Exercise 1

Exercise 1: We consider a-Si based modules with an i-layer thickness of 200 nm. Calculate how much energy per g of Si will be generated if the modules have an average 7% efficiency in real conditions (taking into account temperature effects, cables losses), 30 years lifetime, and that the annual irradiation in the plane of the module is 2500 kW h m^{-2} (desert conditions). Compare it with $E = mc^2$!

Exercise 2:

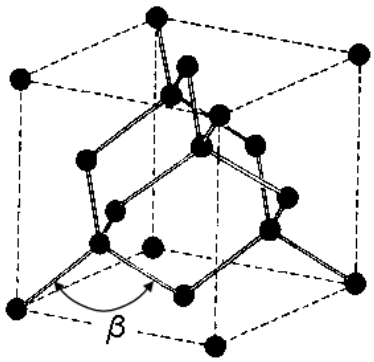

Figure 1: Cubic unit cell of c-Si with tetrahedral covalent bonds.

This exercise deals with the structure of c-Si and a-Si. The unit cell of c-Si is represented in fig. 1 (2 fcc lattices shifted by 1/4 along the cube diagonal).

a) Given the lattice parameter $a = 5.430\,95$ Å, calculate all the distances between the different nearest neighbours inside a unit cell of c-Si! As a hint, you can use fig. 2[1], where high-energy X-ray diffraction was performed on c-Si powder from where you can deduce and check the different inter atomic distances.

b) Calculate the angle β between two bonds!

c) Discuss the case of a-Si with the help of fig. 3[2]. What could happen in term of short-range and long-range order? Why?

[1] K. Laaziri et al., Physical Review B **60** 19, 520-533 (1999), fig. 9
[2] K. Laaziri et al., Physical Review B **60** 19, 520-533 (1999), fig. 15

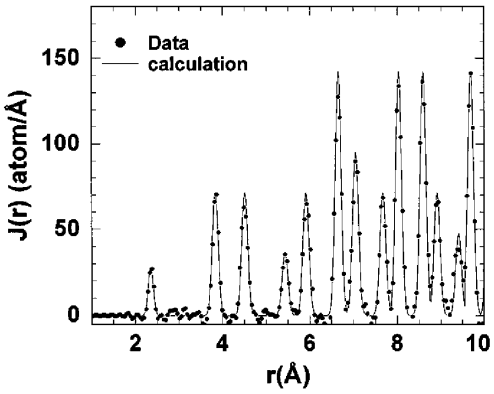

Figure 2: The radial distribution function J(r) of powder crystalline silicon as measured (dots). The solid line represents a theoretical calculation of the crystalline J(r) broadened by a Gaussian distribution.

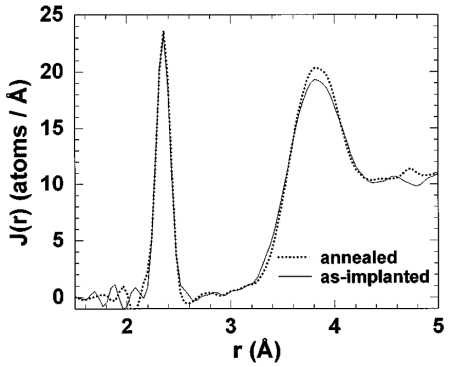

Figure 3: The first two peaks of the radial distribution function J(r) of amorphous silicon.

Exercise 3 (Vacancies and voids in Si):

a) With the help of fig. 1, calculate the density (atoms/cm^3) of crystalline silicon.

b) Assume a full hydrogen passivation of the (100) surface, compute then the hydrogen density on this surface.

c) Imagine you have a spherical void of radius r = 3.3 Å, what would be, in average, the ratio of missing Si atoms to hydrogen atoms (δ)?

Remarks: The lecture and exercises will take place on Monday afternoon (15:15 pm to 16 pm). In case of any questions about the exercises or the lecture, please feel free to contact the assistant – **Julien Hurni (julien.hurni@epfl.ch)** by email!There is also a moodle website available (moodle.epfl.ch), where you find the slides as well as the exercises and solutions (one week later).