

國立臺灣科技大學

114學年度碩士班招生

試題

系所組別：0430材料科學與工程系碩士班丙組

科 目：材料導論

<<504303>>



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(總分為 100 分；所有試題務必於答案卷內頁依序作答)

1. (50%) Multiple choice questions

(1) (2%) What is true about martensite?

- A. Martensite is formed when austenitized iron-carbon alloys are annealed to high temperature.
- B. Martensitic transformation occurs when quenching rate is low.
- C. All of the above.
- D. None of the above.

(2) (2%) What is true about bainite?

- A. Bainitic steels are generally weaker and softer than pearlitic steels.
- B. The cooling rate for forming bainite is slower than that for forming martensite.
- C. All of the above.
- D. None of the above.

(3) (2%) What is true about diffusion mechanisms in solids?

- A. There must be an empty adjacent site.
- B. The atom does not need to have sufficient energy to break bonds with its neighbor atoms.
- C. All of the above.
- D. None of the above.

(4) (2%) Which processing technique can be used to define the pattern on a semiconductor substrate?

- A. Etching.
- B. Lithography.
- C. Diffusion.
- D. Thin-film deposition.

(5) (2%) What is true about diffusion in solids?

- A. The diffusion flux is always proportional to the concentration gradient.
- B. The diffusion coefficient is usually independent of temperature.
- C. All of the above.
- D. None of the above.

(6) (2%) What is true about kinetics of phase transformation?

- A. Homogeneous nucleation is the nucleation that occurs at surfaces and interfaces.
- B. For the heterogeneous nucleation, nuclei of the new phase form uniformly throughout the parent phase.
- C. All of the above.
- D. None of the above.

(7) (2%) What is true about tempering?

- A. Tempering can be used to enhance the ductility and toughness of martensite.
- B. Tempered martensite contains only single phase.
- C. All of the above.
- D. None of the above.

(8) (2%) What is true about iron-carbon alloys?

- A. Cementite has higher carbon concentration than ferrite.
- B. The carbon concentration of austenite is higher than that of pearlite under the eutectoid reaction.
- C. All of the above.
- D. None of the above.



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- (9) (2%) What is true about the corrosion prevention process?
- A. Cathodic protection involves supplying holes to the semiconductor to make it a cathode.
 - B. In a galvanic couple, the more reactive metal experiences oxidation and is often called a sacrifice anode.
 - C. All of the above.
 - D. None of the above.
- (10) (2%) Rate of solid-state diffusion does not depend on which of the following?
- A. Gravity.
 - B. Diffusing species.
 - C. Temperature.
 - D. Host solid.
- (11) (2%) What are the characteristics of large supercooling in nucleation?
- A. Many nuclei and large crystals.
 - B. Few nuclei and small crystals.
 - C. Few nuclei and large crystals.
 - D. Many nuclei and small crystals.
- (12) (2%) What does phase transformation involve?
- A. Rearrangement of atoms.
 - B. Changes in microstructures.
 - C. All of the above.
 - D. None of the above.
- (13) (2%) Which of the following processes is not an application of thermoelectric effect?
- A. Seebeck effect.
 - B. Thomson effect.
 - C. Ettingshausen effect.
 - D. Peltier effect.
- (14) (2%) The insulating capacity of material against high voltages is known as ____
- A. Dielectric strength.
 - B. Piezoelectricity.
 - C. Conductivity.
 - D. Mobility.
- (15) (2%) What effect does the addition of thermal energy have on a material?
- A. No change.
 - B. Freezing.
 - C. Thermal contraction.
 - D. Thermal expansion.
- (16) (2%) Which property helps a material to absorb lubricants?
- A. Density.
 - B. Porosity.
 - C. Absorptivity.
 - D. Mobility.



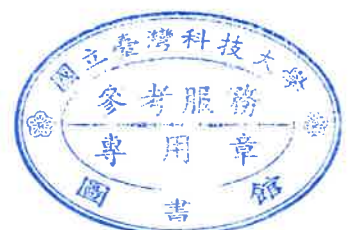
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- (17) (2%) Which of the following can explain the particle nature of light?
- A. Bragg's law.
 - B. Diffraction.
 - C. Interference.
 - D. Photoelectric effect.
- (18) (2%) Which is the advantage of GaAs over Si?
- A. Light weight.
 - B. Higher electron mobility.
 - C. Cheap.
 - D. Higher effective mass of carriers.
- (19) (2%) How can the conductivity of ionic crystals be increased?
- A. By increasing vacancy concentration.
 - B. By reducing the temperature.
 - C. By increasing the activation energy for diffusion.
 - D. All of the above.
- (20) (2%) How can the responsivity of a photodetector be improved?
- A. By depositing a reflection layer.
 - B. By designing an exceptionally flat surface.
 - C. All of the above.
 - D. None of the above.
- (21) (2%) Which statement is true for a ferroelectric material?
- A. Below the Curie temperature, it exhibits ferroelectric behavior.
 - B. It is usually made of Fe.
 - C. All of the above.
 - D. None of the above.
- (22) (2%) For a material with an absorption edge at around 413 nm, what is the band gap energy?
- A. 1 eV.
 - B. 2 eV.
 - C. 3 eV.
 - D. 4 eV.
- (23) (2%) Which property of light mainly contributes to low-loss of optical signals within an optical fiber?
- A. Absorption.
 - B. Reflection.
 - C. Refraction.
 - D. Dissipation.
- (24) (2%) Which of the following is a direct band gap material in bulk?
- A. Silicon.
 - B. Molybdenum disulfide.
 - C. Indium phosphide.
 - D. Gallium phosphide.



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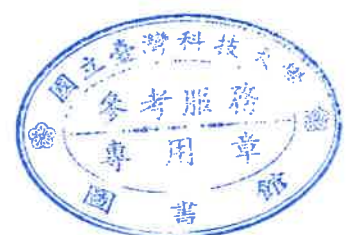
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(25) (2%) What can most likely be contributed to the dielectric constant of a material under very high frequency of alternating electric field?

- A. Ionic polarization.
- B. Orientation polarization.
- C. Electronic polarization.
- D. All of the above.



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2. (50%) Multiple choice questions (multiple answers) [No score for incomplete answers]

(1) (5%) What are true about crystallographic equivalent in crystals?

- A. [100] and [010] are equivalent in FCC (face-centered cubic) crystals
- B. [100] and [010] are equivalent in tetragonal crystals
- C. [100] and [010] are equivalent in HCP crystals
- D. [100] and [001] are equivalent in FCC crystals
- E. [100] and [001] are equivalent in tetragonal crystals
- F. [100] and [001] are equivalent in HCP crystals

(2) (5%) What are true about atomic packing in crystal structures?

- A. FCC (face-centered cubic) crystals exhibit a stacking sequence of ABCABC for the close-packed plane.
- B. BCC (body-centered cubic) crystals exhibit a stacking sequence of ABCABC for the close-packed plane.
- C. HCP (hexagonal close-packed) crystals exhibit a stacking sequence of ABAB for the close-packed plane.
- D. The atomic packing factor sequence is FCC (0.74) = HCP (0.74) > BCC (0.68).
- E. The atomic packing factor sequence is FCC (0.74) > HCP (0.68) > BCC (0.52).

(3) (5%) What are true about interfacial defects?

- A. Dislocations belong to interfacial defects.
- B. Surfaces belong to interfacial defects.
- C. Twin boundaries belong to interfacial defects.
- D. Stacking faults belong to interfacial defects.
- E. Cracks belong to interfacial defects.

(4) (5%) What are true about mechanical properties?

- A. Stiffness can be described as the resistance to elastic deformation.
- B. Yield strength can be described as the resistance to plastic deformation.
- C. Ductility can be described as the capacity of energy absorption when it is deformed plastically.
- D. Toughness can be described as the degree of plastic deformation at fracture.
- E. Hardness can be described as the resistance to localized surface deformation.

(5) (5%) What are true about typical stress-strain curves of metals?

- A. Before necking, the applied force increases when the strain is increasing.
- B. After necking, the applied force increases when the strain is increasing.
- C. Before necking, the engineering stress increases when the strain is



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increasing.

D. After necking, the engineering stress increases when the strain is increasing.

E. Before necking, the true stress increases when the strain is increasing.

F. After necking, the true stress increases when the strain is increasing.

(6) (5%) What are true about screw dislocations and plastic deformation?

A. Direction between Burgers vector and dislocation line has a parallel relationship.

B. Direction between shear stress and dislocation line has a parallel relationship.

C. Direction between Burgers vector and dislocation motion has a parallel relationship.

D. Direction between shear stress and dislocation motion has a parallel relationship.

E. The presence of screw dislocations causes only shear stress with no tensile and compressive stresses.

(7) (5%) What are true about slip systems in crystals?

A. The slip direction must have the highest linear density in the crystal.

B. The slip direction must be the close-packed direction in the crystal.

C. The slip plane must have the highest planar density in the crystal.

D. The slip plane must be the close-packed plane of the crystal.

E. The slip direction is perpendicular to the normal of slip plane.

F. The slip direction is parallel to the normal of slip plane.

(8) (5%) What are true about strengthening mechanisms in metals?

A. Grain boundary strengthening: Grain boundaries act as barriers and hinder dislocation motion.

B. Grain boundary strengthening: Internal grains act as barriers and hinder dislocation motion.

C. Solid-solution strengthening: Solute atoms trap dislocations and hinder dislocation motion.

D. Solid-solution strengthening: Solute atoms eliminate dislocations and hinder dislocation motion.

E. Strain (work) hardening: The increase in dislocation density decreases the average dislocation distance and further hinders dislocation motion due to dislocation interaction.

F. Strain (work) hardening: The decrease in dislocation density increases the average dislocation distance and further hinders dislocation motion due to dislocation interaction.

(9) (5%) What are true about fracture modes of materials?



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- A. Ductile mode requires more energy for crack propagation than brittle mode.
- B. Ductile mode exhibits higher crack propagation rate than brittle mode.
- C. Ductile mode exhibits higher impact energy than brittle mode.
- D. Ductile mode exhibits higher fracture toughness than brittle mode.
- E. Ductile mode exhibits a dimple feature, and brittle mode exhibits a cleavage feature.

(10) (5%) What are true about creep of metals?

- A. At higher temperatures, metals are expected to exhibit higher steady-state creep rate.
- B. At higher applied stresses, metals are expected to exhibit higher steady-state creep rate.
- C. At higher temperatures, metals are expected to exhibit higher rupture lifetime.
- D. At higher applied stresses, metals are expected to exhibit higher rupture lifetime.

