{재료공학원리}

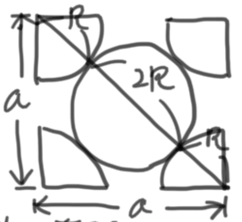
Chapter 4 예제문제 풀이

Example problem 4.1)

: Let a as a cube edge length.

The cube edge length a and the atomic radius R are related through $a = 2R\sqrt{V}$.

∵



$$a^2 + a^2 = (4R)^2$$
$$2a^2 = 16R^2$$
$$a^2 = 8R^2$$
$$a = 2R\sqrt{2}$$

The FCC unit cell volume $V_c = a^3$

$$= (2R\sqrt{2})^3$$
$$= 16R^3\sqrt{2}$$

Example problem 4.2)

$$\text{Atomic packing factor} = \frac{(\text{number of atoms per unit cell}) \times (\text{volumes for a sphere})}{\text{total unit cell volume}}$$

i) Volumes for a sphere $= \frac{4}{3}\pi R^3$

ii) Number of atoms per unit cell $= N_i + \frac{N_f}{2} + \frac{N_c}{8}$

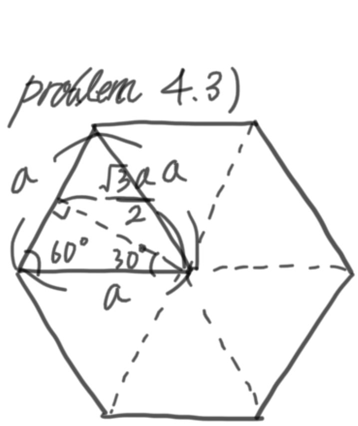
$$= 0 + \frac{6}{2} + \frac{8}{8}$$
$$= 4.$$

iii) According to Example problem 4.1, total unit cell volume $= 16R^3\sqrt{2}$.

$$\therefore APF = \frac{4 \times \frac{4}{3}\pi R^3}{16R^3\sqrt{2}} = \frac{\pi}{3\sqrt{2}} \approx 0.74.$$

Example problem 4.3)

(a)



The base area of HCP unit cell

$$= 6 \times \frac{\sqrt{3}a}{2} \times \frac{a}{2} = \frac{3\sqrt{3}a^2}{2}$$

∴ The volume of HCP unit cell

$$= \frac{3\sqrt{3}a^2}{2} \times c = \frac{3a^2c\sqrt{3}}{2}$$

(b)

$a = 2R$,

$$\therefore V_C = \frac{3a^2c\sqrt{3}}{2} = \frac{3(2R)^2c\sqrt{3}}{2} = 6R^2c\sqrt{3}$$

Example problem 4.4)

Theoretical density $\rho = \frac{nA_{Cu}}{V_C N_A}$

i) Volumes of the unit cell $= 16R^3\sqrt{2} = 16(0.128 \times 10^{-8})^3\sqrt{2}.cm^3$

ii) Numbers of atoms associated with each unit cell $= 4$.

iii) Atomic weight $= 63.5\ g/mol$

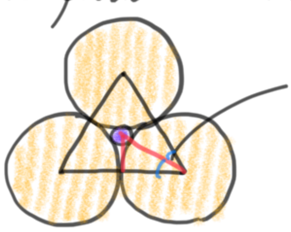
iv) Avogadro's number $= 6.022 \times 10^{23}$ atoms/mol

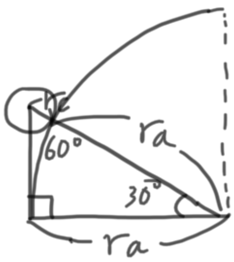
$$\therefore \rho = \frac{(4\ \text{atoms/unit cell})(63.5\ g/mol)}{[16\sqrt{2}(1.28 \times 10^{-8}\ cm)^3/\text{unit cell}](6.022 \times 10^{23}\ \text{atoms/mol})}$$

$$= \frac{4 \times 10 \times (63.5\ g)}{(16\sqrt{2}) \times (1.28)^3 \times 6.022}$$

$$\approx 8.89$$

Example problem 4.5)





$$\frac{r_A}{r_A + r_C} = \frac{\sqrt{3}}{2}$$

$(\because \cos 30° = \frac{\sqrt{3}}{2})$

let $r_A = \sqrt{3}x$, $r_C = (2-\sqrt{3})x$

Cation-anion radius $\frac{r_C}{r_A} = \frac{(2-\sqrt{3})x}{\sqrt{3}x} = \frac{2-\sqrt{3}}{\sqrt{3}}$

$$= \frac{2\sqrt{3}-3}{3}$$

$$\approx 0.155$$