

※ 請在答案卷上標明題號依序作答

Q1. (5 marks)

What wt% oxygen must be present in FeO to prevent any vacancies? What fraction of the iron sites are vacancies if FeO contains 25 wt% O?

Q2. (10 marks)

"The maximum service temperature of a silica refractory brick can be increased by upgrading the alumina content!" Is this statement correct? Why or why not?

Q3. (10 marks)

- (a) Calculate the density of a FCC unit cell packed with C_{60} buckyballs and with a lattice parameter of 1.41 nm.
(b) What are the key reasons for carbon nanotubes' exceptional mechanical properties?

Q4. (10 marks)

- (a) Explain why the physical and mechanical properties of a material determine its possible fabrication and processing techniques.
(b) Which ceramic-forming process or processes could be used for:
i. High-density parts?
ii. Dinnerware (陶瓷餐具)?
iii. Irregular-shape parts with thin walls?

Q5. (10 marks)

- (a) Write the coordinates for all of the tetrahedral interstitial sites in the FCC crystal structure.
(b) Calculate the number of octahedral sites that uniquely belong to one FCC unit cell.

Q6. (15 marks)

Please calculate the amounts of Fe_3C and pearlite in steels containing 0.2% C, 0.4% C, 0.8% C, and 1.2% C. Then plot the % of Fe_3C and % of pearlite versus the carbon content. (You need to know the iron-carbon phase diagram to answer this question.)

Q7. (5 marks)

- * Describe a simple test to separate high-nickel stainless steel from low-nickel stainless steel.

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Q9. (25 marks)

<i>Material</i>	<i>Tensile Modulus MPa</i>	<i>Tensile Strength MPa</i>	<i>Elongation at Break(%)</i>
Polyethylene (low density)	0.17-0.28	8.3-31.4	100-650
Polyethylene (high density)	1.06-1.09	22.1-31.0	10-1200
Polyvinyl chloride	2.4-4.1	40.7-51.7	40-80
Polytetrafluoroethylene	0.40-0.55	20.7-34.5	200-400
Polypropylene	1.14-1.55	31-41.4	100-600
Polystyrene	2.28-3.28	35.9-51.7	1.2-2.5
Polymethyl methacrylate	2.24-3.24	48.3-72.4	2.0-5.5
Phenol-formaldehyde	2.76-4.83	34.5-62.1	1.5-2.0
Nylon 6,6	1.58-3.80	75.9-94.5	15-300
Polyester (PET)	2.8-4.1	48.3-72.4	30-300
Polycarbonate	2.38	62.8-72.4	110-150

Room-temperature mechanical properties of some common polymers are listed in the table. Polyethylene (low density), polyethylene (high density), polytetrafluoroethylene, polypropylene, nylon 6,6, polyester (PET), and polycarbonate are semi-crystalline polymers. Polyvinyl chloride, polystyrene, polymethyl methacrylate, phenol-formaldehyde are amorphous polymers.

- (1) Why are tensile moduli of polymers listed in the table about same? 5%
- (2) Why is the elongation at break of polystyrene much less than it of polypropylene? 5%
- (3) Why is the tensile modulus of polyethylene (low density) less than it of polyethylene (high density)? 5%
- (4) Is the glass transition temperature of phenol-formaldehyde less or greater than room temperature? Explain it. 5%
- (5) Give two methods to increase the tensile modulus of polypropylene without the modification of chemical structure. 5%

Q8. (10 marks)

For a polymer-matrix glass-fiber-reinforced composite, list functions of the matrix phase.