SAP ID - 60004200182
Name - Ayush Jain

03/04/2021

Engineering Physics

2) $n_1 = 1$, $\theta_1 = 3.4^\circ$
$n_2 = 2$, $\theta_2 = ?$

We know,

$$n\lambda = 2d\sin\theta$$

$$n_1\lambda = 2d\sin\theta_1 \quad -(1)$$

$$n_2\lambda = 2d\sin\theta_2 \quad -(2)$$

$(1) \div (2)$

$$\therefore \frac{n_1}{n_2} = \frac{\sin\theta_1}{\sin\theta_2}$$

$$\frac{1}{2} = \frac{\sin(3.4)}{\sin\theta_2}$$

$$\sin\theta_2 = 2\sin 3.4$$

$$\theta_2 = \sin^{-1}(2\sin 3.4)$$

$$\theta_2 = 6.81^\circ$$

3) $n = 1$, $\theta = 21.7^\circ$
$\lambda = 1.54\,\mathring{A}$
To find: $d = ?$
$\therefore$ We know that,

$$n\lambda = 2d\sin\theta$$

$$1 \times 1.54 \times 10^{-10} = 2 \times d \times \sin(21.7)$$

$$\therefore d = \frac{1.54 \times 10^{-10}}{2\sin(21.7)}$$

$$d = 2.083\,\mathring{A}$$

$\therefore$ Here, $d = a$ ~~property of~~ since planes are parallel.

4) $d = 2.82\,\mathring{A}$, $n = 1$

$\theta_1 = 10^\circ$

∴ By Bragg's law,

$n\lambda = 2d\sin\theta$

∴ $1 \times \lambda = 2 \times 2.82 \times \sin 10$

$\lambda = 0.979\,\mathring{A}$

For, $n = 2$, $\theta = ?$

$n\lambda = 2d\sin\theta$

$2 \times 0.979 = 2 \times 2.82 \sin\theta_2$

$\sin\theta_2 = \frac{2 \times 0.979}{2 \times 2.82}$

$\theta_2 = \sin^{-1}\left(\frac{0.979}{2.82}\right) = 20.31^\circ$

$= 20^\circ 18'$

For highest order diffraction, $\sin\theta$ must be maximum.

∴ $\sin\theta = 1$

$d = 2.82$

$\lambda = 0.979$

∴ $n\lambda = 2d\sin\theta$

$n \times 0.979 = 2 \times 2.82 \times 1$

$n = \frac{2 \times 2.82}{0.979}$

$n \leq 5.76$

∴ Highest order $= 5$

5) $n = 1$, plane $= (111)$, $\theta = 30^\circ$, $\lambda = 1.75\,\mathring{A}$

∴ We know that,

$n\lambda = 2d\sin\theta$

$1 \times 1.75 \times 10^{-10} = 2 \times d \sin(30)$

$d = \frac{1.75 \times 10^{-10}}{2\sin 30}$

$d = 1.75\,\mathring{A}$

Now, $d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$

$1.75 \times 10^{-10} = \frac{a}{\sqrt{1+1+1}}$

∴ $a = 1.75 \times 10^{-10} \times \sqrt{3}$

$a = 3.03\,\mathring{A}$

6) $d = 0.58 \mathring{A}$, Plane = (132), n = 2, $a = 3.81 \mathring{A}$

$\therefore$ By Bragg's law,

$n\lambda = 2d\sin\theta$

$\theta = \sin^{-1}\left(\frac{n\lambda}{2d}\right)$

$= \sin^{-1}\left(\frac{\cancel{2} \times 0.58 \times 10^{-10}}{\cancel{2} \times 1.018 \times 10^{-10}}\right)$

$\theta = \cancel{\sin^{-1}}$ = 34.72

$d = \frac{a}{\sqrt{h^2+k^2+l^2}}$

$= \frac{3.81}{\sqrt{1+9+4}} = \frac{3.81}{\sqrt{14}}$

$= 1.018 \mathring{A}$

7) n = 1, $\theta = 20^\circ$, Plane = (212), $a = 3.615 \mathring{A}$

To find : $d = ?$

$\therefore d = \frac{a}{\sqrt{h^2+k^2+l^2}} = \frac{3.615}{\sqrt{2^2+1^2+2^2}} = \frac{3.615}{\sqrt{9}} = 1.205 \mathring{A}$

Now,

$n\lambda = 2d\sin\theta$

$1.\lambda = 2 \times 1.205 \times \sin(20)$

$\lambda = 0.824 \mathring{A}$

8) $d = 1.549\,\mathring{A}$, $d = 4.255\,\mathring{A}$

For smallest glancing angle, $n = 1$

$\therefore \theta = \sin^{-1}\left(\frac{d}{2d}\right) = \sin^{-1}\left(\frac{1.549}{2\times 4.255}\right) = 10.486\,\mathring{A}$

For highest order,

We know that $\sin\theta \leq 1$

$\therefore$ for $n=1$, $\sin\theta = \frac{nd}{2d} = \frac{d}{2d} = \frac{1.549}{2\times 4.255} = 0.18$

for $n=2$, $\sin\theta = \frac{2\times 1.549}{2\times 4.255} = 0.36$

for $n=3$, $\sin\theta = \frac{3\times 1.549}{2\times 4.255} = 0.54$

for $n=4$, $\sin\theta = \frac{4\times 1.549}{2\times 4.255} = 0.72$

for $n=5$, $\sin\theta = \frac{5\times 1.549}{2\times 4.255} = 0.9$

for $n=6$, $\sin\theta = \frac{6\times 1.549}{2\times 4.255} = 1.087 > 1$

$\therefore$ As $\sin\theta$ cannot be greater than 1, highest order possible is 5.

9) Given: $\theta_1 = 5.4°$, Plane (100)

$\theta_2 = 7.6°$, ~~Plane (9.4°)~~ Plane (110)

$\theta_3 = 9.4°$, Plane (111)

$n = 1$.

∴ Using Bragg's law,

$n\lambda = 2d\sin\theta$.

$\therefore d = \dfrac{\lambda}{2\sin\theta}$

$\therefore$ for (100), $d_1 = \dfrac{\lambda}{2\sin(5.4)} = \dfrac{\lambda}{0.1882}$

for (110), $d_2 = \dfrac{\lambda}{2\sin(7.6)} = \dfrac{\lambda}{0.2645}$

for (111), $d_3 = \dfrac{\lambda}{2\sin(9.4)} = \dfrac{\lambda}{0.3266}$

$\therefore d_1 : d_2 : d_3 = \dfrac{\lambda}{0.1882} : \dfrac{\lambda}{0.2645} : \dfrac{\lambda}{0.3266}$

$= 1 : 0.711 : 0.576$

$\therefore d_1 : d_2 : d_3 = 1 : \dfrac{1}{\sqrt{2}} : \dfrac{1}{\sqrt{3}}$

∴ It is SC.

10) $\lambda = 0.71 \mathring{A}$

$(hkl) = (200)$

$n = 2$

$\rho = 1.99 \times 10^3 \ kg/m^3$

Weight $= 74.6$

To find: $d = ?$, $\theta = ?$

We know that,

$$\rho = \frac{Z \times M}{N_a \times a^3}$$

$$\therefore a^3 = \frac{Z \times M}{N_a \times \rho} = \frac{4 \times 74.6 \times 10^{-3}}{6.022 \times 10^{23} \times 1.99 \times 10^3}$$

$$\therefore a^3 = 249 \times 10^{-30}$$

$$a = 6.29 \times 10^{-10} = 6.29 \mathring{A}$$

$$\therefore d = \frac{a}{\sqrt{h^2+k^2+l^2}} = \frac{6.29}{\sqrt{4+0+0}} = \frac{6.29}{2} = 3.145 \mathring{A}$$

By Bragg's law,

$$n\lambda = 2d\sin\theta$$

$$2 \times 0.71 = 2 \times (3.145) \sin\theta$$

$$\therefore \theta = \sin^{-1}(0.2257)$$

$$\theta = 13.05'$$