國立成功大學 107 學年度碩士班招生考試試題

系　　所：材料科學及工程學系

考試科目：材料科學　　考試日期：0205，節次：3

※ 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 material has the highest melting point?

(a) Cristobalite　(b) mullite　(c) alumina　(d) zirconia

2. There are some properties of glass below, please choose the incorrect statement.

(a) The index of refraction is the same in any direction.

(b) It shows a non-equilibrium state, which called meta-stable.

(c) There is a certain melting point to transform from solid to liquid.

(d) A non-crystalline ceramic transforms from a super-cooled liquid into a rigid glass at glass transition temperature.

3. The crystal structure of UO2 is fluorite. What is the coordination number for each cation and anion in UO2?

(a) 4 , 8　(b) 6 , 6　(c) 4 , 4　(d) 8 , 4

4. Which material has the largest electrical resistivity ?

(a) Diamond　(b) graphite　(c) carbon nanotube　(d) graphene

5. The ionic radius of Na^+ and Cl^- are 0.102 nm and 0.181 nm, respectively. What is the theoretical density for NaCl ? (Molecular weight　Na : 22.99　Cl : 35.45)

(a) 1.64　(b) 2.14　(c) 2.64　(d) 3.14　g/cm3

6. Which following statement is incorrect?

(a) Glass-ceramics may not be transparent because they are polycrystalline.

(b) Glass-ceramics may be transparent in the size of the crystals are smaller than the wavelength of visible light.

(c) Glass-ceramics can be used as ovenware because of their low coefficients of thermal expansion.

(d) none of above

7. For the $MgO–Al_2O_3$ system, what is the maximum temperature that is possible without the formation of a liquid phase?

(a) 2800°C　(b) 2050°C　(c) 1890°C　(d) 1600°C

8. Which common ceramic materials have the highest flexural strength?

(a) zirconia　(b) alumina　(c) mullite　(d) fused silica

9. Which kind of material has highest index of refraction?
   (a) Corundum (Al_2O_3) (b) Polypropylene (c) Copper (d) Silver

10. The minimum wavelength and the minimum wave length for visible light is about 0.4 μm and 0.7 μm, respectively. Assume that the velocity of light is a constant of 3.0×10^{8} m/s and Planck's constant is 4.13×10^{-15} eV-s. What kind of material will appear colored?
   (a) The material with band gap of 1.0 eV (b) The material with band gap of 2.0 eV
   (c) The material with band gap of 3.2 eV (d) The material with band gap of 3.5 eV

11. What kind of optical fiber can has largest intensity of output impulse?
   (a) Step-index optical fiber with high index material in core
   (b) Graded-index optical fiber with high index material in core
   (c) Step-index optical fiber with low index material in core
   (d) Graded-index optical fiber with low index material in core

12. Which kind of material is most likely a hard magnetic material?
   (a) pure copper
   (b) single crystal iron
   (c) very fine single domain iron-cobalt particle within a non magnetic matrix phase
   (d) iron ingot with large grain size

13. Which kind of material has highest thermal conductivity?
   (a) Alumina (b) Teflon (c) Soda-lime glass (d) Aluminum

14. Which kind of material has high electrical conductivity at high temperature but low electrical conductivity at low temperature?
   (a) Silicon (b) Silver (c) Silica (d) polyethylene

15. The room-temperature electrical conductivity if intrinsic silicon is 4×10^{-4} $(\Omega\text{-m})^{-1}$. An extrinsic p-type silicon material is desired having a room-temperature conductivity of 150 $(\Omega\text{-m})^{-1}$. Specify an impurity type as well as its concentration in atom percent to yield these electrical characteristics?
   (a) 1.34×10^{-5} at% of Phosphorus (b) 6.7×10^{21} at% of Arsenic
   (c) 1.34×10^{-5} at% of Boron (d) 6.7×10^{21} at% of Aluminum

16. parallel-plat capacitor having an area of 6.45×10^{-4} m^2 and a plate separation of 2×10^{-3} m across which a potential of 10 V is applied. If a material having dielectric constant of 6.0 is positioned within the region between the plates, what is the magnitude of the charge stored on each plate?
   (a) 1.71×10^{-10} C (b) 1.71×10^{-9} C (c) 1.71×10^{-8} C (d) 1.71×10^{-7} C

17. What is the origin of thermal expansion in solids?
(a) asymmetric curvature of potential energy between bonding atoms
(b) vibration of atoms
(c) heat conduction in solids
(d) diffusion of atoms

18. Which structure is for a stainless steel 430 with 25 %Cr and 0.20 %C?
(a) fcc (b) fct (c) bct (d) bcc

19. Give the structure of a stainless steel 304 with 19 %Cr and 10 % Ni.
(a) bcc (b) bct (c) fcc (d) fct

20. Which metal is not suitable for cold working?
(a) Aluminum (b) nickel (c) magnesium (d) copper

21. What is the carbon content of a hypoeutectic plain carbon steel containing 9.1% eutectoid ferrite?
(a) 0.1% (b) 0.2% (c) 0.3% (d) 0.4%.

22. A 0.4% C hypoeutectic plain carbon steel is slowly cooled from 940°C to a temperature below 723°C. What is the weight percent eutectoid cementite?
(a) 2.7% (b) 3.7% (c) 4.7% (d) 5.7%.

23. Which of the following fiber/matrix combination has potential to fabricate a composite with 0 thermal expansion coefficient?
(a) glass fiber/epoxy (b) SiC fiber/Al (c) graphite/Al (d) PU fiber/Al

24. Which of the following fiber is more suitable for strengthening ceramics
(a) Kevlar 49 (b) E-glass (c) graphite (d) SiC

25. The drawback of graphite is its resistance to
(a) high temperature (b) thermal shock (c) high temperature corrosion (d) corrosion

26. Which material is mostly used for constructing the Boeing 787 Dreamliner
(a) fiberglass composite (b) Aluminum (c) Titanium (d) carbon composite

27. To strengthen the composite, the reinforcement of a composite must
(a) have higher strength than matrix
(b) have higher strength and stiffness than the matrix
(c) have higher stiffness than the matrix
(d) have perfect bonding with the matrix so that there will be no resistance during load transfer

28. The major disadvantage to polymeric materials is:
(a) temperature sensitivity (b) light weight (c) compatibility to other materials (d) electric insulation

29. Conductive polymers require:
(a) large amount of lone pairs (b) high molecular polarity
(c) long conjugation length (d) short carbon-to-carbon distance

30. Which one is not considered as a biopolymer?
(a) Polypeptide (b) Polythiophene (c) Poly-L-lactic Acid (PLLA) (d) Cellulose

31. Viscoelasticity of polymeric materials encourages unique physical responses, such as deformation, relaxation, crazing, and more. Important factors to viscoelasticity do NOT include:
(a) Time (b) Temperature (c) Frequency (d) Isotope

32. For a typical polymer with molecular weight distribution, which molecular weight determination gives the highest molecular weight?
(a) the viscosity-average molecular weight (b) the number-average molecular weight
(c) the weight-average molecular weight (d) the atom-average molecular weight

33. Frenkel defect is
(a) a cation-vacancy and a cation-interstitial pair (b) a cation-vacancy and an anion vacancy pair
(c) an anion-vacancy and a cation-interstitial pair (d) a cation-interstitial and an anion interstitial pair

34. A Schottky defect is
(a) a cation-vacancy and a cation-interstitial pair (b) a cation-vacancy and an anion vacancy pair
(c) an anion-vacancy and a cation-interstitial pair (d) a cation-interstitial and an anion interstitial pair

35. What time will be required at 600 °C to produce the same diffusion result (in terms of concentration at a specific point) as for 10 h at 500 °C? ($D_{600} = 4.69 \times 10^{-13}$ m^2/s, $D_0 = 6.5 \times 10^{-5}$ m^2/s, Q_d = 136,000 J/mol, R = 8.31 J/mol×K)
(a) 0.88 h (b) 1.15 h (c) 1.78 h (d) 2.13 h

36. Consider the diffusion of water vapor through a polypropylene (PP) sheet 2 mm thick. The pressures of H_2O at the two faces are 1 kPa and 10 kPa, which are maintained constant. Assuming conditions of steady state, the diffusion flux [in (cm^3 STP) / cm^2xs] at 298 K is (The permeability coefficient of H_2O through PP is 3 x 10^{-13} (cm^3 STP) cm / cm^2xs xPa)
(a) 1.71 x 10^{-7} (b) 2.13 x 10^{-7} (c) 3.57 x 10^{-7} (d) 3.89 x 10^{-7}

37. At room temperature, a typical vibrational frequency of atoms is on the order of
(a) 10^{10} vibrations/s (b) 10^{11} vibrations/s (c) 10^{12} vibrations/s (d) 10^{13} vibrations/s

38. At room temperature, a typical vibrational amplitude of atoms is on the order of
(a) a few thousandths of a nanometer (b) a few hundredths of a nanometer
(c) a few tenths of a nanometer (d) a few nanometers

39. For an ASTM grain size of 8, approximately how many grains would there be per square centimeter at magnification of 100x:
(a) 15.8 (b) 17.8 (c) 19.8 (d) 21.8

40. For a steel alloy it has been determined that a carburizing heat treatment of 10-h duration will raise the carbon concentration to 0.45 wt% at a point 2.5 mm from the surface. Estimate the time necessary to achieve the same concentration at a 5.0-mm position for an identical steel and at the same carburizing temperature.
(a) 35 h (b) 40 h (c) 45 h (d) 50 h

41. Which is the crystal structure of a silicon wafer for IC
(a) single crystal (b) poly-crystal with columnar structure
(c) poly-crystal with equiaxed grain (d) poly-crystal with hybrid structure

42. Steels which carbon is the primary alloy element are termed
(a) plain carbon steel (b) alloy steel (c) stainless steel (d) die steel

43. Which strengthening mechanism can improve both the strength and ductility
(a)precipitation hardening (b) solution hardening (c) work hardening (d) grain refinement

44. Which facility is commonly employed to reduce iron from iron ore
(a) electric arc furnace (b) blast furnace (c) basic oxygen furnace (d) rotary furnace

45. Which metal is listed in RoHS (Restriction on Hazardous Substances) by the European Union
(a) tin (b) zinc (c) indium (d) lead

46. Which one is the hardest phase in steel
(a) pearlite (b) ferrite (c) austenite (d) martensite

47. Which one of the following materials can be used at very high temperature and still electrically conductive?
(a) copper (b) plastics (c) MgO (d) graphite

48. Which of the following statement is not support about the static recrystallization structure?
(a) A higher hardness (b) higher ductility (c) higher formability (d) higher conductivity

49. 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

50. Which of the following statement is support about increasing the diffusivity pertaining to the pipe diffusion
(a) twining (b) dislocations (c) porosities (d) vacancies