國立成功大學

111學年度碩士班招生考試試題

編　號：96

系　所：材料科學及工程學系
(綠色應用材料碩士班)

科　目：基礎材料科學

日　期：0220

節　次：第 3 節

備　註：可使用計算機

編號： 96　　國立成功大學 111 學年度碩士班招生考試試題

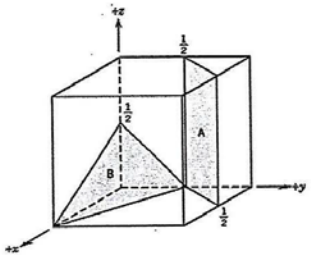
系　　所：材料科學及工程學系(綠色應用材料碩士班)

考試科目：基礎材料科學　　考試日期：0220，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。

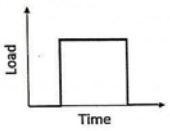
基礎材料科學共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

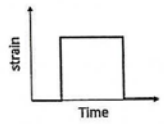
1. Which one of following is the CORRECT Miller indices for the plane B shown in the following unit cell? (a) (122) (b) (211) (c) (111) (d) (221)



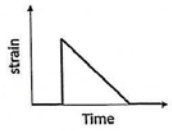
2. Which of the following is not a creep mechanism? (a) Grain growth (b) Thermally activated dislocation glide (c) Dislocation climb (d) Grain boundary sliding.
3. For the heterogeneous nucleation, which of the following show the highest energy barrier (a) Twins (b) screw dislocations (c) point defects (d) grain corners
4. A tension test is carried out on a steel specimen and the values of load is given by: 11.1, 30.9, 35.8, 40.3, 43.7, 53.1, 63.3, 64.1, 62.1 and 58.7 kN. What is the percentage of theses load values being in the range of 18.1 and 83.7? (a) 68% (b) 74% (c) 95% (d) 99.7%.
5. Given the atomic weight of 195.08 g/mol for Pt and 63.55 g/mol for Cu, the wt% of Pt in a 3 at% Pt-97 at% Cu alloy will be? (a) larger than 3 (b) equal to 3 (c) smaller than 3 (d) cannot determine with the provided information.
6. Temperature and time are the two main parameters to reach the designed carbon concentration at specific position during carburizing heat treatment of steel. To reduce the annealing time by a factor of 10, how much the temperature needs to be adjusted from 1000K. The parameters D_0 and Q for carbon diffusion in iron are 2.3×10^{-5} m^2/s and 148000 J/mol respectively. (a) increase by 150 K (b) decrease by 150 K (c) increase by 300 K (d) decrease by 300K.
7. In FCC crystals, it is much easier for the dynamic recovery to occur for a crystal (a) with small stacking fault energy (b) with dislocations that are easier to do cross-slip (c) with high surface energy (d) with small dislocation density.
8. Which one of following substances is NOT bounded by metallic bonding? (a) Li (b) Si (c) Hg (d) Fe.
9. Which of following does not correlate with theoretical density of a metallic solid? (a) atomic weight (b) Avogadro's number (c) volume of the unit cell (d) molecule weight.
10. For a solid, when the periodic and repeated arrangement of atoms is perfect or extends throughout the entirely of the specimen without interruption. This kind of solid is (a) paracrystalline (b) polycrystalline (c) single crystalline (d) noncrystalline.

11. Viscoelastic materials exhibit both viscous and elastic characteristics when undergoing deformation. Which of the following figure is the typical strain-time curve of viscoelastic materials when a squire load-time cycle is applied?

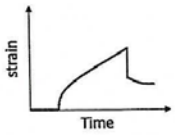




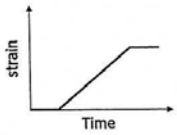
(a)



(b)



(c)



(d)

12. Rank the magnitude of the Burgers vector for 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.
13. Which of following does not correlate with optical transmittance properties? (a) refraction index (b) absorption coefficient (c) dielectric constant (d) None of them.
14. 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) 2×10^{14} m^{-2} (b) 1×10^{14} m^{-2} (c) 4×10^{14} m^{-2} (d) 1×10^{10} m^{-2}.
15. Which one of the following material was commonly used to produce plastic toys? (a) Polystyrene (b) Polyacetylene (c) Polyfluorene (d) Graphene.
16. Which of the following phenomenon can be used to measure the interstitial diffusion coefficient of alloys? (a) Kirkendall effect (b) Darken equation (c) Matano method (d) Frank-Read mechanism
17. Which one of following compounds DO NOT contain sp^3 hybrid orbital? (a) graphite (b) methane (c) silicon (d) ammonia.
18. Which of the following statement about "Self-Diffusion" is correct: (a) the self-diffusion represents the diffusion of impurity atoms in a crystal; (b) the self-diffusion represents the diffusion of interstitials in a crystal; (c) the direction of diffusion flux of vacancy is same as that of self-diffusion; (d) the self-diffusion represents motion of atoms when the chemical potential gradient equals to zero.
19. What is the material most commonly used for optical fiber? (a) Silica (b) Carbon (c) As (d) Ge.
20. For Kirkendall effect, which of the following description is wrong? (a)The region in tension can accompany pore formation. (b)The effect shows that the main diffusion mechanism for substitutional solid solution is the vacancy mechanism. (c)The region is in compression for the side of slower moving species (d) Element with a higher melting temperature usually diffuses faster.

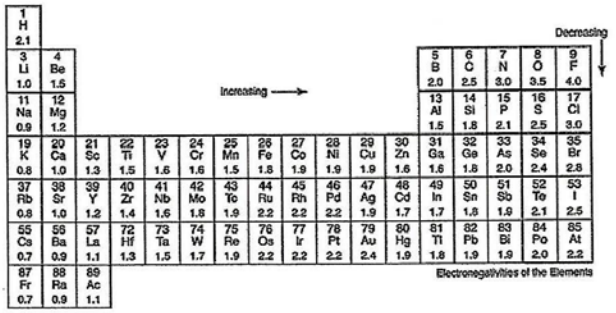
國立成功大學 111 學年度碩士班招生考試試題

系　所：材料科學及工程學系(綠色應用材料碩士班)

考試科目：基礎材料科學

考試日期：0220，節次：3

21. The periodic table below exhibits the Pauling scale of electronegativity for the elements. Which one of the following materials has the lowest "% ionic character"?



1 H 2.1																	
3 Li 1.0	4 Be 1.5											5 B 2.0	6 C 2.5	7 N 3.0	8 O 3.5	9 F 4.0	
11 Na 0.9	12 Mg 1.2											13 Al 1.5	14 Si 1.8	15 P 2.1	16 S 2.5	17 Cl 3.0	
19 K 0.8	20 Ca 1.0	21 Sc 1.3	22 Ti 1.5	23 V 1.6	24 Cr 1.6	25 Mn 1.5	26 Fe 1.8	27 Co 1.9	28 Ni 1.9	29 Cu 1.9	30 Zn 1.6	31 Ga 1.6	32 Ge 1.8	33 As 2.0	34 Se 2.4	35 Br 2.8	
37 Rb 0.8	38 Sr 1.0	39 Y 1.2	40 Zr 1.4	41 Nb 1.6	42 Mo 1.8	43 Tc 1.9	44 Ru 2.2	45 Rh 2.2	46 Pd 2.2	47 Ag 1.9	48 Cd 1.7	49 In 1.7	50 Sn 1.8	51 Sb 1.9	52 Te 2.1	53 I 2.5	
55 Cs 0.7	56 Ba 0.9	57 La 1.1	72 Hf 1.3	73 Ta 1.5	74 W 1.7	75 Re 1.9	76 Os 2.2	77 Ir 2.2	78 Pt 2.2	79 Au 2.4	80 Hg 1.9	81 Tl 1.8	82 Pb 1.9	83 Bi 1.9	84 Po 2.0	85 At 2.2	
87 Fr 0.7	88 Ra 0.9	89 Ac 1.1															

(a) CaF_2 (b) NaCl (c) SiC (d) Al_2O_3.

22. Usually materials with following crystal structure fail in ductile mod (a) FCC (b) BCC (c) HCP (d) monoclinic.

23. When two or more crystal structures are possible for a material of given composition, it is called (a) isomerism (b) polymorphism (c) anisotropy (d) spherulites.

24. Which of following does not correct for screw dislocation? (a) It may be formed by a tensile stress (b) It belongs to one-dimensional defect (c) It can be found in crystalline materials (d) The dislocation line can be linear.

25. Which one of the following metal has a high corrosion resistance due to the formation of oxygen-rich layer on the surface (a) Ag (b)Ti (c) Au (d)Fe.

26. Which of the following is not the primary strengthening mechanisms of single-phase metals? (a) Grain-boundary strengthening (b) grain coarsening (c) Strain hardening (d) Solid solution strengthening.

27. The recrystallization rate of a cold-worked metal is not dependent to (a) annealing temperature (b) annealing time (c) purity of the metal (d) deformation amount.

28. 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.

29. 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.

30. Martensite: (a) diffusion-controlled growth (b) interface-controlled growth (c) recrystallization (d) Sphere nucleation.

31. When Al^{3+} ions substitute the Mg sites in MgO, what is the charge-compensated defect? (a) Hole (b) Electron (c) Mg vacancy (d) Oxygen ion.

32. MgO is a very stable insulator, when Al^{3+} ions substitute the Mg sites of MgO, what kind of defect will be generated? (a) Electron (b) Hole (c) Mg vacancy (d) Oxygen vacancy.

國立成功大學 111 學年度碩士班招生考試試題

系　　所：材料科學及工程學系(綠色應用材料碩士班)

考試科目：基礎材料科學

考試日期：0220，節次：3

33. 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) the primary mechanism involved in dynamic recovery is dislocation cross-slip.
34. To support a 300 Kg silicon single crystal, growing a long-thin and dislocation-free "neck" (diameter 2–4 mm, length about 30 mm) is necessary during the Czochralski process. If dislocations are not completely eliminated in the neck, in what direction will the dislocations slip under the heavy load of grown single crystal? (Silicon has a FCC crystal structure) (a) {111}<110> (b) {110}<111> (c) {112}<111> (d) {123}<111>.
35. In grain growth, the relationship between grain diameter(D) and time(t) is that D is proportional to (a) t^{-1} (b) $t^{-0.5}$ (c) $t^{0.5}$ (d) t.
36. The most critical factor in the heterogeneous nucleation of solidification: (a) heat transfer direction (b) interface energy (c) undercooling (d) composition.
37. Work hardening is mainly due to the interactions between (a) dislocations and solute atoms (b) dislocations and grain boundaries (c) dislocations and precipitates (d) dislocations and dislocations
38. What is the secondary recrystallization? (a) stress release (b) increase the number of grains (c) increase the total grain-boundary energy (d) abnormal grain growth.
39. The impact strength of a polymer is measured as (a) elasticity (b) yield strength (c) creep (d) toughness.
40. 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.
41. How many equivalent {111}<110> slip systems are there in the fcc lattice? (a) 3 (b) 4 (c) 6 (d) 12
42. What is the most common defect that can significantly degrade the elastic properties and strength of ceramics? (a) staking faults (b) point defects (c) pores (d) dislocations.
43. Predict one of the following elements having a complete solubility in aluminum. (a)Manganese (b)silicon (c)copper (d)zinc.
44. How many are there the octahedral sites in a bcc lattice? (a)4 (b)6 (c)8 (d)9.
45. For an ASTM grain size of 5, estimate how many grains can one observe under a magnification of 25. (a) 16 (b) 64 (c) 256 (d) 1024.
46. Fick's First Law: some physical factors are not considered, they are: (a) temperature and time (b) activation energy and diffusion rate (c) temperature and composition (d) time and distance.
47. Which of following statement is correct? (a) The valence electrons of metals are not bound to any particular atom in the solid; (b) The valence electrons of metals are weakly bound to any particular atom in the solid; (c) The valence electrons of metals are strongly bound to any particular atom in the solid; (d) None of them.

國立成功大學 111 學年度碩士班招生考試試題

系　　所：材料科學及工程學系 (綠色應用材料碩士班)

考試科目：基礎材料科學

考試日期：0220，節次：3

48. Which of the following is more effective to stop dislocation motion? (a) High-angle boundaries (b) Coherent boundaries (c) Low-angle boundaries (d) Twin boundaries.

49. How many of the following factors are critical to determine the formation of interstitial sites or substitutional sides? Atomic size, atomic weight, crystal structure, density, crystal size, valences, conductivity, fermi energy. (a) 5 (b) 4 (c) 3 (d) 2.

50. Considering nitrogen diffusion in steel with intrinsic nitrogen concentration of 0.02 wt% while the surface concentration of nitrogen is maintained at 0.2 wt%. Determine the diffusion time required to reach at nitrogen content of 0.1 wt% at a position 0.47 mm below the surface under 500°C. The diffusion coefficients for nitrogen in iron at 500°C is 2.1×10^{-12} m^2/s. The tabulation of error function is included as reference. (a) 30 hr (b) 25 hr (c) 20 hr (d) 15 hr.

x	erf x
0	0
0.02	0.022564575
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