

國立臺北科技大學九十六學年度碩士班招生考試

系所組別：3302 材料科學與工程研究所不分組

第二節 物理冶金（選考）試題

第一頁 共一頁

注意事項：

1. 本試題共七題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

All problems must be answered concisely in English. Total score is 100%.

1. (a) Please derive the ideal c/a ratio in hcp crystal structure. (5%)
(b) What rotational symmetry (disregarding other types of symmetry elements) does hcp crystal structure have along the $[0001]$ axis? (5%)
2. Considering spherical nuclei of radius, r , in nucleation with a surface energy γ per unit area, strain energy ΔG_s and chemical driving force $-\Delta G_v$ per unit volume, please derive the critical nucleus size (r^*) and its critical energy barrier to nucleate (ΔG^*). (15%)
3. Please explain the formation of macrosegregation in casting process. (hint: by use of phase diagram) (15%)
4. Very often in engineering applications, fine grain size microstructures are preferred which bear better properties. As a materials engineer, what strategies do you have to refine the grain size of materials? (15%)

5. (a) Write down a dissociation reaction for a full dislocation with Burgers vector $\frac{1}{2}[110]$ in fcc crystal structure. (5%)
(b) Prove that this reaction is energetically favorable given that the dislocation energy is proportional to the square of its Burgers vector. (5%)
(c) Write the stacking fault plane indices where these partial dislocations form. (5%)
6. Please rank in correct order the diffusion coefficients of the following cases from low to high based on your physical metallurgy knowledge: (15%)
 - (a) C atoms in α -Fe at 500°C.
 - (b) C atoms in γ -Fe alloy (e.g. stainless steel) at 500°C.
 - (c) Si atoms in α -Fe at 700°C.
 - (d) Cr atoms in γ -Fe alloy (e.g. stainless steel) at 700°C.
 - (e) Cr atoms in α -Fe at 700°C.
 - (f) Cr atoms in γ -Fe alloy (e.g. stainless steel) at 500°C.
 - (g) Grain boundary diffusion of Cr atoms in γ -Fe alloy (e.g. stainless steel) at 500°C.
7. Please rank the tensile strengths of the following materials in the order from low to high: (15%)
 - (a) SiO₂ glass.
 - (b) Cu-10wt%Zn alloy with fcc structure.
 - (c) Tempered AISI 1040 carbon steel with 0.4%C.
 - (d) AISI 1008 carbon steel with 0.08% C.
 - (e) Quenched AISI 4340 NiCrMo steel containing 0.4% C.
 - (f) Fully annealed AISI 1040 carbon steel with 0.4% C.
 - (g) Quenched AISI 1040 carbon steel with 0.4% C.