

國立交通大學 100 學年度碩士班考試入學試題

科目：半導體材料與製程技術相關課題(8091)

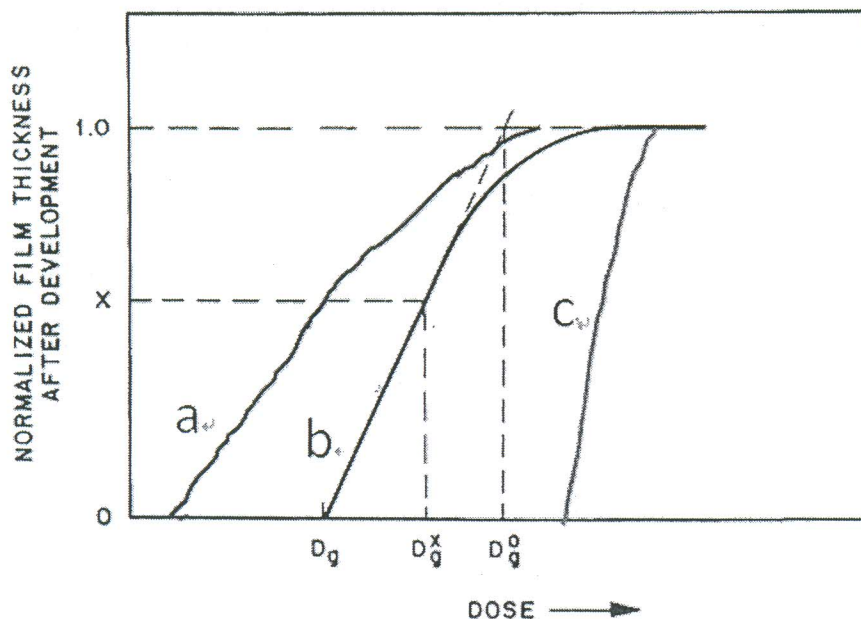
考試日期：100 年 2 月 19 日 第 2 節

系所班別：工學院碩士在職專班 組別：半導體材料與製程設備組 第 / 頁, 共 2 頁

【可使用計算機】*作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符!!

下列考題共 10 題。任選五題做作答，每題佔 20%，總分 100 分。作答五題以上者，以較低分之五題計算總分。請在答案卷中標示所選答之題號。

1. 在 Lithography 製程中，請列出 Soft Bake、Hard Bake、Priming 三個步驟之先後製程順序及製程方法。並寫出這三個步驟的用意何在？解釋在 Lithography 中(a) Numerical aperture (b) Resolution (c) Depth of focus 之定義為何，並解釋稜鏡 Numerical aperture 大小和 Resolution、Depth of focus 之間的關係？
2. 請回答有關半導體材料分析問題
 - (a) 如何決定金屬矽化物之成分及結構？
 - (b) 如何決定介電薄膜氮化矽之元素成分及厚度？
 - (c) 如何決定半導體摻雜濃度之分佈？
 - (d) 如何決定磊晶材料對基板所造成的應力？
 - (e) 如何決定 Si 基板之缺陷密度？
3. As to the basic lithography, please explain the following concept from the photoresist in this Figure: (1) what is the tone for the photoresist (positive or negative)? (2) which photoresist has the best image contrast for mass production (curve a, b, or c)? (3) which photoresist has the highest throughput for semiconductor manufacturing (curve a, b, or c)? (4) what is the meaning of D_g for curve b? (5) what is the meaning of D_g^0 for curve b?



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4. A: photoresist spin-coating, B: TMAH development, C: HMDS primer, D: post exposure bake, E: soft bake, F: hard bake, G: exposure, H: SEM inspection.

TMAH= tetramethylammonium hydroxide, HMDS= hexamethyldisilazane, SEM= scanning electron microscope.

During standard foundry photolithography, please answer the following items:

(1) what is the correct processing sequence (please arrange ABCDEFGH in sequence)?

(2) what is the purpose of SEM inspection? (3) what is the purpose of HMDS priming? (4) which factors affect the thickness of spin-coated photoresist film? (5) what is the purpose of TMAH development?

5. Explain (1) what is the conventional RCA clean? (2) what is the modified RCA clean? (3) what are the chemical composition for DHF and BOE? (4) What methods/tools are used to verify the metal-free wafer surface after modified RCA cleaning? (5) what is the purpose of using brush scrubber tool for post-CMP clean?

6. 在一個超高真空的環境，你有一個已知波長的 x 光源，一個電子能量分析器，你如何得知真空腔內某一個試片表面的元素種類？依據的原理為何？

7. 為什麼固態材料(如 Si 半導體)的功函數(work function)會隨晶面方向改變？

8. 什麼是電子穿隧效應？請以 Si(100)/SiO₂/poly-Si 三層薄膜結構為例說明。

9. Draw the curve of electron concentration against temperature for boron-doped Si($\sim 10^{17}/\text{cm}^3$). Explain the three regions in the figure.

10. (a) The room-temperature electrical conductivity of a silicon specimen is $500 (\Omega\text{-m})^{-1}$. The hole concentration is known to be $2.0 \times 10^{22} \text{ m}^{-3}$. Compute the electron concentration. (b) On the basis of the result in part (a), is the specimen intrinsic, n -type extrinsic, or p -type extrinsic? Why?

Material	Band Gap (eV)	Electrical Conductivity [$(\Omega\text{-m})^{-1}$]	Electron Mobility ($\text{m}^2/\text{V}\cdot\text{s}$)	Hole Mobility ($\text{m}^2/\text{V}\cdot\text{s}$)
Elemental				
Si	1.11	4×10^{-4}	0.14	0.05
Ge	0.67	2.2	0.38	0.18