GEOL3010 X-Rays Problem Set 7

1. Mo k-series radiation has an absorption edge corresponding to a wavelength of 0.61977 Å. The $k\alpha_1$ line has a wavelength of 0.70926 Å and the $k\beta_1$, a wavelength of 0.63225 Å.

A. What is the minimum potential in KV that can be used to produce Mo k-series radiation from a Mo-target X-ray tube?

Convert the energy of the absorption edge to eV.

$E = hc/\lambda$

$E = 6.6*10^{-34}*3.0*10^{8}/0.61977*10^{-10}$

$E = 3.1047*10^{-15}$ joules

$E = 3.1047*10^{-15} / 1.602*10^{-19}$

E = 19,947 eV

Voltage = 19.947 KV

B. What is the frequency of Mo $k\beta$ radiation?

$\nu = c/\lambda$

$\nu = 3*10^{8}/0.63225*10^{-10}$

$\nu = 4.745*10^{18}$ hz

C. Nb has an absorption edge corresponding to a wavelength of 0.65291Å. Can Nb be used as a β-filter for Mo radiation? Why?

$K\beta$ (Mo)= 0.63225Å Is this energetic enough to remove inner K-shell electrons from Nb?

Yes

$K\alpha$(Mo) = 0.70926Å Is this energetic enough to remove inner K-shell electrons from Nb?

No

Then the $K\beta$ of Mo will be absorbed strongly but the $K\alpha$ will not. So it can be used as a β-filter.

Planck's Constant = 6.6 x 10^{-34} joule-sec
1 ev = 1.6016 x 10^{-19} joule
c = 3.0 x 10^{8} m/sec

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2. Barite ($BaSO_4$) has orthorhombic cell edges *a* = 7.157 Å, *b* = 8.884Å, and *c* = 5.457Å. Calculate 2θ for Cukα radiation λ = 1.5405Å) for the following X-ray diffractions:

a. (002)

$d = 1/[h^2/a^2 + k^2/b^2 + l^2/c^2]^{1/2}$
$d = c/2$
$d = 2.728$Å

$\lambda = 2d * \sin\theta$
$2\theta = 2*\sin^{-1}(\lambda/2d)$
$2\theta = 2* \sin^{-1}(1.5405/5.457)$
$2\theta = 32.79^o$

b. (110)

$d = 1/[h^2/a^2 + k^2/b^2 + l^2/c^2]^{1/2}$
$d = 1/[(1/7.157)^2+(1/8.884)^2]^{1/2}$
$d = 5.574$Å

$\lambda = 2d * \sin\theta$
$2\theta = 2*\sin^{-1}(\lambda/2d)$
$2\theta = 2* \sin^{-1}(1.5405/2*5.574)$
$2\theta = 15.88^o$

c. (021)

$d = 1/[h^2/a^2 + k^2/b^2 + l^2/c^2]^{1/2}$
$d = 1/[(2/8.884)^2+(1/5.457)^2]^{1/2}$
$d = 3.445$Å

$\lambda = 2d * \sin\theta$
$2\theta = 2*\sin^{-1}(\lambda/2d)$
$2\theta = 2* \sin^{-1}(1.5405/2*3.445)$
$2\theta = 25.84^o$

d. (111)

$d = 1/[h^2/a^2 + k^2/b^2 + l^2/c^2]^{1/2}$
$d = 1/[(1/7.157)^2+(1/8.884)^2+(1/5.457)^2]^{1/2}$
$d = 3.899$Å

$\lambda = 2d * \sin\theta$
$2\theta = 2*\sin^{-1}(\lambda/2d)$
$2\theta = 2* \sin^{-1}(1.5405/2*3.899)$
$2\theta = 22.79^o$

e. (301)

$d = 1/[h^2/a^2 + k^2/b^2 + l^2/c^2]^{1/2}$
$d = 1/[(3/7.157)^2+(1/5.457)^2]^{1/2}$
$d = 2.262$Å

$\lambda = 2d * \sin\theta$
$2\theta = 2*\sin^{-1}(\lambda/2d)$
$2\theta = 2* \sin^{-1}(1.5405/2*2.262)$
$2\theta = 39.82^o$