MAT E 201: Solution to Assignment #1

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Q1.

a) ***Composition*** is the chemical make-up of a material.

b) ***Structure*** is a description of arrangements of atoms or ions in materials.

c) ***Synthesis*** is a process by which materials are made from naturally occurred or other chemicals.

d) ***Processing*** is a method for shaping materials into useful components or changing their properties.

e) ***Microstructure*** is a structure of a material at a length scale of about 10-1000nm.

Q2.

Materials Science is a field that emphasizes studies of relationship between the structure, synthesis, processing and the properties of materials**.**

Materials engineering focuses on how to transform materials into useful device and structure.

Q3.

Microstructure: Length scale is about 10 to 1000 nm.

Macrostructure: Length scale is more than 1000 nm.

Q4. $A_r(Bi) = 208.98\ g/mol$, $\rho(Bi) = 9.808\ g/cm^3$

$N(Bi) = 2.5 \cdot 10^{21}$ atoms, $N_A = 6.023 \cdot 10^{23}\ at/mol$

$S = 50\ cm^2$

$$m(Bi) = \frac{N(Bi) \cdot A_r(Bi)}{N_A} = \frac{2.5 \cdot 10^{21}\ at. \cdot 208.98\ g/mol}{6.023 \cdot 10^{23}\ at/mol}$$

$$\boxed{m(Bi) = 0.86742\ g}$$

Thickness: $V = S \cdot \delta$

$$\rho = \frac{m}{V} \qquad V = \frac{m}{\rho} \Rightarrow \delta = \frac{m}{S \cdot \rho}$$

$$\delta = \frac{0.86742\ g}{50\ cm^2 \cdot 9.808\ g/cm^3} = 1.76881 \cdot 10^{-3}\ cm$$

$1\ \mu m = 10^{-6}\ m = 10^{-4}\ cm \Rightarrow$ $\boxed{\delta = 17.6881\ \mu m}$

Q5 In : $\rho = 7.286\ g/cm^3$, $A_r(In) = 114.82\ g/mol$

Al : $\rho = 2.699\ g/cm^3$, $A_r(Al) = 26.981\ g/mol$

$$N = \frac{\rho N_A}{A_r}$$

a) Indium: $N = \frac{7.286 \cdot 6.023 \cdot 10^{23}}{114.82} = 3.821945 \cdot 10^{22}$

b) Aluminum: $N = \frac{2.699 \cdot 6.023 \cdot 10^{23}}{26.981} = 6.025009 \cdot 10^{22}$

$\Rightarrow$ Al has more atoms than In per cm^3

$$N_{Al} > N_{In}$$

Q6 Tungsten film, $S = 3\,cm^2$, $d = 2\,\mu m = 2 \cdot 10^{-4}\,cm$

$A_r(W) = 183.85\,g/mol$, $\rho(W) = 19.254\,g/cm^3$

$$N(W) = \frac{m(W)\,N_A}{A_r(W)} \qquad m(W) = ?$$

$$m = \rho V = \rho \cdot S \cdot d$$

$$m = 19.254 \cdot 3 \cdot 2 \cdot 10^{-4} = 0.0115524\,g$$

a) $$N(W) = \frac{0.0115524 \cdot 6.023 \cdot 10^{23}}{183.85} = 3.7846 \cdot 10^{19}\ atoms$$

b) $$\text{Number of W moles} = \frac{0.0115524\,g}{183.85\,g/mol} = 6.2836 \cdot 10^{-5}\,mol$$

Q7 Valence 2, Atomic Number 27

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$

$\downarrow$

$3d^7\ 4s^2$

$\Rightarrow$ 7 electrons

Q8 Sb_2S_3 Electronegativity of Sb = 2
Electronegativity of S = 2.5

$$\Delta E = 2.5 - 2 = 0.5$$

$$\text{Fraction Covalent} = \exp(-0.25\,\Delta E^2) = \exp(-0.25 \cdot 0.5^2) = 0.9394$$

$$\text{Fraction Ionic} = 1 - 0.9394 = 0.0606$$