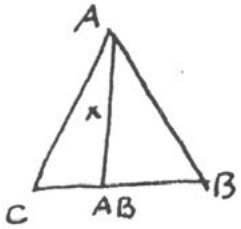
PART I : 50%

1. A few percents (5~15wt%) of Y_2O_3 are added to ZrO_2 ceramics. Indicate the effects of Y_2O_3 addition on the structure change and defects induced in ZrO_2, and describe the possible applications for Y_2O_3 - ZrO_2 ceramic system. (10 %)
2. What is Tm and Tg for polymers ? How to increase Tg for a polymer. (10 %)
3. The corrosion resistance of steels can be improved by Zn coating or Sn coating.Indicate the difference in the protection principles for the two kinds of coating. (10 %)
4. In diffusion of solid, the diffusion coefficient can be described by Arrhenius Equation of D＝Do exp（-Q/RT）.Please explain the physical meanings of Do and Q in the equation. (10%)
5. Please determine the composition(in A , B , C)and phases(in A , B , C , AB) at x in the phase diagram. (10%)



Part II (50%)

1. Modulus of elasticity is a measure of the resistance to separation of adjacent atoms. As a result, Statement 1 says that modulus is proportion to the slope $(dF/dr)_{r0}$ (see Fig. A1) of the interatomic force-separation curve at the equilibrium spacing. However, for ceramic materials, Statement 2 says that the modulus of ceramic materials decreases with porosity as shown in Fig. A2. Is Statement 1 contradictory to Statement 2? Why? (10%)

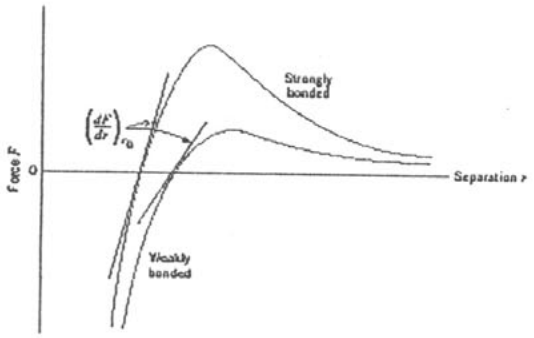


Fig. A1. Force versus interatomic separation for two materials.

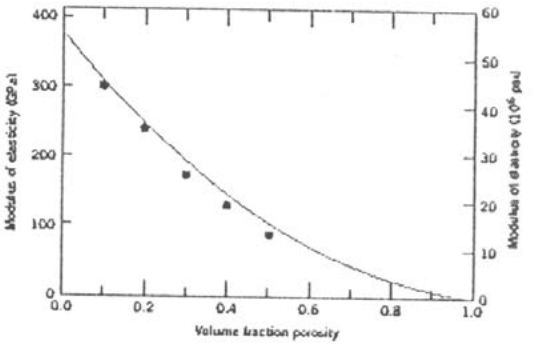


Fig. A2. Modulus of a ceramic as a function of its porosity.

2. In a fiber reinforced composite a critical fiber length exists for effective strengthening and stiffening of the composite. Discuss if this is a sufficient and/or necessary condition. (10%)

3. The word "polarization" is used in various areas in the field of materials science. Describe as many uses as you can and brief explain them. (10%)

4. A metallic thin film may become transparent as the thickness is below a certain value, say, 10 nm. Explain it from the viewpoint of basic optical concepts. (10%)

5. Many scientists believe that diamond is the ultimate material. Diamond therefore has a great potential to replace currently used materials in many applications. Can you use diamond in your mobile phone? Describe and explain the use(s). (10%)