

MAT E 201: Solution to Assignment #6

Q1.

Intermetallic compounds are formed from two or more metals. They represent a new phase with its own composition, crystal structure and properties.

$TiAl$ is an intermetallic compound composed of two metals: Ti and Al .

Al_2O_3 is a ceramic compound composed of a metal (Al) and non-metal (O).

Q2.

Eutectic: A three phase invariant reaction in which one liquid phase solidifies to produce two solid phases

Eutectoid: A solid phase transforms into two different solid phases

Peritectic: A liquid and a solid phase combine to produce a second solid phase

Peritectoid: Two solid phases combine to produce a new solid phase

Monotectic: One liquid phase transforms into a solid phase and a second liquid phase

Q3.

Q3 Refer to Fig. 1

a) Pouring temperature 1150°C

b) Superheat $= 1150 - 1000 = 150^{\circ}\text{C}$

c) Liquidus temperature $= 1000^{\circ}\text{C}$

d) Eutectic temperature $= 577^{\circ}\text{C}$

e) Freezing Range $= 1000 - 577 = 423^{\circ}\text{C}$

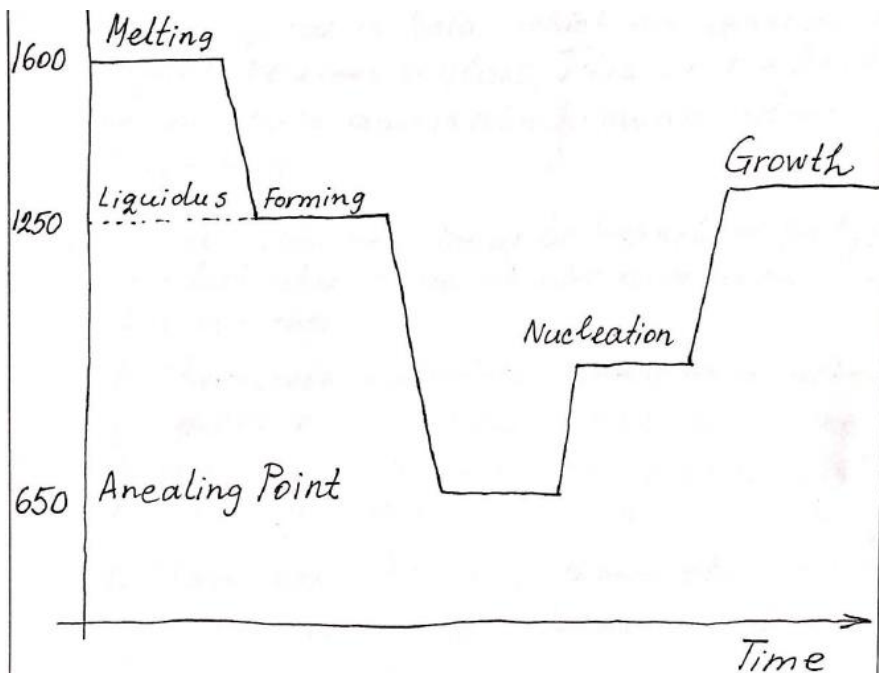
f) Solidification Time $= 11.8 - 1 = 10.8 \text{ min}$

g) Total Solidification Time $= 11.8 \text{ min}$

h) Composition: Refer to Figure 11.9 (Book)

\Rightarrow Approximately 45%

Q4



Example: $\text{Li}_2\text{O} - \text{Al}_2\text{O}_3 - \text{SiO}_2$ system

Glass-ceramics : Materials formed in the glassy-state and allowed to crystallize during a heat treatment

Q5

Most widely used ceramic materials:
 Al_2O_3 (alumina), Diamond (C), Silica (SiO_2)
Silicon carbide (SiC), Silicon Nitride (Si_3N_4)
 TiO_2 , ZrO_2

Q6

The temperature below which an undercooled liquid becomes a glass. This is not a fixed temperature and is also known as glass-transition.

Q7

- a) Thermoplastic : Linear or branched polymer in which chains are not inter-connected to one another.
- b) Thermosetting plastics : Linear or branched polymers in which chains are cross-linked to one another to form three-dimensional network structures.

c) Elastomers - Polymers (thermoplastics or lightly cross-linked thermosets) that have an elastic deformation $> 200\%$

d) Thermoplastic Elastomers: Polymers that are heavily cross-linked to produce strong three-dimensional structures.

Q 8 Polyvinyl chloride, From Table 16-3 Repeat unit

$$\begin{array}{c} \text{Cl} \quad \text{Cl} \\ | \quad | \\ \cdots - \text{C} - \text{C} - \cdots \\ | \quad | \\ \text{Cl} \quad \text{Cl} \end{array} \quad M_r'(\text{C}_2\text{H}_3\text{Cl}) = 2 \cdot 12 + 3 \cdot 1 + 35.5 = 62.5 \text{ g/mol}$$

$$M_r = 150000 \text{ g/mol}$$

a) Degree of polymerization (DP) $DP = \frac{M_r}{M_r'}$

$$DP = \frac{150000}{62.5} = 2400$$

b) Number of chains in 5g of polymer:

$$\frac{1 \text{ mol (150000 g)}}{5 \text{ g}} \quad \frac{6.023 \cdot 10^{23} \text{ chains}}{n}$$

$$n = \frac{5 \cdot 6.023 \cdot 10^{23}}{150000} = 2.0077 \cdot 10^{19} \text{ chains}$$

Q 9 Repeat unit (RU) $\cdots - \begin{array}{c} \text{F} \quad \text{F} \\ | \quad | \\ \text{C} - \text{C} \\ | \quad | \\ \text{F} \quad \text{F} \end{array} - \cdots$

$$M_r'(\text{RU}) = 2 \cdot 12 + 4 \cdot 19 = 100 \text{ g/mol}$$

$$a) DP = \frac{M_r(\text{PTFE})}{M_r'(\text{RU})}; \quad M_r(\text{PTFE}) = DP \cdot M_r'(\text{RU}) = 5000 \cdot 100$$

$$M(\text{PTFE}) = 500000 \text{ g/mol}$$

b) Mass of the polymer

$$\frac{1 \text{ mol (500000 g)}}{m} \quad \frac{6.023 \cdot 10^{23} \text{ chains}}{5 \cdot 10^{21} \text{ chains}}$$

$$m = \frac{500000 \cdot 5 \cdot 10^{21}}{6.023 \cdot 10^{23}} = 4150.76 \text{ g}$$