

## **MAT E 201: Solution to Assignment #2**

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**Q1.**

*Polycrystalline materials* are composed of many crystallites of varying size and orientation. Most inorganic solids are polycrystalline, including all common metals, many ceramics, rocks, and ice.

**Q2.**

*Liquid Crystals* are usually polymeric materials that are typically amorphous but can become partially crystalline when an external electric field or heat is applied.

**Q3.**

*Amorphous* materials exhibit only a SRO (short range order) and no LRO (Long range order)

Q4.

a) Metal with  $a_0 = 4.0415 \text{ \AA}$ ,  $r = 1.75 \text{ \AA}$   
one atom per lattice point

SC:  $a_0 = 2r$        $2 \cdot 1.75 = 3.50 \text{ \AA} \neq 4.0415 \text{ \AA}$

BCC:  $a_0 = \frac{4r}{\sqrt{3}} = \frac{4 \cdot 1.75}{\sqrt{3}} = 4.04145 \text{ \AA} \approx 4.0415 \text{ \AA}$

$\Rightarrow$  BCC structure

b) Metal with  $a_0 = 0.42906 \text{ nm}$ ,  $r = 0.1517 \text{ nm}$

SC:  $a_0 = 2r$        $2 \cdot 0.1517 = 0.3034 \text{ nm} \neq 0.42906 \text{ nm}$

BCC:  $a_0 = \frac{4r}{\sqrt{3}} = \frac{4 \cdot 0.1517}{\sqrt{3}} = 0.3503 \text{ nm} \neq 0.42906 \text{ nm}$

FCC:  $a_0 = \frac{4r}{\sqrt{2}} = \frac{4 \cdot 0.1517}{\sqrt{2}} = 0.42907 \approx 0.42906 \text{ nm}$

$\Rightarrow$  FCC structure

Q5 Fe, BCC structure,  $\rho = 7.87 \text{ g/cm}^3$ ,  $A_r(\text{Fe}) = 55.847 \frac{\text{g}}{\text{mol}}$

a)  $a_0 = ?$

$$\rho = \frac{N \cdot A_r}{V_{uc} \cdot N_A} \Rightarrow V_{uc} = a_0^3 = \frac{N \cdot A_r}{\rho \cdot N_A} = \frac{2 \cdot 55.847}{7.87 \cdot 6.023 \cdot 10^{23}} = 2.3564 \cdot 10^{-24} \text{ cm}^3$$

$$\Rightarrow a_0 = 2.866 \cdot 10^{-8} \text{ cm}$$

b) BCC  $\Rightarrow a_0 = \frac{4r}{\sqrt{3}} \Rightarrow r = \frac{a_0 \sqrt{3}}{4}$

$$r = 1.241 \cdot 10^{-8} \text{ cm}$$

Q6  $\rho = 19.302 \text{ g/cm}^3$ ,  $A_r = 196.97 \text{ g/mol}$ ,  $a_0 = 4.0786 \text{ \AA}$   
 $a_0 = 4.0786 \cdot 10^{-8} \text{ cm}$

$$\rho = \frac{N_{\text{at/u.c.}} \cdot A_r}{a_0^3 \cdot N_A} \Rightarrow N_{\text{at/u.c.}} = \frac{\rho \cdot a_0^3 \cdot N_A}{A_r}$$

$$N_{\text{at/u.c.}} = \frac{19.302 \text{ g/cm}^3 \cdot (4.0786 \cdot 10^{-8} \text{ cm})^3 \cdot 6.023 \cdot 10^{23} \text{ at/mol}}{196.97 \text{ g/mol}}$$

$$N_{\text{at/u.c.}} = 4.004501257 \approx 4 \Rightarrow \text{FCC structure}$$

Q7  $\gamma$ ,  $a_0 = 0.3648 \text{ nm}$ ,  $c_0 = 0.5732 \text{ nm}$

$$r_\gamma = 0.1824 \text{ nm}, \rho = 4.469 \text{ g/cm}^3, A_r(\gamma) = 88.9 \text{ g/mol}$$

$$V_{\text{uc.}} = a_0^2 c_0 \cos 30^\circ = (3.648 \cdot 10^{-8})^2 \cdot (5.732 \cdot 10^{-8}) \cos 30^\circ$$

$$V_{\text{uc.}} = 6.60612 \cdot 10^{-23} \text{ cm}^3$$

$$N_{\text{at/u.c.}} = \frac{\rho \cdot V_{\text{uc.}} \cdot N_A}{A_r(\gamma)} = \frac{4.469 \cdot 6.60612 \cdot 10^{-23} \cdot 6.023 \cdot 10^{23}}{88.91}$$

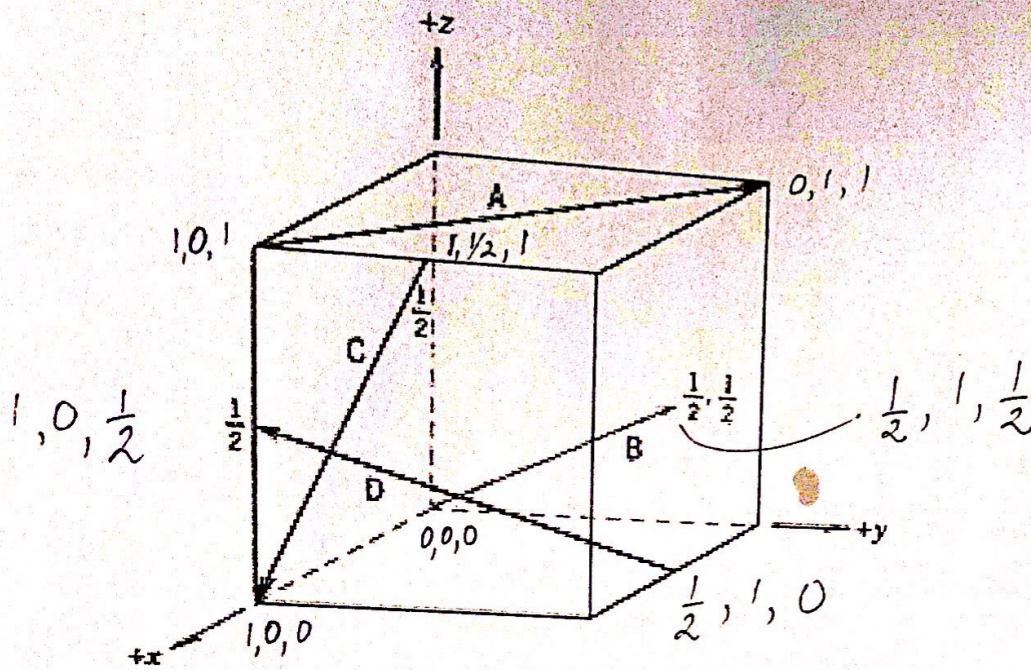
$$N_{\text{at/u.c.}} = 1.999949734 \approx 2$$

b)  $p_F = \frac{N_{\text{at/u.c.}} \cdot V_{\text{at}}}{V_{\text{uc}}} = \frac{2 \cdot \frac{4}{3} \pi (1.824 \cdot 10^{-8})^3}{6.60612 \cdot 10^{-23}} =$   
 $= 0.769$



Figure 1. Assignment No.2

Dr. S. Djokić



$$\vec{A} \quad 0,1,1 - 1,0,1 = -1,1,0$$

No Fractions to clear  $\Rightarrow [\bar{1}10]$

$$\vec{B} \quad \frac{1}{2}, 1, \frac{1}{2} - 0,0,0 = \frac{1}{2}, 1, \frac{1}{2} \quad / \cdot 2$$

$$1, 2, 1 \Rightarrow [121]$$

$$\vec{C} \quad 1,0,0 - 1,\frac{1}{2},1 = 0,-\frac{1}{2},-1 \quad / \cdot 2$$

$$0, -1, -2 \Rightarrow [0\bar{1}\bar{2}]$$

$$\vec{D} \quad 1,0,\frac{1}{2} - \frac{1}{2},1,0 = \frac{1}{2}, -1, \frac{1}{2} \quad / \cdot 2$$

$$1, -2, 1 \Rightarrow [1\bar{2}1]$$