Háskóli Íslands
Raunvísindadeild
Eðlisfræði

Haust 2017

Eðlisfræði þéttefnis I

Dæmablað 5

Skilafrestur 28. September 2017 kl. 15:00

1. **Hliðarsetinn teningur og bylgjubognun – Face centered cubic and diffraction** (20)

   (a) Með hjálp teikningar, sýnið hvernig atómum er pakkað í hliðarsetna teningsgrind. Sýnið þétt pökkuðu plönin og Miller vísa þeirra.

   (b) Grindarfasti einingargrindar miðjusetins kopar er 0.36 nm. Reikna skal lengstu bylgjulengd Röntgengeisla sem framkallar bylgjubognun frá þétt pökkuðu plönunum.

   (c) Innkomandi Röntgengeisli er gefinn með $3.49 \times 10^{10}(2\mathbf{i} - \mathbf{j} + 2\mathbf{k})$ m^{-1} og er beint á koparsýnið. Rita tilsvarandi bylgjuvigur fyrir útgangandi geisla, sem kemur frá þétt pakkaða planinu í lið (a).

   (d) Hver er radíi koparatóms ? Gerið grein fyrir öllum nálgunum sem notaðar eru.

   (e) Útskýrið hvers vegna ekki kemur fram bylgjubognun frá Röntgengeisla sem hefur bylgjulengd 0.6 nm.

   (f) Myndurðu vænta þess að sjá bylgjubognun frá NaCl (grindarfasti einingargrindar er 0.56 nm) með Röntgengeisla af bylgjulengd 0.8 nm ? Réttlættu svar þitt.

   (a) With the aid of a diagram, show how atoms are packed on a face-centered cubic lattice. Identify the close-packed planes and their Miller indices.

   (b) The unit cell dimensions of face-centered cubic copper is 0.36 nm. Calculate the longest wavelength of X-rays that will produce diffraction from the closed-packed planes.

(c) An incoming X-ray beam given by $3.49 \times 10^{10}(2\mathbf{i} - \mathbf{j} + 2\mathbf{k})$ m^{-1} is incident on a copper sample. Write down the corresponding wavevector for an outgoing beam, diffracted by the close-packed plabe from part (a).

(d) Stating any assumptions that you use, what is the radius of a copper atom ?

(e) Explain why there is no diffraction from X-rays of 0.6 nm.

(f) Would you expect to see diffraction from NaCl (unit cell lattice constant 0.56 nm) using X-rays of wavelength 0.8 nm ? Justify your answer.

(Próf desember 2016)

2. **Neutrons vs electrons** (10)

   Why is the energy of a neutron so much smaller than that of an electron in radiation beams employed in crystal diffraction ?

3. **Diamond and silicon lattice** (10)

   Diamond and silicon have the same type of lattice structure, an fcc with a basis, but different lattice constants. Is the lattice structure factor S the same for both substances ?

4. **Structure factor of diamond lattice** (10)

   The diamond structure is described in your text. The basis consists of eight atoms if the unit cell is taken as the conventional cube.

   (a) Find the structure factor S of this basis.

   (b) Find the zeros of S and show that the allowed reflections of the diamond structure satisfy $h + k + l = 4n$, where all indices are even and n is any integer, or else all indices are odd.

5. **X-ray diffraction** (10)

   The edge of a unit cell in a cubic crystal is $a = 2.62$ Å. Find the Bragg angle corresponding to reflection from the planes (100), (110), (111), (200), (210), and (211), given that the monochromatic X-ray beam has a wavelength $\lambda = 1.54$ Å.