國立臺灣科技大學

115學年度碩士班招生

試題

系所組別：0350機械工程系碩士班戊組

科　　目：材料製造與應用

<<503502>>

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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. (30%) Multiple choose

(1) (5%) An engineer is designing a rotating driveshaft intended for infinite service life. They prioritize selecting a ferrous alloy because it exhibits a distinct "Fatigue Limit" (Endurance Limit). To further ensure the part does not fail, they review the manufacturing process. Which of the following proposed steps should be REJECTED because it will likely DECREASE the fatigue performance?

A. Shot Peening the surface to induce residual stresses.
B. Polishing the surface to reduce roughness (Ra).
C. Full Annealing to soften the microstructure and relieve all internal stresses.
D. Carburizing (Case Hardening) the outer layer.

(2) (5%) You need to select a strengthening mechanism for a turbine blade that will operate at 0.7 Tm (70% of melting temperature). Which mechanism is LEAST effective and why?

A. Solid Solution Strengthening: Because diffusion becomes too rapid, it homogenizes the lattice.
B. Precipitation Hardening: Because precipitates will coarsen (Ostwald Ripening), increasing inter-particle spacing.
C. Strain Hardening (Cold Work): Because recrystallization will occur, annihilating the dislocation forest.
D. Dispersion Strengthening: Because oxide particles will dissolve back into the matrix.
E. Single Crystal Solidification: Because grain boundaries are needed to stop creep.

(3) (5%) Which of the following correctly ranks the steel microstructures from highest ductility to lowest ductility?

A. Spheroidite > Coarse Pearlite > Fine Pearlite > Bainite > Tempered Martensite > Martensite
B. Spheroidite > Fine Pearlite > Coarse Pearlite > Tempered Martensite > Bainite > Martensite
C. Martensite > Tempered Martensite > Bainite > Fine Pearlite > Coarse Pearlite > Spheroidite
D. Coarse Pearlite > Spheroidite > Bainite > Fine Pearlite > Tempered Martensite > Martensite
E. Spheroidite > Coarse Pearlite > Bainite > Fine Pearlite > Martensite > Tempered Martensite

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(4) (5%) Imagine a system containing liquid bromine (Br_2) and sodium ions (Na^+). Which pair of terms correctly identifies (1) the bond holding a single bromine molecule together, and (2) the primary attractive force between a sodium ion and a bromine molecule?

A. Polar covalent; Ion-dipole
B. Nonpolar covalent; Ion-induced dipole
C. Ionic; Temporary dipole
D. Nonpolar covalent; Ion-dipole
E. Polar covalent; Ion-induced dipole

(5) (5%) Two materials, Material A (High Strength, Low Ductility) and Material B (Moderate Strength, High Ductility), are tested. If the elastic limits are similar, which statement is most likely true based on their stress-strain curves?

A. Material A has higher Resilience and higher Toughness.
B. Material B has lower Resilience but significantly higher Toughness.
C. Material A has higher Resilience, but Material B has higher Fracture Toughness.
D. Both materials have similar Toughness, but Material B has higher Brittleness.

(6) (5%) A design engineer needs to select a material for an intricate die-casting mold used to produce high-volume automotive parts. The mold experiences rapid heating/cooling cycles, high compressive forces, and must maintain precise geometric stability over thousands of uses. Which material property is the LEAST critical factor when making this selection?

A. High Yield Strength at elevated temperatures.
B. High Thermal Shock Resistance (a function of high thermal conductivity and low coefficient of thermal expansion).
C. Low Ductility and High Hardness to resist abrasive wear and creep.
D. High Fracture Toughness (K_{IC}) to resist the rapid propagation of microscopic surface cracks.

2. (20%) For a 75 wt% Pb-25 wt% Mg alloy, make schematic sketches of the microstructure that would be observed for conditions of very slow cooling at the following temperatures:
Label

(1) (10%) 500°C, phase compositions (5%) and weight fractions (5%).
(2) (10%) 400°C, phase compositions (5%) and weight fractions (5%).

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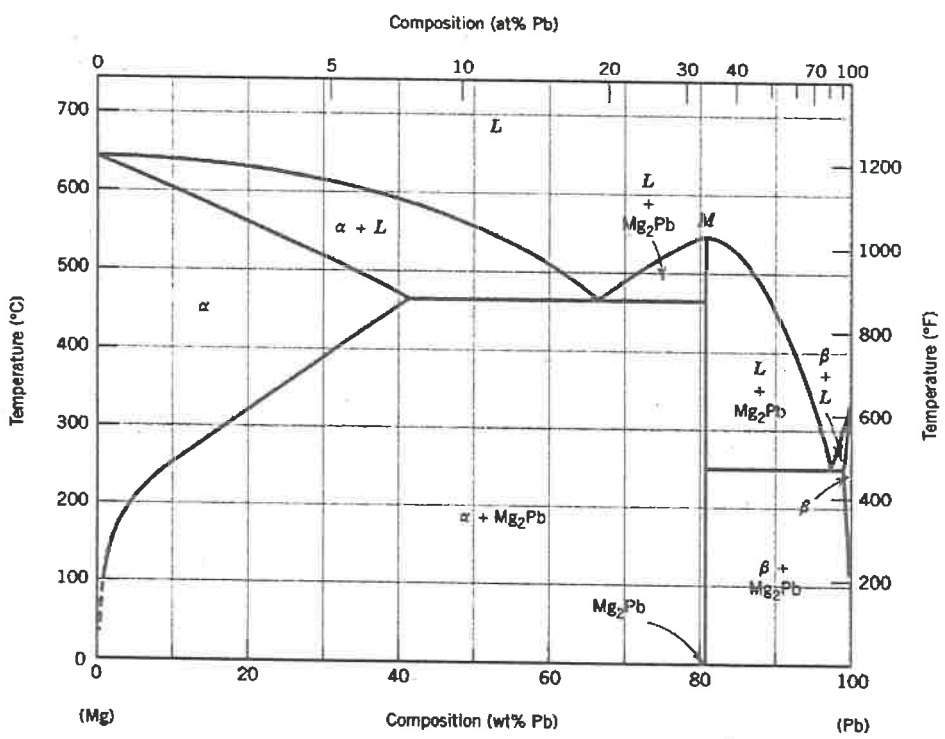

3. (15%)
   (1) (5%) Define "Curie temperature."
   (2) (10%) A magnetic steel temperature limiter (also known as a magnetic thermostat) is a mechanical automatic switch in standard rice cookers that controls the transition from "cook mode" to "keep-warm mode." The device uses the physical properties of magnets to deteet when the rice is done without using complex electronics. Explain how the magnetic steel temperature limiter works by using the concept of "Curie temperature."

4. (7%) A glassware having a larger thickness tends to have a higher thermal stress upon rapid cooling or heating. Why?

5. (8%) A machine part made of metals or alloys can be produced by either powder metallurgy or casting.
   (1) (4%) Cite an advantage for powder metallurgy.
   (2) (4%) Cite a disadvantage for powder metallurgy

6. (20%) While magnesium (Mg) is roughly 33% lighter than aluninium (Al), 75% lighter than steel, and can significantly improve vehicle fuel efficieny, the use of Mg in the automotive industry remains limited today due to several critical challenges.

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(1) (4%) Mg has a HCP crystal structure. What does the abbreviation HCP stand for? Write the full name of HCP in English (2%) and in Chinese (2%).

(2) (8%) Comment on the formability of Mg at room temperature by using its crystal structure.

(3) (8%) Besides the manufacturing/processing challenges, name another type of challenge for using Mg in the automotive industry and give a brief explaination.