

Sixth Semester Examination – 2008

X-RAY AND METAL PHYSICS

Full Marks – 70

Time : 3 Hours

*Answer Question No. 1 which is compulsory
and any **five** from the rest.*

*The figures in the right-hand margin
indicate marks.*

1. Answer all the questions. State your answers

True or False and justify it : 2 × 10

(a) X ray diffraction scattered by a unit cell
of crystals determine the structure factor.

(b) Powder method used in the determination
of d-spacings and simple crystal struc-
tures.

(c) As the crystal size decreases, the
breadth of the diffraction peaks should
increase.

(d) Fluorescent radiation is characteristic to
specific elements and is widely used for
chemical analysis.

(e) In X-ray tube operation, as the turning
tube down, decreases the mA first, and
then decreases the kV.

(f) NaCl was the first structure determined
by X-ray diffraction.

(g) The intensity of a Bragg reflection is
proportional to the square of the structure
factor.

- (h) X-ray diffraction is the only analytical method that can non-destructively measure residual stresses in materials.
- (i) Highly ordered structures in which the long-range order extends over many unit cells are often called superlattices.
- (j) The Scherrer constant K depends on the shape of the crystallites.
2. (a) State Compton effect. Explain briefly how it is different from Thomson effect of x-ray scattering. 5
- (b) Explain the origin of all characteristic wavelengths on a schematic drawing and an energy diagram respectively. 5
3. For an unknown cubic metal the diffracting angles, θ , obtained with CuK_α radiation ($\lambda = 1.541 \text{ \AA}$) are : 20.1° , 29.2° , 36.6° , 43.5° , 50.2° , 57.4° , 65.5° .

- (a) Determine the lattice constant "a" for this metal.
- (b) Determine the atomic radius for this metal.
- (c) Determine the crystal structure of this metal. 10
4. (a) Define preferred orientation. Discuss the common types of preferred orientations. 5
- (b) Explain the various factors that alter the diffracted intensity. 5
5. (a) State the basic principles of the Laue method. Explain how to determine the orientation of single crystals using the Laue method. 6
- (b) Explain Cu-radiation fluoresces iron, but Cr-radiation does not. 4

6. Calculate the intensity of lines in typical powder pattern experiments of NaCl obtained with CuK_α radiation ($\lambda = 1.541 \text{ \AA}$). 10

7. (a) Discuss reasons for the difference in electrical conductivity between metals, semiconductors and insulators in terms of electron energy band structure. 4

(b) Assuming that there are 1.3 free electrons per silver atom. The electrical conductivity and density for Ag are $6.8 \times 10^7 (\Omega - \text{m})^{-1}$ and 10.5 g/cm^3 , respectively, (a) Calculate the number of free electrons per cubic meter for silver (b) Compute the electron mobility for Ag. 6

8. (a) Explain the origin of residual stresses. Describe physical principles that permit X-ray diffraction used to measure residual stresses in materials. 6

(b) What are Order-disorder transformations? Write down the typical ordered system occurred crystals. 4