國立交通大學 97 學年度碩士班考試入學試題

科目：材料科學與工程導論(6521)　　考試日期:97 年 3 月 9 日 第 3 節

系所班別：加速器光源科技與應用碩士學位學程　　

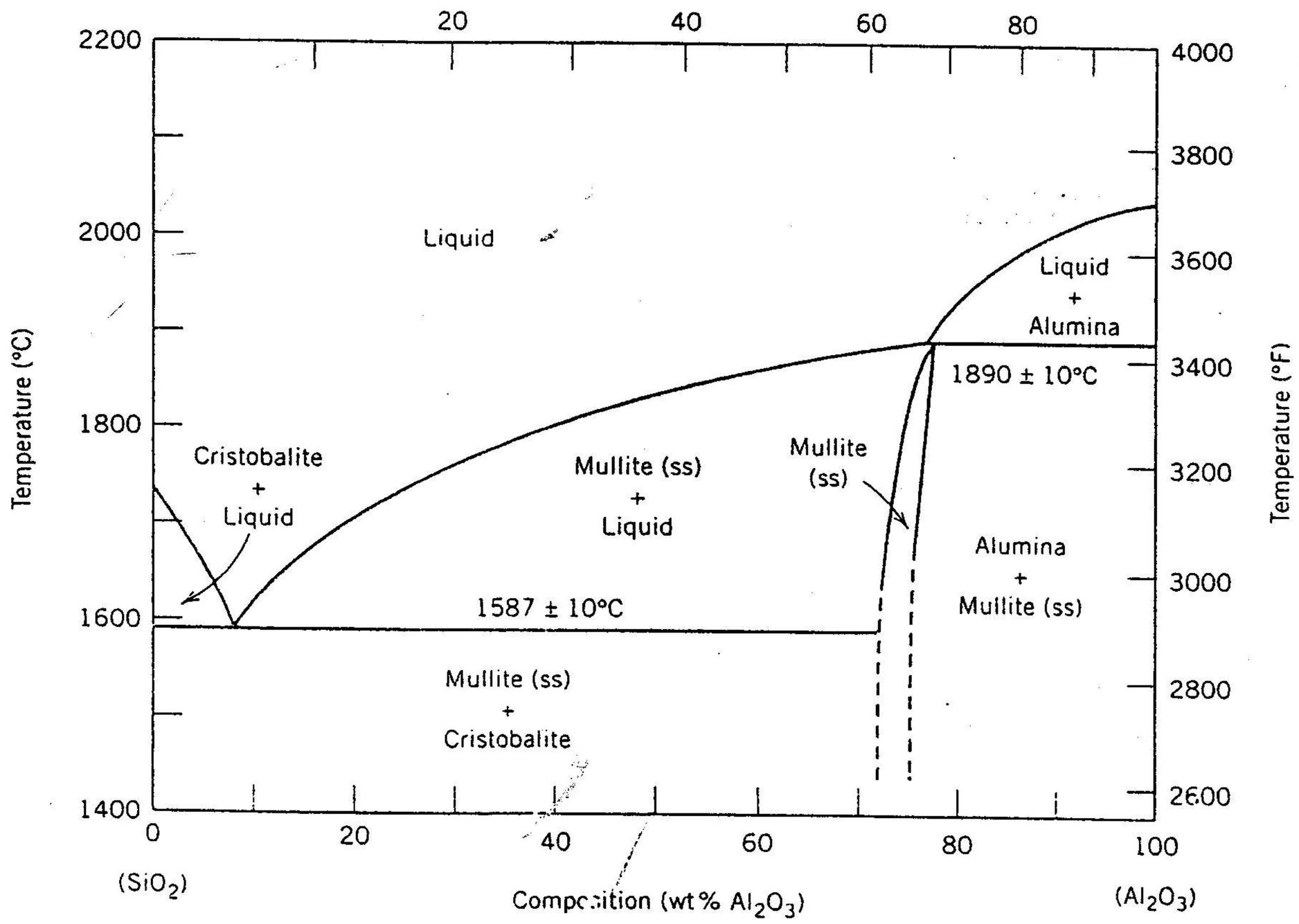
【可使用計算機】＊作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符！！

1. Calculate the minimum cation-to-anion radius ratio for a coordination number of 4 and 8, respectively. (10 points)

2. (a) Consider the phase diagram shown in Figure-1 that is adopted from the SiO_2-Al_2O_3 system. Draw a series of free energy diagrams to illustrate phase equilibria over the entire temperature range. (5 points)

   (b) During rapid cooling of SiO_2-Al_2O_3 liquid, the intermediate phase β (mullite), does not form for kinetic reasons. Redraw the phase diagram to represent this (metastable) situation. Your diagram should be based on a modification of the free energy diagrams in (a). (5 points)

   (c) Another way to process ceramics is to first chemically mix SiO_2 and Al_2O_3 at the atomic level to form an amorphous substance that can be regarded as a supercooled liquid (glass). The mixture is then heated to a relatively low temperature to allow crystallization (if thermodynamics allow) but not long-range diffusion. Thus, the composition remains at a microscopic scale despite crystallization and at any composition that the phase forms is the one that has the lowest free energy. Outline the approximate compositional range in which an amorphous phase must form because of lack of driving force for crystallization in this process. (8 points)



3. A copper single crystal is plastically deformed in tension.

(a) Please derive the resolved shear stress $\tau_R = \sigma \cos\Phi \cos\lambda$. Let Φ represent the angle between the normal to slip plane and the applied stress direction and λ the angle between the slip and stress direction.

(8 points)

(b) The critical resolved shear stress for yielding in Copper is 0.35 MPa. Shear modulus for Copper is 45.2 GPa. You test a copper single crystal by applying uniaxial tensile load along the [001] direction. Calculating the tensile stress required to cause yielding on the $(111)[01\bar{1}]$ slip system. The angle between the tensile axis and the normal to the (111) plane is 54.73° and the angle between [001] and $[01\bar{1}]$ directions is 45°. (4 points)

(c) The lattice parameter for Copper is 3.61 and it has a FCC structure. Calculate the magnitude of the Burgers vector for Copper. (4 points)

4. Calculate the number-average molecular weight ($\overline{Mn}$), the weight-average molecular weight ($\overline{Mw}$), and the polydispersity index (PDI $= \overline{Mw}/\overline{Mn}$) of the following mixtures (a) and (b) prepared from polymer A ($\overline{Mn}$ = 40,000 and PDI=1.5) and polymer B ($\overline{Mn}$ = 80,000 and PDI=2).

(a) 1 moles of polymer A and 2 moles of polymer B.

(b) 1 g of polymer A and 2 g of polymer B.

(10 points)

5. (a) Describe the differences between the amorphous, semicrystalline, and crystalline polymers in terms of their Tg and Tm.

(b) Compare the difference between thermoplastic and thermosetting polymers.

(12 points)

6. (a) What type of structures develop at the intersection of dislocation?

(b) When do these structures affect ductility during a given stress-strain measurement?

(c) How would the stress-strain curve of the metal which depends on dislocation glide for ductility be affected by an array of microvoids?

(12 points)

7. Consider the carburization of a thick iron plate.

(a) If it is decided that the case depth of the plate should be doubled, how will this affect the carburization time? Assume that the carburization temperature is unchanged. (5 points)

(b)What would be the percentage decrease in carburization time when the temperature is increased from 1050℃ to 1150℃. (5 points)

$D = 0.12\ cm^2/sec\ exp\ (-32{,}000/RT)$, $R = 1.99$ cal/mole

8. (a)What is the definition of Mobility?

(b)What are the dopants used for Si semiconductor?

(c)How does the mobility changes with dopant concentration?

(d)For the dopants used for Si semiconductor,which dopant results in the lowest carrier Mobility in Si? (12 points)