

## Homework Assignment #5 (November 20, 2008)

Due date November 27, 2008

### Problems:

1. Calculate the density in grams per cubic centimeter of CsI, which has the CsCl structure. Ionic radii are  $\text{Cs}^+ = 0.165 \text{ nm}$  and  $\text{I}^- = 0.220 \text{ nm}$ .
2. What is the antifluorite structure? What ionic compounds have this structure? What fraction of the tetrahedral interstitial sites are occupied by cations?
3. Explain the plastic deformation mechanism for some single-crystal ionic solids such as NaCl and MgO. What is the preferred slip system?
4. Calculate the average molecular weight  $M_m$  for a thermoplastic that has the following weight fractions  $f_i$  for the molecular ranges listed:

Molecular weight range (g/mol)	$f_i$	Molecular weight range (g/mol)	$f_i$
0-5,000	0.01	20,000-25,000	0.19
5,000-10,000	0.04	25,000-30,000	0.21
10,000-15,000	0.16	30,000-35,000	0.15
15,000-20,000	0.17	35,000-40,000	0.07

5. The stress on a sample of a rubber material at constant strain at  $27^\circ\text{C}$  decreases from 6.0 to 4.0 MPa in three days. (a) What is the relaxation time  $\tau$  for this material? (b) What will be the stress on this material after (i) 15 days and (ii) after 40 days?
6. Write structural formulas for the mers of the following vinyl polymers: (a) polyethylene, (b) polyvinyl chloride, (c) polypropylene, (d) polystyrene, (e) polyacrylonitrile, and (f) polyvinyl acetate. Write a general reaction for the polymerization of a vinylidene polymer.
7. How does chain branching affect the following properties of polyethylene: (a) amount of crystallinity, (b) strength, and (c) elongation?
8. Explain (a) why bulky side groups strengthen thermoplastics; (b) how highly polar atoms bonded to the main carbon chain strengthen thermoplastics; (c) Explain how oxygen atoms covalently bonded in the main carbon chain strengthen thermoplastics. Give an example for each case.
9. Derive an equation relating the elastic modulus of a layered composite of unidirectional fibers and a plastic matrix that is loaded under isostrain conditions.
10. A unidirectional carbon-fiber-epoxy-resin composite contains 68 percent by volume of carbon fiber and 32 percent epoxy resin. The density of the carbon fiber is  $1.79 \text{ g/cm}^3$  and that of the epoxy resin is  $1.20 \text{ g/cm}^3$ . (a) What are the weight percentages of carbon fibers and epoxy resin in the composite? (b) What is the average density of the composite?