IET 307: Materials Science

HW 7 (based on chapters 12 & 13), Due by 11.55 PM, November 7’Th, 2010

100 points

1. What are the AX-Type crystal structures? Explain the rock salt structure, cesium chloride structure & zinc blende structure in a few sentences and then draw a schematic of each structure. (10 points)

ROCK SALT STRUCTURE: the most common crystal structure is sodium chloride. The coordination number for both cations and anions is 6. A unit cell for this crystal structure is generated from an FCC arrangement of anions with one cation situated at the cube center and one at the center of each of the cube's 12 edges.

CESIUM CHLORIDE STRUCTURE: the coordination number is 8 for both of the ion types. The anions are located at each of the corners of a cube, whereas the cube center is a single cation. This isn't a BCC crystal structure because ions of two different kinds are involved.

ZINC BLENDE STRUCTURE: coordination number is 4. All corner and face positions of the cubic cell are occupied by S atoms, while Zn atoms fill interior tetrahedral positions. An equivalent structure results if Zn and S atom positions are reversed. Most often the atomic bonding is highly covalent in compounds exhibiting this crystal structure.

2. Explain in a few sentences for each of the following ceramic materials, their properties and applications (10 points).

(a) Lead zirconium titanate

(b) Cordierite

(c) Barium titanate

(d) Zirconia

3. What material is used to make the tiles that provide thermal protection in NASA’s space shuttle? What properties of this material enable it to be used at very high temperatures? Why is the tensile strength of ceramics much lower than that under a compressive stress? (10 points)

Silica is used to make the space shuttle tiles. It is used because of it's ability to withstand high temperatures.

4. On the basis of crystal structure, compute the theoretical density for manganese sulphide (MnS). How does this compare with its measured density? (Hint: See example problem 12.3 on page 463 of your text book) (10 points).

5. Discuss the various polymorphic forms of carbon and its properties. 10 points)

6. Discuss micro-electro-mechanical systems (MEMS) and why ceramics play an important role in these systems. (10 points)

7. What is the role of Yttria stabilized coating (YSZ) on certain turbine blades? Why does the zirconia have to be stabilized? Give examples of some ceramic materials that are used to make lasers? (10 points)

8. What are some of the important properties of sintered ceramics? Explain the powder pressing process? (10 points)

Powder pressing is used to fabricate both clay and nonclay compositions, including electronic and magnetic ceramics as well as some refactory brick products. In essence a powdered mass, usually containing a small amount of water or other binder, is compacted into the desired shape by pressure.

9. Explain hydroplastic forming & slip casting in a few sentences and then draw schematics of both the process. (10 points)

HYDROPLASTIC FORMING: the molding or shaping of clay based ceramics that have been made plastic and pliable by adding water.

SLIP CASTING: a forming technique used for some ceramic materials. A slip or suspension of solid particles in water is poured into a porous mold. A solid layer forms on the inside wall as water is absorbed by the mold, leaving a shell having the shape of the mold.

10. What are refractrories? Discuss the various types of refractrories. (10 points)

REFRACTORY: a metal or ceramic that may be exposed to extremely high temperatures without deteriorating rapidly or without melting.