國立成功大學

110學年度碩士班招生考試試題

編　號：92

系　所：材料科學及工程學系

科　目：材料科學

日　期：0202

節　次：第 3 節

備　註：可使用計算機

編號： 92　　國立成功大學 110 學年度碩士班招生考試試題

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※ 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. Which of the following effects can demonstrate that the substitutional diffusion of alloys results from vacancy mechanism?
   (a) Darken effect　(b) Matano effect　(c) Snoek effect　(d) Kirkendall effect.

2. Corrosion is a chemical reaction that involves
   (a) the bulk of the object changing from an element to a compound
   (b) the surface of the object changing from an element to a compound
   (c) the environment of the object changing from one compound to another compound
   (d) the bulk of the object changing from one element to another element
   (e) the surface of the object changes from one element to another element.

3. Rapidly freeze the materials favors the formation of a _____ solid.
   (a) crystalline　(b) dense　(c) noncrystalline　(d) ductile.

4. 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 (Vc) can be expressed as $Vc = \exp(-\triangle H/Kt)$, where $\triangle H$ = 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 plastic deformation of metals (e.g. hot rolling) will create significantly excess concentration of vacancy than that of equilibrium vacancy concentration.
   (e) the primary terms considered in the derivation of equilibrium vacancy concentration are entropy of mixing and enthalpy for the formation of vacancy.

5. What is the secondary recrystallization?
   (a) abnormal grain growth　(b) increase the number of grains
   (c) increase the total grain-boundary energy　(d) stress release.

6. As the molecular weight increase, the tendency of a polymer to crystallize
   (a) decrease　(b) increase　(c) remain the same　(d) disappear.

7. Calculate the resolved shear stress on the (1 1 1) [0 -1 1] slip system for copper single crystal, if a stress of 20 MPa is applied in the [0 0 1] direction.
   (a) 3.4MPa　(b) 5.4MPa　(c) 7.4MPa　(d) 9.4MPa　(e) 11.4MPa.

8. Which of the following statement about "dynamic recovery" is correct:
   (a) dynamic recovery will increase the dislocation density and strength.
   (b) dynamic recovery typically occurs at lower temperature compared with that of static recovery.
   (c) dynamic recovery is much easier to occur for BCC crystals compared with that of FCC crystals.
   (d) dynamic recovery typically occurs in the aging process.
   (e) the primary mechanism involved in dynamic recovery is dislocation cross-slip.

9. The impact strength of a polymer is measured as
   (a) elasticity (b) yield strength (c) creep (d) permeability (e) toughness

10. The following five values of Rockwell B hardness were measured on a steel: 80.7, 84.4, 87.2, 86.2 and 88.3. Determine the standard deviation values of hardness.
   (a) 2.65 (b) 2.97 (c) 5.93 (d) 5.34 (e) 2.42

11. Carbon is allowed to diffuse through a steel plate 10 mm thick. The concentrations of carbon at the two faces are 0.85 and 0.40 kg C/cm^3 which are kept constant. If the preexponential and activation energy are 6.2 x 10^{-7} m^2/s and 80,000 J/mol, respectively, compute the temperature at which the diffusion flux is 6.3 x 10^{-10} kg/m^2-s.
   (a) 300K (b) 600K (c) 900K (d) 1200K

12. Which is the highest strain energy precipitate?
   (a) Disk (b) Sphere (c) Needle (d) Plate.

13. For eutectic solidification, the rate of grows depend on:
   (a) heat flow (b) the critical nucleus size (c) lamellar spacing (d) melting temperature.

14. The number of vacancies in solids
   (a) increases linearly with temperature
   (b) increases exponentially with temperature
   (c) is independent to the temperature
   (d) decreases linearly with temperature
   (e) decreases exponentially with temperature.

15. Which of the following statement is support about the strain hardening effect
   (a) oversaturated solid solution (b) precipitations (c) deformation (d) diffusion.

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16. What is the order of surface energy (γ) of different surfaces in iron crystal?
    (a) γ (111) > γ (110) > γ (100)　　(b) γ (110) > γ (111) > γ (100)
    (c) γ (100) > γ (111) > γ (110)　　(d) γ (110) > γ (100) > γ (111).

17. For the crystal structure of sodium chloride, what is the coordination number for cations (X) and anions (Y). (Represented in the form of (X ,Y))
    (a) (4,4)　(b) (6,6)　(c) (8,8)　(d) (8,4)

18. Two edge dislocations which are side by side at the same slip plane with opposite Burgers factor will
    (a) Attract each other　(b) Release stress in grain　(c) Disappear finally　(d) All of above.

19. Which of the following statement is support about the eutectoid composition?
    (a) Aluminum alloy　(b) low carbon steel　(c) high carbon steel　(d) stainless steel.

20. Estimate the yield stress (in MPa) of the material using Vickers hardness test under 500g with the length of diagonal 250 μm.
    (a) 48.5　(b) 14.8　(c) 4.9　(d) 145.4　(e) 65.3.

21. 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

22. Calculate the fracture toughness K_{IC} ($MPa.m^{-1/2}$) for a 0.45C-Ni-Cr-Ti steel having a flaw size of 4.8 mm and a yield strength of 760 MPa.
    (a) 26　(b) 36　(c) 46　(d) 56　(e) 66.

23. Which of the following statement is not support about the dominant factor of increasing hardness and strength of an oversaturated solid solution aluminum alloy pertaining to artificial aging
    (a) diffusional phenomenon　(b) GP zone
    (c) strain induced phenomenon　(d) precipitation hardening

24. A twin boundary is
    (a) a special type of grain boundary　(b) a specific mirror lattice symmetry
    (c) resulted from atomic displacements　(d) an interfacial defect　(e) all of them.

25. What is the c/a ratio of the HCP crystal structure < 1.63?
(a)Cobalt (b)zirconium (c)magnesium (d)zinc (e)cadmium.

26. Why does not consider the grain boundary diffusion under high temperature condition for metal materials:
(a) coarse grains (b) segregation (c) recrystallization (d) high temperature brittleness.

27. Which one of the following carbon allotropes composed of a closely packed **SINGLE** layer of carbon atoms with sp^2 hybridization, forming a 2D honeycomb lattice plane?
(a) graphite (b) graphene (c) fullerene (d) carbon nanotube (e) diamond.

28. Which of the following structure is more effective to stop dislocation movement?
(a) Low-angle boundaries (b) High-angle boundaries (c) Coherent boundaries
(d) semi-coherent boundaries (e) Twin boundaries

29. What is the measured stress at onset of plastic deformation?
(a) fracture stress (b) ultimate tensile stress (c) maximum stress
(d) principal stress (e) yield strength.

30. Which one is not found after cooling in hypereutectoid plain-carbon steels?
(a) austenite (b) pearlite (c) cementite (d) ferrite (e) bainite.

31. 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.

32. For a binary solid solution with two different inter-diffusing coefficients, which of the following equations is used to describe the net flux of vacancy into the diffusion bonding interface?
(a) Darken's equation (b) Arrhenius' equation (c) Avrami equation (d) Fick's 1^{st} law equation.

33. Fick's second law is derived from
(a) interstitial diffusion mechanism (b) conservation of matter
(c) thermodynamic first law (d) thermodynamic second law.

34. In a 10cm x 10cm TEM photograph from a metallic foil of 200 nm thickness, the total dislocation length of dislocations at a magnification of 100,000 X is 400 cm. Determine the dislocation density in the foil.
(a) $2 \times 10^{14}\ m^{-2}$ (b) $1 \times 10^{14}\ m^{-2}$ (c) $4 \times 10^{14}\ m^{-2}$ (d) $1 \times 10^{10}\ m^{-2}$ (e) $2 \times 10^{10}\ m^{-2}$

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35. Which one of the following is CORRECT lattice parameter relationship of a CUBIC structure?
(a) $a = b = c$, $\alpha = \beta = \gamma = 90^\circ$ (b) $a = b = c$, $\alpha = \beta = \gamma \neq 90^\circ$ (c) $a \neq b \neq c$, $\alpha = \beta = \gamma = 90^\circ$
(d) $a = b \neq c$, $\alpha = \beta = \gamma = 90^\circ$ (e) $a = b \neq c$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$.

36. The diffusion coefficient for copper in aluminum at 500 and 600℃ are 4.8×10^{-14} and 5.3×10^{-13} m^2/s, respectively. Determine the approximate time at 500℃ that will produce the same diffusion result (in terms of concentration of Cu at some specific point in Al) as a 10-h heat treatment at 600℃.
(a) 50.1h (b) 23.7h (c) 13.5h (d) 110.4h

37. Which one of the following has the highest degree of crystallinity?
(a) Metallic Glass (b) Kaolinite Clay (c) Amorphous Carbon (d) Poly(vinyl chloride) (e) Water.

38. Which one shows a distinguished temperature transition from brittle to ductile?
(a) Low carbon steels (b) aluminum alloys (c) copper alloys
(d) high strength steels (e) austenitic stainless steels.

39. The diffusion coefficient is lower at low temperature, which of the following method is used to measure the diffusion of carbon in steel at room temperature?
(a) Torsion pendulum (b) trace element (c) diffusion couple
(d) Matano method (e) Darken's method

40. What type of protection is galvanizing?
(a) physical protection (b) thermal protection (c) chemical protection
(d) sacrificial protection (e) physical and sacrificial protection

41. Which of the following statement about "creep" is correct.
(a) Creep deformation of metal occurs at temperature lower than 30% of its melting temperature.
(b) Creep deformation of metal is related to the dislocation motion, vacancy diffusion, and grain boundary sliding.
(c) Creep rate is independent of the stress applied.
(d) The characterized "creep strain rate" typically refers to the rate in this initial stage.
(e) The most common cause of structural failure in aircraft is due to creep.

42. Which one of following substances is NOT bounded by covalent bonding?
(a) CH_4 (b) H_2 (c) Si (d) H_2O (e) NaCl.

43. The activation energy is an important parameter related to diffusion coefficients. Which of the following four conditions has the largest activation energy?
(a) Mn atom on the ferrite grain boundary (b) Carbon atom in the ferrite grain
(c) Mn atom in the surface of MnS inclusion (d) Mn atom in the ferrite grain.

44. For the BCC crystal structure, the Miller indices (h, k, and l) of planes must be _____ if diffraction is to occur.
(a) h, k, l are all even (b) h+k+l must be even (c) h+k+l must be odd (d) none of them.

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

46. Which of the following statements about heat treating is incorrect ?
(a) the composition of a precipitation-hardenable alloy must be less than the maximum solubility.
(b) stress relief annealing heat treatment in which the piece is heated to the recommended temperature, held there long enough to attain a uniform temperature, and finally cooled to room temperature.
(c) the influence of alloy composition on the ability of a steel alloy to transform to martensite for a particular quenching treatment is related to a parameter called hardness.
(d) air cooling of austenitized plain carbon steels ordinarily produces an almost totally pearlitic structure.
(e) reduction in strength and hardness that occurs after long time periods is known as overaging.

47. Calculate the stored energy (J/m^3) in a copper crystal with a dislocation density of $10^{11}cm^{-2}$ and G= 48 GPa and a lattice constant a = 0.36nm.
(a) $1.5x10^3$ (b) $1.5x10^4$ (c) $1.5x10^5$ (d) $1.5x10^6$ (e) $1.5x10^2$.

48. 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.

49. In comparison with the thermoset and thermoplastic polymers, which one is the advantage of thermoplastic?
(a) easier process (b) better solvent resistance (c) better heat resistance (d) better cool process.

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50. If D denotes diffusivity and C denotes concentration, the activation energy for diffusion can be obtained with a plot of

(a) InC vs 1/T　　(b) InC vs T　　(c) InD vs T　　(d) InD vs 1/T