國立中央大學105學年度碩士班考試入學試題

所別： 機械工程學系 碩士班 製造與材料組(一般生) 共2頁 第1頁

科目： 材料導論與機械製造

本科考試可使用計算器，廠牌、功能不拘 ＊請在答案卷(卡)內作答

1. The outer surface of a steel gear is to be hardened by increasing its carbon content. The carbon is to be supplied from an external carbon-rich atmosphere, which is maintained at an elevated temperature. A diffusion heat treatment at 850°C for 10 min increases the carbon concentration to 0.90 wt% at a position 1.5 mm below the surface. Estimate the diffusion time required at 650°C to achieve this same concentration also at a 1.5-mm position. Assume that the surface carbon content is the same for both heat treatments, which is maintained constant. The diffusion data for the diffusion of C in α-Fe are Q_d = 80,000 J/mol, $D_0 = 6.2 \times 10^{-7}$ m^2/s and gas constant = 8.31 J/mol K (5%).

2. Describe the influence of temperature on impact energy, by plotting impact energy against temperature to compare different response of (a) the FCC metal like Cu (2%), (b) BCC metal like a ferritic steel α (-steel) (2%) and (c) a high strength steel with its yield strength higher than E/150 (2%) to reveal the possible ductile and brittle fracture after energy adsorption.

3. Draw the continuous thermal transformation (CTT) diagrams for (a) the eutectoid steel (2%) and (b) hypoeutectoid steel (2%), respectively;
(c) in the CCT diagram of eutectoid steel, from 780℃ to room temperature, plot a cooling curve of "A" to demonstrate the full annealing (2%);
(d) in the CCT diagram of eutectoid steel, from 780℃ to room temperature, plot another curve of " B" to show a sequence of quenching and tempering processes (2%);
What are the microstructures of the (e) full annealing (2%), (f) quenching (2%) and (g) tempering (2%).

4. Briefly describe and discuss electronic polarization, electron transitions, and scattering the three absorption mechanisms for light in nonmetallic materials. (3%) Why do some transparent materials appear colored while others are colorless? (4%)

5. Briefly describe what intrinsic silicon and extrinsic silicon are. Draw their energy-band diagrams for comparison. (7%) What is the difference in the change of **resistivity** between intrinsic silicon and extrinsic silicon if temperature is increased from room temperature to 200°C? Why? (3%)

6. Why may thermal stresses be introduced into a Cu (30 μm)/Si (200 μm) substrate during rapid heating processing? Write down a thermal stresses relative equation to confirm your answer if possible. (5%) For a cooling case, what is the nature of the surface stresses? (3%)

注意：背面有試題

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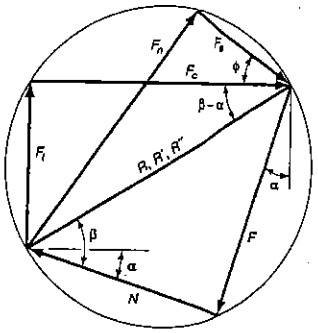
7. You want to use etching to make a tiny hole on a silicon wafer.
   (a) Briefly describe the photolithography steps and the etching steps. Draw the cross-sectional views of each step. (10%)
   (b) What is the typical problem(s) if you want to make a very deep hole using regular chemical etching? How to prevent the problem(s)? (7%)

8. Sputtering and evaporation are the common techniques to deposit thin films. What are the differences between them? (8%)

9. Machining-orthogonal model and Merchant equation (10%)
   (a) Name three most common machining processes (3%)
   (b) Using the force diagram of 2D orthogonal metal cutting model, please identify the four forces on the right diagram that act upon the chip but cannot be measured directly in an operation (4%).
   (c) Please elaborate the Merchant equation based on the force diagram? (3%).



10. Machining- tool life and others (15%)
    (a) Please draw schematically the up milling（向上銑削）and down milling（向下銑削）processes and state the main differences. (5%)
    (b) Please specify five machining operations that can be performed on a lathe (5%)
    (c) Tool life tests in turning yield the following data: (i) when cutting speed is 100 m/min, tool life is 10 min; (ii) when cutting speed is 75 m/min, tool life is 30 min. Please draw schematically of above data and specify the *n and C* values in the *Taylor tool life equation.* (5%)

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