

國立成功大學

111學年度碩士班招生考試試題

編 號：93

系 所：材料科學及工程學系

科 目：材料科學

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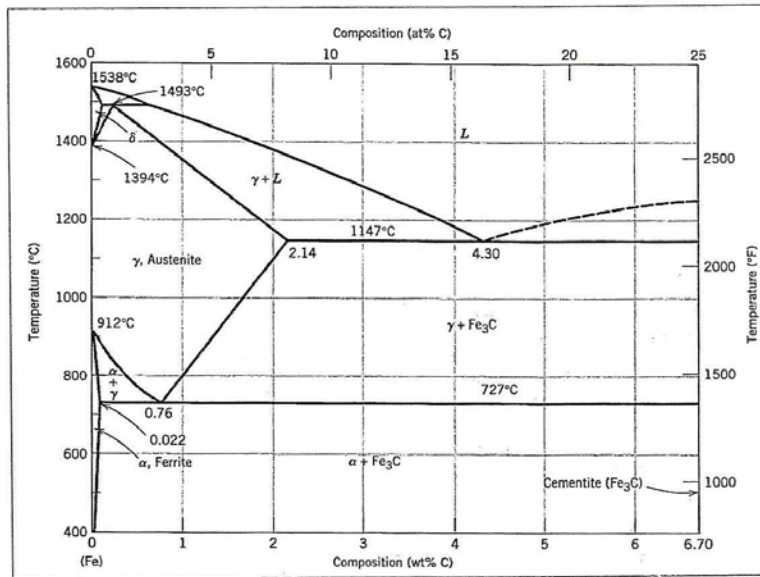
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備 註：可使用計算機

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。材料科學共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

1. Fatigue is the general phenomenon of material failure after several cycles of loading to a stress below the tensile strength. Which statement is correct about fatigue? (a) Ferrous alloys show a characteristic fatigue strength. (b) The rate of crack growth is a function in a simple power law of the stress-intensity factor range. (c) Non-ferrous alloys show an unclear fatigue strength. (d) The fatigue cracks occur at the stress intensity factor larger than the fracture toughness.
2. For a glass subjected to a tensile test, fractures occur without any prior yielding under the normal stress corresponding the ultimate strength σ_0 of the glass. Taking the maximal strength of fracture as σ_0 for the glass, predict which of applied stressing is safe without fracture? (a) The applied normal stress in a tension test is equal to σ_0 . (b) Applied shear stresses in a torsion test are equal to σ_0 . (c) An applied normal stress in a compression test is equal to σ_0 . (d) A applied flexure stress in a four-point bending test at the top surface on the middle position between two applied forces is equal to σ_0 .
3. Which one is not the key factor that affects creep in materials? (a) grain size (b) micro-structure (c) previous strain history (d) stacking faults.
4. For a cold-worked metal, the recrystallized grain size is insensitive to (a) initial grain size (b) purity of the metal (c) amount of deformation (d) annealing temperature.
5. Which of the following statements is wrong? (a) Reactions that occur spontaneously are always irreversible. (b) The entropy is a function of state. (c) Gibbs free energy can be used to predict the reaction rate. (d) Gibbs free energy change is zero for any reversible reaction that takes place at constant temperature and pressure.
6. The degree of freedom for a two-component system with only one phase is (a) 3 (b) 2 (c) 1 (d) 0.
7. Which of the following statements about Gibbs free energy is incorrect? (a) Gibbs free energy is a function of composition, temperature and pressure. (b) Gibbs free energy increases with increasing temperature. (c) At low temperatures, enthalpy has more influence on Gibbs free energy. (d) At high temperatures, entropy has more influence on Gibbs free energy.
8. Which one of the following is CORRECT lattice parameter relationship of a HEXAGONAL structure? (a) $a = b = c$, $\alpha = \beta = \gamma = 90^\circ$ (b) $a \neq b \neq c$, $\alpha = \beta = \gamma = 90^\circ$ (c) $a = b \neq c$, $\alpha = \beta = \gamma = 90^\circ$ (d) $a = b \neq c$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$.
9. As the molecular weight decrease, the tendency of a polymer to crystallize (a) decrease (b) increase (c) remain the same (d) disappear.
10. How to introduce an impurity ion having a charge different from the host ions in ceramics? (a) formation of lattice defects (b) removal of twin boundary (c) formation of additional element (d) None of them.
11. Which of the following statement about the "theoretical shear stress of single crystal" is correct: (a) the theoretical shear stress will increase as the shear modulus increases. (b) the theoretical shear stress will increase as the temperature increases. (c) the theoretical shear stress will increase as the inter-planar distance increases. (d) the theoretical shear stress is independent of the inter-atomic potential well.

12. Which of the following statement about "vacancy in a crystal" is correct. (a) the existence of vacancy in the crystal lattice will increase the internal energy of the crystal. (b) the equilibrium vacancy concentration (V_c) can be expressed as $V_c = \exp(-\Delta H/Kt)$, where ΔH = formation energy of vacancy, K = Boltzmann constant, and t = time. (c) the slow cooling process from liquid to solid will trap a lot of vacancy in the solidified crystal. (d) the primary terms considered in the derivation of equilibrium vacancy concentration are entropy of mixing and enthalpy for the formation of vacancy.
13. Which one of the following is the eutectic reaction? C_E is the eutectic composition. L is the liquid phase. (a) $L(C_E) \rightarrow \alpha(C_{\alpha E}) + \beta(C_{\beta E})$ (b) $L(C_E) \rightarrow \gamma(C_{\gamma E}) + L(C_E)$ (c) $L(C_E) \rightarrow \alpha(C_{\alpha E})$ (d) $L(C_E) \rightarrow \beta(C_{\beta E}) + L(C_E)$.
14. Consider 3.5 kg of austenite containing 0.95 wt% C, cooled to below 727°C. How many kilograms of pearlite form? (a) 0.11kg (b) 3.4kg (c) 1.8kg (d) 2.9kg



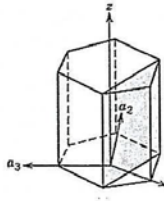
15. Failure due to excessive deformation is controlled by: (a) Yield strength (b) Tensile strength (c) Young's modulus (d) compressive strength
16. Which of the following statement is support about shortening the holding time of heat- treatment under an identical holding temperature? (a) deformation (b) quenching (c) refining (d) inoculation.
17. What is the diameter after 25% cold work is applied on a cylindrical rod of noncold-worked steel with a diameter of 7 mm? (a) 5 mm (b) 5.25 mm (c) 5.6 mm (d) 6.1 mm.
18. Which of following statement is correct? (a) Diamond has a high thermal conductivity because it belongs to carbon materials; (b) Diamond has a low electrical conductivity due to the strong interatomic ionic bonds;

- (c) Diamond has a low electrical conductivity due to the strong interatomic covalent bonds; (d) Diamond has a low thermal conductivity due to the weak van der Waals bond.
19. What is Schottky defect in ceramics? (a) It involves a cation–vacancy and a cation–interstitial pair; (b) It was created by removing one cation and one anion from the interior of the crystal and then placing them both at an external surface; (c) It exists when there are equal numbers of positive and negative charges from the ions; (d) None of them above.
20. About surface energy, which of the following statement are true?
1. The surface energy will be greater for an FCC (100) plane than for a (111) plane.
 2. The surface energy will be lower than the grain boundary energy.
 3. The surface energy increase with an increase in planar density.
 4. The small angle grain boundary energy will be lower than for a high angle one.
- (a) 1 & 2 (b) 2 & 3 (c) 3 & 4 (d) 1 & 4.
21. Which direction of Iron exhibits the largest Modulus of Elasticity? (a) [100] (b) [110] (c) [111] (d) None of them.
22. A hypothetical A-B alloy of composition 40 wt% B-60 wt% A at some temperature is found to consist of mass fractions of 0.66 and 0.34 for the α and β phases, respectively. If the composition of the α phase is 13 wt% B-87 wt% A, what is the composition of the β phase(in wt% B)? (a)92.4 (b)35.7 (c)25.6 (d)16.8.
23. How the porosity affects the flexural strength of ceramics? (a) Pores may reduce the cross-sectional area across which a load is applied; (b) Pores may increase the cross-sectional area across which a load is applied; (c) Pores may release the stress inside ceramics; (d) Pores may increase the lattice displacement.
24. Which one is not found after cooling in hypereutectoid plain-carbon steels? (a)austenite (b)pearlite (c)cementite (d)ferrite.
25. What is called as K_{Ic} ? (a) stress-intensity factor (b) fracture toughness (c) theoretical cohesive strength (d) stress-concentration factor.
26. PbTe alloys are one of the most promising TE materials for power generation in intermediate temperature range, which has been used to provide power for space crafts. PbTe has sodium chloride structure and deforms on {110}<1-10> slip systems. Show the number of slip systems for it. (a) 4 (b) 6 (c) 8 (d) 12.
27. Visco-elastomeric materials are employed in applications of noise and vibration isolators in machinery and the automotive and aerospace industry, bridge bearings and seismic shock absorbers in civil engineering applications as well as soft robotics, which exhibit both viscous and elastic characteristics under undergoing deformation. Which one does not belong to viscoelastic materials? (a) plexiglass (b) soda-lime-silica glass (c) silica (d) rubbery.
28. What is the ideal c/a ratio in HCP crystal structure? (a) 2 (b) 1.732 (c) 1.633 (d) 1.5.

29. Assume p is the number of phases present, F is the number of degrees of freedom, C is the number of components in the system, N is the number of noncompositional variable, the Gibbs phase rule can be expressed as (a) $P+C = F+N$ (b) $P+N = F+C$ (c) $P+F = C+N$ (d) $P = F+C+N-1$.

30. Metals does not exist in nature in the form of (a) Nitrates (b) Sulphates (c) Carbonates (d) Oxides.

31. Which one of following is the CORRECT Miller indices for the plane shown in the hexagonal unit cell?



(a) $(2\bar{1}10)$ (b) $(2\bar{1}\bar{1}0)$ (c) $(12\bar{1}0)$ (d) $(1\bar{2}10)$.

32. Which of following exhibit the largest fracture toughness? (a) aluminum alloy (b) SiC (c) polystyrene (d) glass.

33. Determine the number of Pt atoms per cubic centimeter for a 3 at% Pt-97 at% Cu solid solution. (Atomic weight: Pt 195.08 g/mol, Cu 63.55 g/mol; Density of pure metal: Pt 21.45 g/cm³, Cu 8.96 g/cm³.) (a) 5×10^{22} atoms/cm³ (b) 2.5×10^{22} atoms/cm³ (c) 5×10^{21} atoms/cm³ (d) 2.5×10^{21} atoms/cm³.

34. Which of the following processes will create the highest dislocation density: (a) cold work (b) annealing (c) solidification (d) hot rolling

35. Which of the following statement is support about enlarging the solid solution limit of the alloy?

(a) raised up heating temperature (b) deformation (c) aging (d) tempering.

36. Which one is the correct statement? (a) Increasing the temperature increases the recrystallization time.

(b) Increasing the degree of deformation increases the recrystallization time. (c) Increasing the degree of deformation reduces the recrystallization temperature. (d) Increasing the purity of the metal increases the recrystallization temperature.

37. Among engineering materials of light alloys, aluminum has been widely applied in the transportation, construction, and packaging industries. Considering pure aluminum, we want to produce high tensile strength by achieving with the thermo-mechanical (TM) process, that is, with rolling and annealing processes. How can we achieve it by the following annealing process after heavy rolling to retain the deformed microstructure? (a) at far below 1/3 melting temperature (b) at 1/3 melting temperature (c) at 3/4 melting temperature (d) at melting temperature.

38. Slip in a single crystal commences on the most favorably oriented slip system. What is the minimum yield stress (σ_y) required to reach the critical resolved shear stress τ_{crss} so that the dislocations start to slip? (a) $\sigma_y = \tau_{crss}$ (b) $\sigma_y = 2\tau_{crss}$ (c) $\sigma_y = 3\tau_{crss}$ (d) $\sigma_y = 4\tau_{crss}$.

39. For isotropic materials, shear (G) and elastic moduli (E) are related to each other and to Poisson's ratio (ν) according to (a) $G = 2E(1 - \nu)$ (b) $G = 2E(1 + \nu)$ (c) $E = 2\nu(1 + G)$ (d) $E = 2G(1 + \nu)$.

40. When a tensile stress is applied along the [010] direction of a single crystalline BCC iron, please calculate the solved shear stress along the [-111] direction on the (110) plane if the applied tensile stress is 97.9 MP. (a) 20 MPa (b) 40 MPa (c) 60 MPa (d) 80 MPa.
41. Which one of the following chainlike paraffin molecules has the highest boiling point (°C)? (a) CH₄ (b) C₂H₆ (c) C₃H₈ (d) C₄H₁₀.
42. In the same crystal system, coherent and incoherent interface forces are balance, who help this balance? (a) tension (b) shear (c) torque (d) activation energy.
43. What type of protection is galvanizing? (a) physical protection (b) thermal protection (c) chemical protection (d) sacrificial protection.
44. For eutectic solidification, the rate of grows depend on: (a) heat flow (b) the critical nucleus size (c) lamellar spacing (d) melting temperature.
45. Secondary ion mass spectrometry can be used to measure the concentration profile of Ge isotope heterostructures. By performing these measurements after various annealing treatments, we are able to determine the diffusion coefficient. The sample consists of a thin layer of ⁷⁴Ge between two thick layers of ⁷⁰Ge. The concentration of ⁷⁴Ge as a function of time and position is given by $c(z, t) = \frac{m}{\sqrt{4\pi Dt}} \exp\left(-\frac{z^2}{4Dt}\right)$. The width of ⁷⁴Ge during an anneal of duration t is defined by $w = 2\sqrt{2Dt}$, the distance between inflection points. The parameters D₀ and Q for Ge are 4.4 × 10⁻³ m²/s and 324545 J/mol. Find the temperature that will result in a width of 0.1 μm during a 1 hour anneal. (a) 780°C (b) 915°C (c) 1050°C (d) 1185°C.
46. Rank the radius of an impurity that just fit into the interstitial site of the following metals with atomic radius 0.128nm for Cu (FCC), 0.126nm for Fe (BCC), 0.144nm for Ag (FCC), 0.186nm for Na (BCC). (a) Ag > Na > Fe > Cu (b) Ag > Na > Cu > Fe (c) Na > Ag > Cu > Fe (d) Na > Ag > Fe > Cu.
47. Which of the following statements about recovery is incorrect? (a) Some internal strain energy is relieved. (b) decrease of dislocation number (c) Grains are in low strain energy state. (d) Physical properties are recovered to their precold-worked states.
48. Diffractometer is one of common diffraction technique used to measure (a) wavelength (b) diffraction angle (c) X-ray intensity (d) diffraction order.
49. The grain boundary diffusion rate is fast, under what condition is it not true? (a) over heating (b) high concentration (c) recrystallization (d) up hill diffusion.
50. How much nitrogen content should be maintained at the surface of steel to reach a half surface concentration condition of nitrogen at 0.3 mm below the steel surface under 700°C heat treatment for 3750 sec. The intrinsic nitrogen concentration in steel is 0.02 wt% and the diffusion coefficients for nitrogen in iron at 700°C is 2.4 × 10⁻¹¹ m²/s. The tabulation of error function is included as reference. (a) 0.42 wt% (b) 0.48 wt% (c) 0.52 wt% (d) 0.6 wt%.

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0.04	0.045111106
0.06	0.067621594
0.08	0.090078126
0.1	0.112462916
0.2	0.222702589
0.3	0.328626759
0.4	0.428392355
0.5	0.520499878
0.6	0.603856091
0.7	0.677801194
0.8	0.742100965
0.9	0.796908212
1	0.842700793