to zero (i.e. diffusion and drift current cancel each other). The sample's temperature is 300 K and the electron mobiblity $\mu_\text{n} = -1000\frac{\text{cm}^2}{Vs}$.

[6 points]

Total: 31 points