國立中山大學八十八學年度碩博士班招生考試試題

科　目：材料科學（材料科學研究所博士班）　

1. **Electrical Conduction in Materials:** (1) Explain electrical conduction by an energy-band model; (2) Draw a conductivity vs. temperature plot indicating the trend of conductivity change for an insulator, a semiconductor, and a conductor when the temperatures are varied from 0 K to 1000 K. (20%)

2. **Defects in a Crystalline Material:** (1) Describe the types of crystalline defects; (2) How do the defects affect material properties? (You may choose any one material for discussion) (3) Is it possible to completely remove the defects from material? Why?(20%)

3. Discuss devitrification (crystallization) of glass in terms of the viewpoints of supercooling, nucleation and dendritic growth.(20%)

4. What are the driving forces for the densification and coarsening of compact ceramic powders?(20%)

5. List five reasons why alloying elements are added to plain-carbon steel bases to make alloy steels.(20%)

Part I –Polymer synthesis

Give plausible explanations for the following facts:

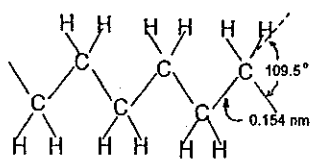
a) Most polymers produced from vinyl monomers are made exclusively from ethylene, monomers that have one substituent on the double bond, or monomers that have two substituents on the same carbon atom of the double bond. Monomers containing one substituent on each carbon of the double bond generally do not polymerize. (15 pts)

b) Polymerization rate and polymer stereochemistry are more sensitive to solvent effects in ionic polymerization than in free radical polymerization. (15 pts)

Part II – Physical properties

1. The polydispersity of molecular size is implied in various definitions of molecular weight.
   (1) Please write done the definitions of number-average molecular weight *Mn* and weight-average molecular weight *Mw*. (6 pts)
   (2) Please prove that *Mn* < *Mw* for polymers. (10 pts)
   (3) For *mono*disperse molecules (such as biological macromolecules), what is the relationship between *Mn* and *Mw*. (4 pts)

2. A linear polyethylene (聚乙烯) of molar mass of 140,000 g/mol, which has a typical C–C bond length of 0.154 nm and a backbone angle of 109.5° as shown below.



   By neglecting its chain end effects, i.e., all repeat unit consists of $-CH_2-$, please calculate
   (1) the end-to-end distance of the fully-extended polyethylene molecule (4 pts)
   (2) the end-to-end distance, if the molecule is a *freely rotating chain*. (8 pts)

3. Most polymers are mainly applied in a solid or bulk form. Among them, there are amorphous polymers having no crystallinity. Atactic polystyrene (無規聚苯乙烯) is a well known example for having steric hindrance (位阻) to prevent crystallization. Please discuss the root-mean-square end-to-end distance of the amorphous polymer with respect to its molecular size in bulk form. (8 pt)

Part III – Polymer Processing

note: remember to define all the symbols you use.

Explain concisely the following questions: (30 pts, 3 pts/each)

1 Viscometric flows
2 Non-linear viscoelastic constitutive equations
3 Three auxiliary parts and their respective function before the mold cavity in a typical injection mold
4 Three regions and their respective function in a general extrusion die
5 Bagley correction in capillary viscometer
6 Screw pump
7 Weld line formation mechanism
8 Fountain flow phenomenon in injection molding process
9 Flow analysis in a coat-hanger die
10 Structuring in the thickness direction in injection molding