

國立臺灣科技大學
九十三學年度碩士班考試試題

系所組別：材料科技研究所

科目：材料導論

「總分 100 分」

不可使用計算機

1. An argon (Ar) laser beam, containing 514 nm and 488 nm monochromatic lights, is directed to a glass (SiO_2) prism in air as shown in Fig. 1.

(a) How will the laser beam propagate through the prism and out to the air? Why? 「9 分」

(b) If the glass is doped with germanium (Ge), how will the laser beam propagate? Why? 「6 分」

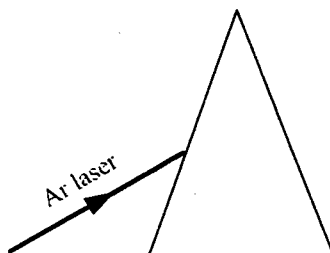


Fig. 1

2. A hole with crack lines in radial shape, as shown in Fig.2, will be left after a bullet passed through a piece of window glass. Two bullets were subsequently shot on a piece of glass and left two holes on the glass. How can you identify the first and the second bullet hole? Why? 「10 分」

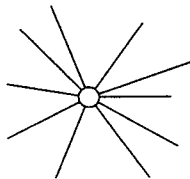


Fig. 2.

3. An iron (Fe) sample is heated. It changes from the *bcc* to *fcc* metal structure at 912°C , and back to the *bcc* at 1400°C . Plot the thermal expansion ($\Delta L/L_{20}$) behavior of iron with temperature ($\Delta L/L_{20}$ versus T). (L_{20} is length of sample at 20°C ; ΔL is change of sample length; T is temperature.) 「13 分」

4. Figure 3 shows arrangement of atoms in a specific plane of *fcc* crystal.

(a) What is the Miller indices of this plane? 「4 分」

(b) Duplicate Fig. 3 on your answer sheet. Plot and label $[001]$, $[011]$, $[111]$ and $[211]$ directions on your drawing if they do exist on this plane. 「8 分」

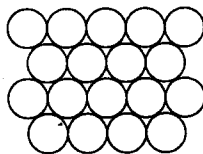


Fig. 3



國立臺灣科技大學
九十三學年度碩士班考試試題

系所組別：材料科技研究所

科 目：材料導論

5. The crystal structure of gray tin (Sn) is diamond cubic. Separated calculations indicate that there are 2.0×10^{25} conduction electrons per m^3 .

(a) What fraction of the electrons has been activated to the conduction band? 「9 分」

(b) What is its conductivity at 20 °C? 「6 分」

Table I. Properties of Semiconductor Tin (20 °C)

Energy gap, E_g	Mobilities, $\text{m}^2/\text{V}\cdot\text{s}$		Lattice constant
eV	Electron, μ_n	Hole, μ_p	a , nm
0.1	0.20	0.10	0.65

6. List all the elements which can not emit characteristic X-ray. Why can't they emit X-ray? 「10 分」

7. Melting points of Pb and Sn are 327 °C and 232 °C, respectively. Pb-Sn eutectic temperature is 183 °C. The solubility limits of Sn in solid α and Pb in solid β are 19.2 % and 2.5 % at eutectic temperature. The eutectic composition is 38.1 Pb-61.9 Sn. All the compositions in this question are in weight percent.

(a) Plot the equilibrium phase diagram of the Pb-Sn eutectic system between 0 °C and 350 °C, and label all the phases. 「8 分」

(b) A solder sample of 80 Pb-20 Sn is maintained at 250 °C. Calculate mass ratio of the phases. (The compositions of α and liquid phases at 250 °C are 88.5 Pb-11.5 Sn and 63 Pb-37 Sn, respectively.) 「7 分」

8. How and why does the supercooling affect the radius of critical nucleus in homogeneous nucleation? 「10 分」

Fundamental physical constants and conversions

Quantity	Symbol	Value with units
Speed of light in vacuum	c	$2.998 \times 10^8 \text{ m s}^{-1}$
Plank's constant	h	$6.626 \times 10^{-34} \text{ J s}$
Avogadro constant	N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
Molar gas constant	R	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
Boltzmann constant, R/N_A	k	$1.381 \times 10^{-23} \text{ J K}^{-1}$
Electron charge	q	$1.6 \times 10^{-19} \text{ C}$
1 ampere		$= 1 \text{ C s}^{-1}$
1 electron volt (eV)		$= 1.6 \times 10^{-19} \text{ J}$

