

# 國立中山大學 113 學年度

## 碩士班暨碩士在職專班招生考試試題

科目名稱：材料科學導論【材光系碩士班選考、材料前瞻應材碩士班選考、材光聯合碩士班選考】

### — 作答注意事項 —

考試時間：100 分鐘

- 考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- 答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以 2B 鉛筆劃記，不可使用修正液（帶）塗改，未使用 2B 鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

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※本科目依簡章規定「不可以」使用計算機(混合題)

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第一部分：單選題，每題 5 分，無倒扣

1. Determine the electron configuration  $1s^2 2s^2 2p^6 3d^5 4s^1$  is (A) an inert gas, (B) a halogen, (C) an alkali metal, or (D) a transition metal. (5 points)
2. Which one of the following bonds is **not** a primary interatomic bond? (A) Covalent bond, (B) metallic bond, (C) dipole bond, or (D) ionic bond. (5 points)
3. Based on the hard-sphere model, what is the atomic radius of molybdenum having a body-centered cubic crystal structure with a unit cell length  $a$ ? (A)  $\frac{a}{4}$ , (B)  $\frac{\sqrt{2}a}{4}$ , (C)  $\frac{\sqrt{3}a}{4}$ , or (D)  $\frac{a}{2}$ . (5 points)
4. Which one of the point coordinates is **not** an interstitial site within an FCC unit cell? (A)  $\frac{1}{2} \ 1 \ \frac{1}{2}$ , (B)  $\frac{1}{4} \ \frac{3}{4} \ \frac{1}{4}$ , (C)  $0 \ \frac{1}{2} \ 1$ , (D)  $\frac{1}{2} \ \frac{1}{2} \ \frac{1}{2}$ . (5 points)
5. Cuprous oxide is a direct bandgap semiconductor with a bandgap of 2.1 eV. Over which one of the following wavelength is it opaque? (A) 500 nm, (B) 600 nm, (C) 700 nm (D) 800 nm. (5 points)
6. Which one of the following descriptions is **not** correct for refraction: (A) Light that is transmitted from vacuum into the interior of a transparent material experiences a decrease in velocity. (B) Light beam is not bent at the interface. (C) A consequence of electronic polarization of the atoms. (D) The larger an atom, the greater the index of refraction. (5 points)
7. Which one of the following descriptions is **not** correct for a ferromagnetic single crystal at a temperature below  $T_c$  (Curie temperature)? (5 points)  
(A) The  $B$  (magnetic flux)- $H$  (magnetic field) behavior for the single crystal is isotropic.  
(B) The single crystal is composed of small-volume regions called magnetic domains.  
(C) As an external magnetic field is applied, the magnetic domains change in shape and size.  
(D) As the magnetization reaches a maximum value, the single crystal is a single domain.
8. Which one of the following descriptions is **not** correct for a ferromagnetic single crystal at a temperature below  $T_c$  (Curie temperature)? (5 points)  
(A) Tangled dislocations which can retard the movement of a grain boundary also retard the movement of a domain boundary.  
(B) The thickness of a domain boundary is similar to that of a grain boundary.  
(C) Both hysteresis and permanent magnetization result from the resistance to movement of domain boundaries.  
(D) For an electric steel, the hysteresis loss decreases with increasing the grain size.

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9. The conductivity of a semiconducting material is **not** affected by (A) pressure, (B) carrier concentration, (C) temperature, (D) dopant content. (5 points)
10. There are three types of electric polarization which do **not** include (A) electronic polarization, (B) ionic polarization, (C) solid solution polarization, (D) orientation polarization. (5 points)

第二部分：問答計算題，無倒扣

11. Fig. 1 is the Al-Ni phase diagram, for which single-phase regions are labeled. Specify temperature-composition points at which all eutectic, eutectoids, peritectics, and congruent phase transformations occur. Also, for each, write the reaction upon cooling. (12 points)

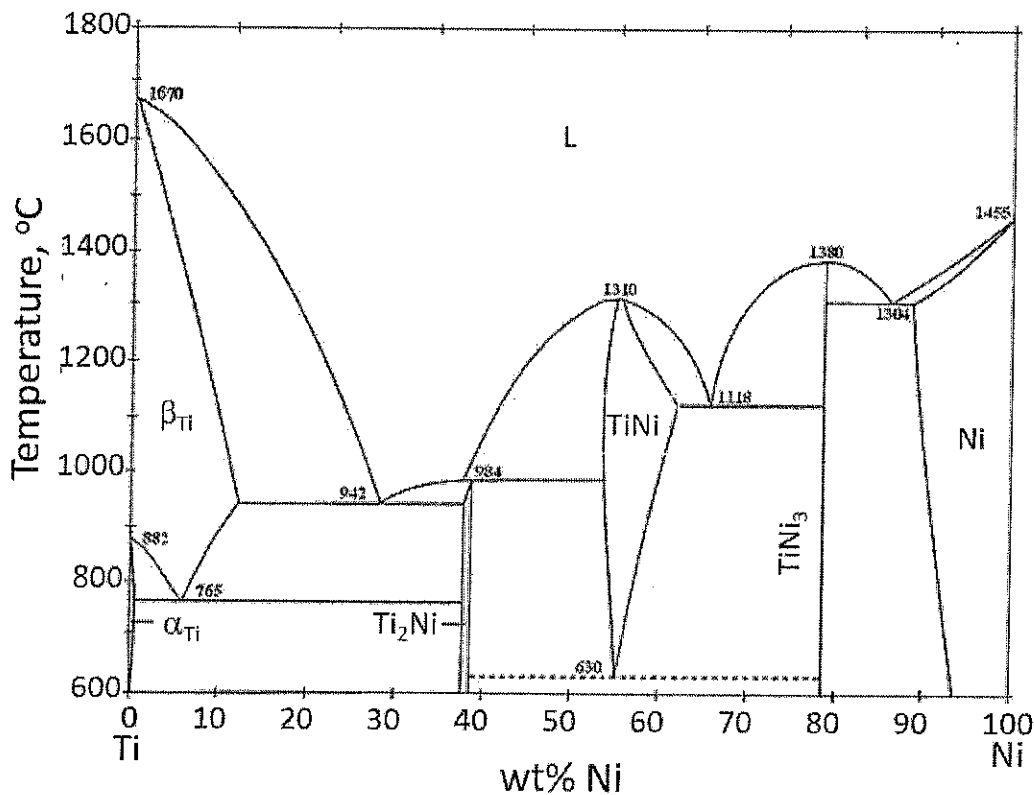


Fig. 1

12. A metal rod will have a length at  $0.95 T_m$  (melting temperature) longer than that at  $0.2 T_m$ . List two reasons contributing to the length increase. (8 points)
13. GaN is a wide bandgap semiconductor having a hexagonal crystal structure. Give the Burgers vector of the edge-type threading dislocations in a GaN (0002) epilayer grown on a sapphire (0002) substrate. An epilayer is a single-crystal thin film, and a threading dislocation is a dislocation extended straightly from the epilayer/substrate interface to the surface of the epilayer. In other words, the dislocation line is perpendicular to the substrate surface. (6 points)

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14. Fig. 2 shows a concentration profile for a non-steady-state diffusion. The concentration at position  $x$  is  $C_x(t)$  at time  $t$ . Predict the concentration  $C_x(t+\Delta t)$  is higher than, equal to, or lower than  $C_x(t)$  after a time period of  $\Delta t$ . Please justify your answer. (8 points)

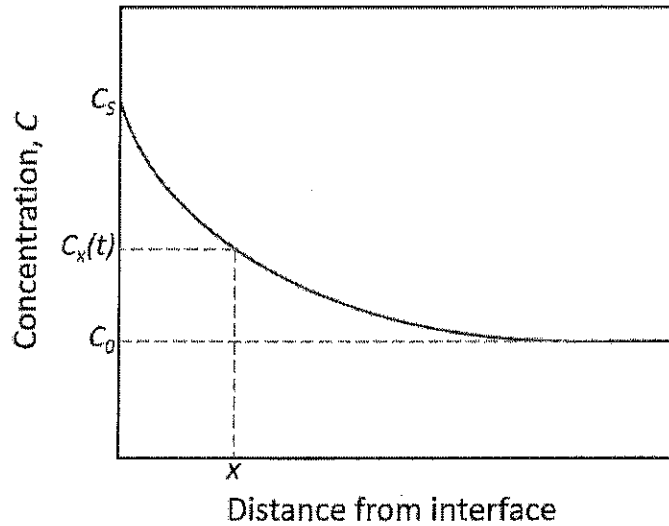


Fig. 2

15. Estimate the yield strength, tensile strength, uniform elongation, and total elongation of a sample whose load-displacement curve is shown in Fig. 3. Explain how the values are derived. (Sample information: gauge width=10 mm, thickness=1 mm, gauge length=40 mm). (8 points)

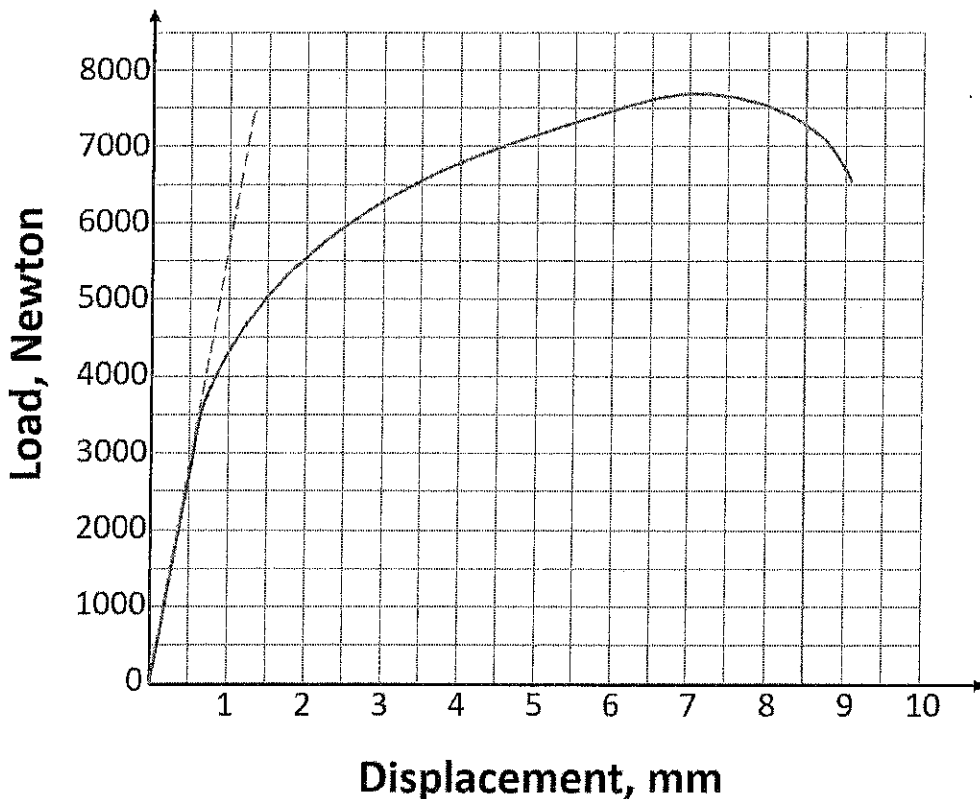


Fig. 3

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16. Consider a given volume of liquid at a temperature  $\Delta T$  below  $T_m$  (melting temperature) with a free energy  $G_1$  as shown in Fig. 4(a). If some of the atoms of the liquid cluster together to form a small sphere of solid (see Fig. 4(b)), the free energy of the system will change to  $G_2$ . The free energy of the system changes from  $G_1$  to  $G_2$  is given by:

$$\Delta G = G_2 - G_1 = -V_s \Delta G_v + A_{SL} \gamma_{SL}$$

where  $\Delta G_v$  the volumetric free energy difference between the solid and liquid,  $V_s$  the volume of the solid,  $A_{SL}$  the solid/liquid interfacial area, and  $\gamma_{SL}$  the solid/liquid interfacial free energy. Please (a) express  $\Delta G_v$  in terms of  $L_v$ , the latent heat of fusion per unit volume,  $\Delta T$ , and  $T_m$ , and (b) derive the critical nucleus radius in term of  $\Delta T$ . (8 points)

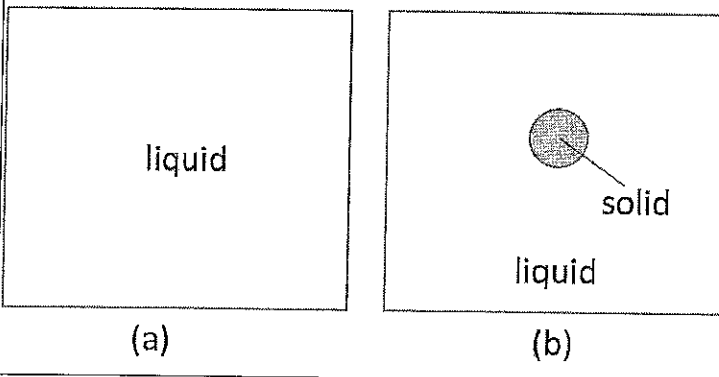


Fig. 4