

國立臺灣科技大學

九十二學年度博士班招生考試試題

系所組別：機械工程系博士班戊組

科目：工程材料

總分 100 分

Closed-Book Entrance Examination, 100 minutes

- Considering atomic packing of an ionic crystal, we have to take into account of ionic radii of ions. (i) Please derive the stability range (limiting values) of the ionic radius ratio ( $r/R$ ) for coordination number,  $CN=6$ . (ii) If the ionic radius of Mg is  $r(\text{Mg}^{2+}) = 0.066 \text{ nm}$  and that of Oxygen is  $r(\text{O}^{2-}) = 0.132 \text{ nm}$ , what do you expect the CNs and the crystal structure (atomic arrangements) for the compound  $\text{MgO}$ ? (14points)
- Figure 1 shows the results of an x-ray diffraction experiment in the form of the intensity of the diffracted peak versus the  $2\theta$  diffraction angle. If X-rays with a wavelength of  $0.15418 \text{ nm}$  are used, please determine (i) the crystal structure of the metal; (ii) the indices of the planes that produce each of the peaks; (iii) the lattice parameter of the metal. Write your analysis in detail. (14points)

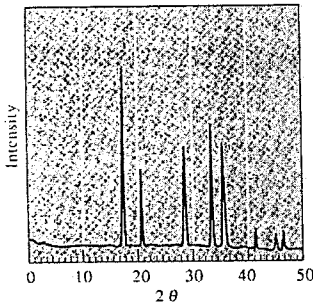


Figure 1 X-ray diffraction pattern of a metal.

- Show why the  $c/a$  ratio in Hexagonal close-packed HCP materials should be close to 1.63. Why does  $c/a$  in some metals differ from 1.63? (12points)
- (i) Calculate the critical resolved shear stress in a crystal if a stress of  $170 \text{ Mpa}$  in the  $[100]$  direction is required to move a dislocation in the  $[111]$  on the  $(101)$ . (ii) Is this a BCC or FCC crystal? Why? (12points)
- What is an "LED" and how does it work? (12points)
- What are "reflection" and "refraction"? What is the "snell's law? How do you use these concepts to design an optical fiber for light transmission in communication applications? (Describe the principles in detail.) (12points)
- A material is placed in an electric field of  $2000 \text{ V/m}$  that causes a polarization of  $5 \times 10^{-8} \text{ C/m}^2$ . Calculate the dielectric constant of the material. (12points)
- If you design a component in which thermal shock resistance is important, how many factors that you should take into account? Using a ceramic component which must be subjected to a cold water quench from  $1000^\circ\text{C}$  to  $25^\circ\text{C}$  as an example. (12points)

