國立台灣科技大學九十七學年度碩士班招生試題

系所組別： 高分子工程系碩士班丁組

科　　目： 材料科學

丁組：材料科學；共 8 大題，總分 100 分；請於答案卷內依序作答。

1. Brief tell what is meant by the drift velocity and mobility of a free electron.(20%)

2. Visible light having a wavelength of 6×10^{-7} m appears orange. Compute the frequency and energy of a photon of this light. (20%)

3. Describe the principle of the field emission filament. Explain why many properties of the field emission SEM are better than those of the thermionic emission SEM. (14 %)

4. Please explain how to characterize a thin film by analytical tools for its:
   (a) crystal structure,
   (b) chemical composition,
   (c) thickness,
   (d) surface morphology.
   (At least two instruments for each of above categories.) (16 %)

5. (7%)

   a) Starting from the electrical conductivity, explain the physical meaning of charge mobility for carriers in semiconductor materials.(2%)
   b) For all of elemental semiconductors, the mobility of holes is less than that of electrons, explain this phenomenon on a physical basis.(2%)
   c) The energy gap of a semiconductor is 1.1 eV, and the acceptor dopant has an 0.06 eV binding energy. Draw a level diagram, indicating the conduction and valence bands, and dopants state with labeled potentials.(3%)

6. (8%) Copper (atomic mass= 63.55; atomic number= 29) has a density of 8.9 g/cc., and electrical resistivity of 0.00000000172 ohm-m at 25 degrees centigrade.
   a) Find the density of free (or conduction) electrons in copper. (3%)
   b) Find the drift velocity of electrons (elementary charge= 1.6E-19 C) in an electric field of 100 V/m. (3%)
   c) How do the electrical resistivities of Cu and Si vary with temperature?(2%)

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7. (7%) Alpha titanium is superheated at 1175 K, and transformed to the beta form. Suppose that, the change of Gibbs free energy of beta titanium forming from the alpha form at 1175 K= -0.065 J per cubic meter, and interfacial energy between the alpha and the beta phase= 0.2 J per square meter.
   a) How does the change of free energy from alpha to beta relate to equilibrium transformation temperature and enthalpy of phase transformation? (3%)
   b) Estimate the minimum radius of beta phase nucleus, leading to the beta phase formation in a superheated alpha titanium matrix. (2%)
   c) If this is a diffusionless transformation, propose a relation between the nucleation rate and the above free energy change during phase transformation. (2%)

8. (8%) In a unit cell of polyethylene (PE) crystal with orthorhombic symmetry, there are eight repeat units (-CHH-CHH-) located at eight corners and one repeat unit within the cell. Lattice parameters: a= 7.4 Angstroms, b= 4.69 Angstroms, c= 2.54 Angstroms. The c corresponds to chain repeat distance when it is fully extended.
   a) Find the number of repeat units per unit cell. (2%)
   b) Predict the density of a totally crystalline polyethylene. (3%)
   c) If a semi-crystalline PE (crystallinity= 0.768) has a density of 0.965 g/cc, predict the density of PE with a crystallinity equal to 0.464. (3%)