

M.TECH MATERIAL ENGG FIRST YEAR FIRST SEMESTER - 2018

Subject: CHARACTERIZATION OF MATERIALS

Time: 3 hours

Full Marks: 100

Question number 1 is compulsory. Answer any two (2) questions from the rest. Answers must be brief and to the point. All parts of the same question must be answered contiguously.

- 1 Answer any seven (7) questions. 7x7
- (a) Calculate the wavelength of an X-ray of energy 2166 eV.
 - (b) A ferritic steel is observed under an optical microscope which has a numerical aperture of 1.5 and uses the radiation of 500 nm. What is the minimum grain size that can be resolved using this microscope?
 - (c) What is the Bragg angle for first order and second order diffraction from planes with $d=0.08934$ nm and the operating voltage of the electron microscope is 400 kV? Electron mass= 9.1×10^{-31} kg; Electron charge= 1.6×10^{-19} Coulomb; Planck's constant= 6.6×10^{-34} J s.
 - (d) It is required to examine a fractured component in the SEM at a magnification of x 1000 and to achieve a depth of field of 1 mm. If the maximum working distance (the distance between pole piece and the point of focus on the specimen surface) that can be used is 50 mm, what is the maximum sized objective aperture that can be used?
 - (e) Al-4Cu wt% aged at 220 °C for 10 days. What technique(s) will you recommend to determine the amount and composition of the precipitates? Justify.
 - (f) The lowest angle reflection in a powder diffraction experiment on a BCC metal using Copper $K\alpha$ radiation ($\lambda=0.154$ nm) occurred at an angle of 20° . What is the lattice parameter of the metal?
 - (g) A TEM is operated at 200 kV. What is the wave length of this TEM? Electron mass= 9.1×10^{-31} kg; Electron charge= 1.6×10^{-19} Coulomb; Planck's constant= 6.6×10^{-34} J s. Why is it necessary to use very thin sample in TEM?
 - (h) A powder diffraction pattern of a material gave reflection at 2θ values 40° , 58° , 73° and 86.8° . Copper $K\alpha$ radiation ($\lambda=0.154$ nm) was used. Determine the crystal structure of the material. Calculate the approximate lattice parameter.
- 2 (a) Iron undergoes allotropic transformation from BCC to FCC phase at 910 °C. At this temperature the atomic radii of the iron atoms in the two structures are 1.258 Angstrom and 1.292 Angstrom respectively. What is the percent volume change as the structure transforms? What experimental technique will you recommend to detect the volume change? Justify. 8+5
- (b) What techniques can be used to measure the heat capacity of a metal? Discuss. Why it is necessary to measure the heat capacity of a metal? 8+4

- 3 Describe the image formation in SEM. Define: depth of field and depth of focus. What are the aberrations present in optical microscope? How is it possible to minimise the aberrations? Is it possible to use back scattered electron in a SEM to identify chemical composition gradient present in the specimen? Justify. 8+4+
6+2+
5
- 4 (a) What is short wave length limit? How is it possible to use x ray diffraction to determine phase diagram? 3+7
- (b) Compare and contrast: dark field imaging and bright field imaging in TEM 7
- (c) Compare and contrast: EDS and WDS 8