Oct. 15/18

$$\% \text{ Crystallinity} = \frac{\rho_c(\rho_s - \rho_a)}{\rho_s(\rho_c - \rho_a)} \times 100\%$$

linear + limited side branches $>$ crosslinked + Network
more crystalline

Example 14.2 →

$$\rho_c = \frac{n \times A}{V \times N_A} \Rightarrow \frac{(2 \text{ repeat unit})(28.05 \text{ g/mol})}{(9.33 \times 10^{-23} \text{ cm}^3)(6.022 \times 10^{23} \text{ repeat units/mol})}$$

1m = 100 cm
1m = 10^9 nm

(Pure crystal)

Volume = (0.225 nm)(0.494 nm)(0.741 nm) → 9.33×10^{-23} cm³

$n = 2$

$-(C_2H_4)-$ = $A = (2 \times 12.01 \text{ g/mol}) + (4 \times 1.008 \text{ g/mol}) = 28.05$ g/mol

∴ $\rho_c = 0.998$ g/cm³

b) $$\% \text{ crystallinity} = \frac{\rho_c(\rho_s - \rho_a)}{\rho_s(\rho_c - \rho_a)} \times 100\%$$

$$\Rightarrow \frac{(0.998)[(0.925 - 0.870)]}{(0.925)[(0.998 - 0.870)]} \times 100\%$$

$\Rightarrow$ 46.4 %

- END OF CHAPTER 14
- START OF CHAPTER 4

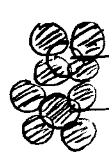
Vacancy → (pure metals)
interstitial
Substitutional → interstitial – alloys

} Point defects, zero dimensional

Self-interstitial – pure metals

Dislocations : line defects
- one dimensional

Grain boundaries : area defects
- two dimensional



→ Vacancy (missing atom) — related to diffusion (Chapter 5)

→ Self interstitial (atom squished into structure)

Imperfections of metals

- just below the melting point of metals : 1 atom is missing, in 10000 atoms

Example :

$$\frac{N_v}{N} = \exp\left(\frac{-Q_v}{kT}\right)$$

$\rho\,(g/cm^3) \times (Mol/(A)g) \times (N_A\ \frac{atoms}{mol}) \times (\frac{100\ cm}{1\ m})^3 = atom/m^3$

e.g. $N = 7.65\ g/cm^3 \times (100cm/(m))^3 \times (1/55.85\ g/mol) \times (6.022 \times 10^{23}\ atom/mol)$

$= 8.75 \times 10^{28}$ atoms / m^3

$T = 850 + 273 = 1123\ K$

$N_v = 8.25 \times 10^{28}\ atoms/m^3\ \exp\left(-\frac{1.08\ eV/atom}{8.62 \times 10^{-5}\ eV/atom\,K \times 1123\ K}\right)$

$= 1.18 \times 10^{24}\ \frac{vacancies}{m^3}$

NiCu : solvent (greater amount), solute (minor concentration)

Substitutional solid - one phase

FeC : interstitial solid, Fe large atoms, C in-between

AISI/SAE : 1060 → wt. ×100% (0.6%)

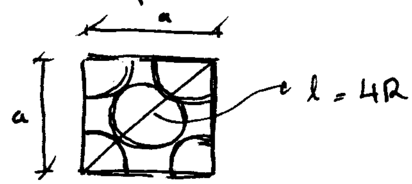
↳ alloy content (Fe, C, Mn)

Rules :

1. atomic size Factor
2. FCC → FCC
3. large difference – intermetallic compounds
4. Al^{+3}, Ni^{+2} { 5 wt % of Al in Ni, but only 0.04% Ni in Al

Cu^{+1}, Zn^{+2} { Zn in Cu : 35%, Cu in Zn : 1%

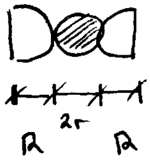
(A) Example :



$$a^2 + a^2 = 16R^2 \rightarrow a = 2\sqrt{2}R$$

$$2\sqrt{2}R = 2(r + R)$$

$$r/R = \sqrt{2} - 1 = 0.414$$



$$a = 2(r + R)$$

Instead $\left[\ a/2 = r + R \longrightarrow \frac{r}{R} = \sqrt{2} - 1 = 0.414\ \right]$

$R_{Fe} = 0.124$ nm

$r = 0.051$ nm

$r_c = 0.071$ nm

Tetrahedral : $r/R = 0.225$
↳ FCC

Tetrahedral : $r/R = 0.291$
↳ BCC

For Fe : $r = 0.036$ nm

Octahedral : $r/R = 0.155$
↳ BCC

(B) Example :

Basis 100g of the alloy

{ 97g Fe, 3g Si }

$$97\ g \times \frac{1}{(55.85\ g/mol)} = 1.7378\ \text{Mol Fe}$$

$$3\ g \times \frac{1}{(28.09\ g/mol)} = 0.1068\ \text{Mol Si}$$

1.8446 mol

Fe : $\text{mol \%} = \left(\frac{1.7378}{1.8446}\right) \times 100\ \% = 94.21\ \%$

Si : $100 - 94.21\ \% = 5.79\ \%$

(c) Number of moles of Ge per cm^3

basis : 100 g

15 g Ge
85 g Si

moles of Ge : $15/72.59 = 0.21$ moles

moles of Si : $85/28.09 = 3.02$ moles

Volume of Ge $= \frac{15g}{5.32\ g/cm^3} = 2.82\ cm^3$

Volume of Si $= \frac{85g}{2.33\ g/cm^3} = 36.48\ cm^3$

total : 39.3 cm^3

a) $\frac{\text{Number of moles of Ge}}{cm^3} = \frac{0.21}{39.3} = 0.0053\ \frac{mol}{cm^3}$

b) $(0.0053\ mol/cm^3)(6.022 \times 10^{23}\ atoms/mol)$

$= 3.21786 \times 10^{21}\ atoms/cm^3$