注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 108 學年度碩士班考試入學試題

系所班組別：**工程與系統科學系　甲組**

考試科目(代碼)：**物理冶金(3001)**

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 108 學年度碩士班考試入學試題

系所班組別：工程與系統科學系碩士班 甲組(0530)

考試科目（代碼）：物理冶金 (3001)

 *請在【答案卷】作答

1. You are in charge of FA team in Tesla automobile company and taking care of the issue in backend process. For recovering the strain of main frame in new model 3 vehicle, you are assigned to control the thermal anneal recipes. In the post-treatment inspection, you found presence of certain densities of line defect in grain and are assigned to be explained for designing a proper thermal budget on removing the defects. (a) please states the types of dislocation and their typical characteristics of geometrical configuration between direction (**4%**); (b) explain the unit length of dislocation in a crystal and explain the difference of this value in different directions in a FCC (3%) and BCC crystal (**3%**) by schematic representations of vector in a unit cell. (c) Explain the interaction result of line defects with different symbols (opposite direction) in the same slip plane (**3%**) and two parallel slip planes (**3%**).

   <total grade of 16/100>

2. Julia Liu is playing with materials property calculator (Vibration Research University) for evaluating materials strength mechanisms on over cold working metal bulk. The first input to be employed is the stress – strain curve shown in **Figure 1**. To help Julia for deliver result in time, please answer following questions: (a) explain the reason for changes of slope in the three regions with schematic representation and proper descriptions from macroscopic to microscopic regimes (**6%**); (b) indicate the two factors that affecting the deformation strain of the metal bulk and explain their influences upon changes of temperature (**6%**); (c) draw the stress-strain curve in **Figure 1** with temperatures higher and below the room temperature of the bulk and explain the reason (**4%**); (d) Assuming that applied force along P axis, please draw three moving trajectories of P point till the equilibrium state in **Figure 2** and explain the reason (**4%**); (e) explain the mechanism on microstructure evolutions of ductile metal by applying a tensile stress till fracture with graphics and descriptions (**8%**); (f) explain the reason on the formation of zigzag type crack propagation in (e) (**4%**).

   <total grade of 48/100>

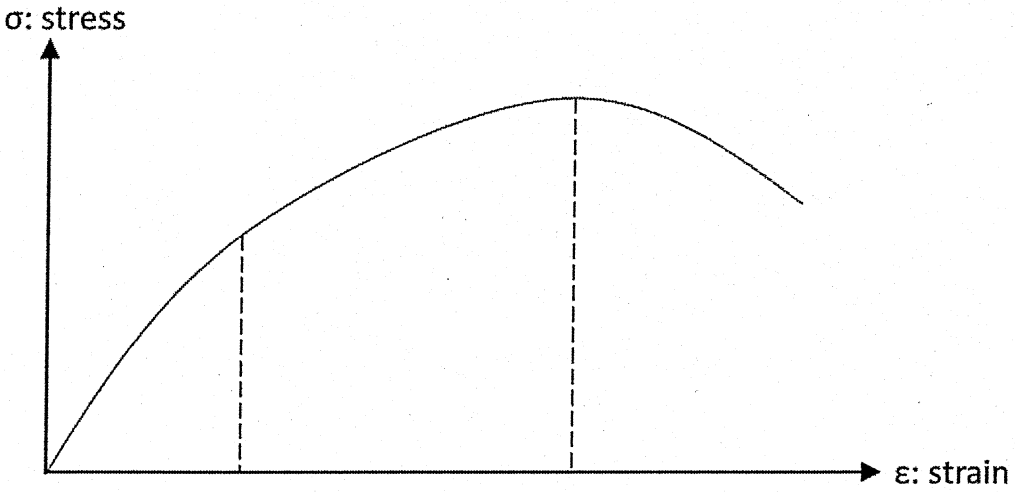

Figure 1 Typical engineering stress-strain curve of metal.

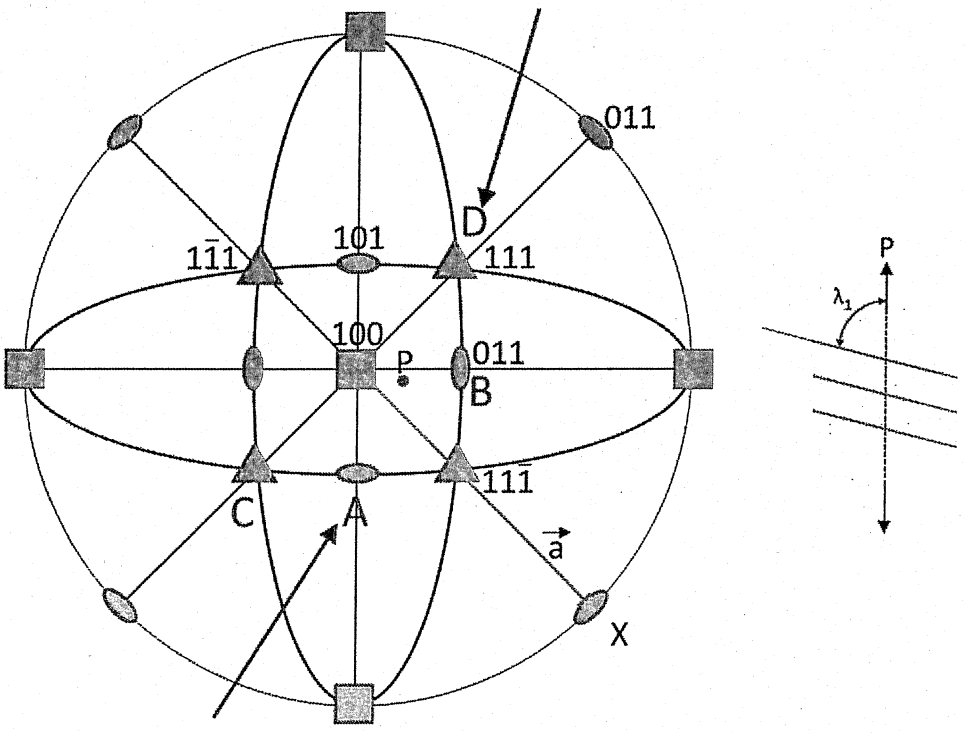

Figure 2 Spherical projection of slip systems for crystal

3. Please (a) explain the reason why equilibrium concentration of vacancy (dopant) concentration is a function of temperature by deriving thermodynamic equilibrium equation with proper assumption and approximation. **(4%)**; (b) state the deciding factor of solubility for impurities in solid solution **(4%)**; (c) derive the equilibrium concentration of vacancy at a temperature Ta, assuming that formation energy of vacancy is ΔH. (please state your assumptions and adopt the thermodynamic parameters with SI unit). **(8%)**

<total grade of 64/100>

4. David Su is a product engineer who is working in charging of toughness improvement on wind turbine blade project issued by swancor Co ltd. In this project, he gets the order of 2,000 giant wind blades made by Co / Ni / W doped super alloy. The size of the blade is designed as 30 meters long with the cross section of 0.35 by 0.22 meters square. A prototype blade was made one week ago and shipped to swancor today. You are in charge of outgoing quality control (OQC) in swancor and found that this blade was distorted by improper handling in process flow. For recovering the shape, you are assigned to propose a process recipe with certain mechanical assessments at room temperature. (a) Please describe the microstructure changes of the metallic blade by your mechanical treatments with increasing mechanical work loading at room temperature **(6%)**. (b) Explain the reason why the treatments come with the hardening of the metallic blade. **(6%)** (c) The hardening will suppress the toughness therefore the operation lifetime of the blade as the components of turbine in the wind power generator. Please provide proper thermal budgets (assuming that the melting temperature of the super alloy is T_m) for restoring the toughness of the blade. In this case, please describe the mechanisms and characters for the microstructure evolutions, strength, and conductivity of the blade upon the thermal treatments with graphical representation and explanations **(24%)**.

<total grade of 100/100>