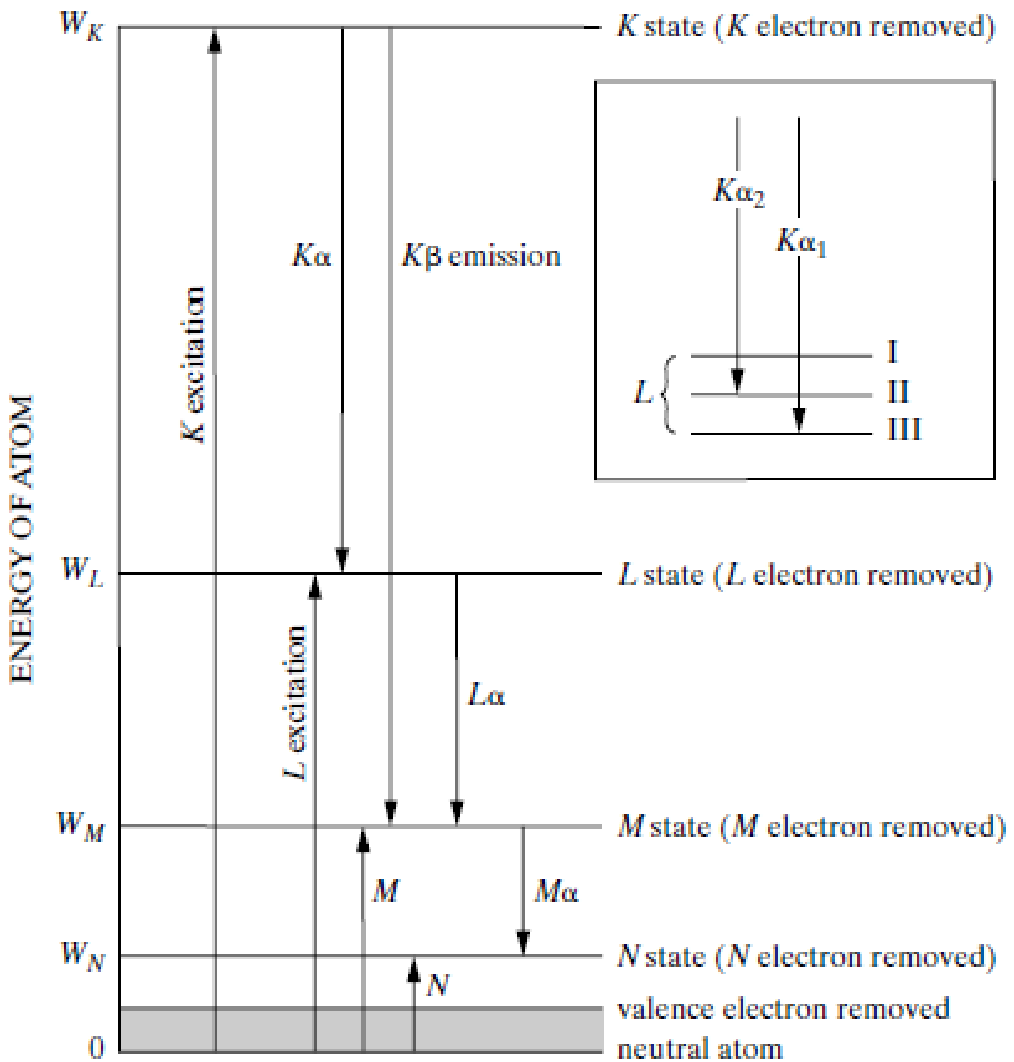
روش های نوین آنالیز مواد

فهرست مطالب

ترازهای انرژی الکترون ها



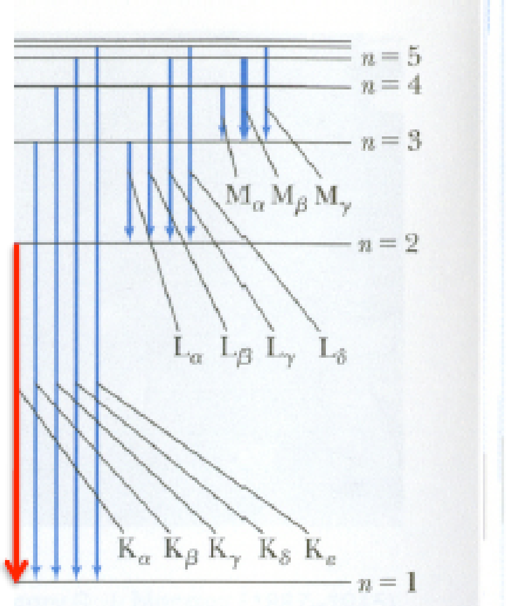
محاسبه اختلاف انرژی ترازها در Cu

$$E_n = -\frac{Z^2 m e^4}{2(4\pi\varepsilon_0)^2 n^2 \hbar^2} = -\left(\frac{me^4}{2(4\pi\varepsilon_0)^2 \hbar^2}\right)\frac{Z^2}{n^2}$$

$$= -\left[\frac{(9.11\times10^{-31}kg)(1.6\times10^{-19}C)^4}{32\pi^2\left(8.85\times10^{-12}\frac{C^2}{Nm^2}\right)^2\left(\frac{6.63\times10^{-34}Js}{2\pi}\right)^2}\times\frac{1eV}{1.6\times10^{-19}J}\right]\frac{Z^2}{n^2}$$

$$= -(13.57eV)\frac{Z^2}{n^2}$$

$^{64}_{29}Cu$ → 64 nucleons {29 electrons, 29 protons, 35 neutrons}



- The energy of an inner shell electron is given by $Z = 29$, and $n = 1$.

$$E_1 = -(13.57eV)\frac{Z^2}{n_{lower}^2} = -(13.57eV)\frac{(29)^2}{(1)^2} = -11412.4eV$$

- The energy of an outer shell electron is given by $Z = 29$, and $n = 2$.

$$E_2 = -(13.57eV)\frac{Z^2}{n_{upper}^2} = -(13.57eV)\frac{(29)^2}{(2)^2} = -2853.1eV$$

The energy of the emitted photon is the difference in energy between the upper state ($n = 2$) and the lower state ($n = 1$).

$$\Delta E = E_{upper} - E_{lower} = -2853.1eV - (-11412.4eV) = 8559.3eV$$

This corresponds to a wavelength of

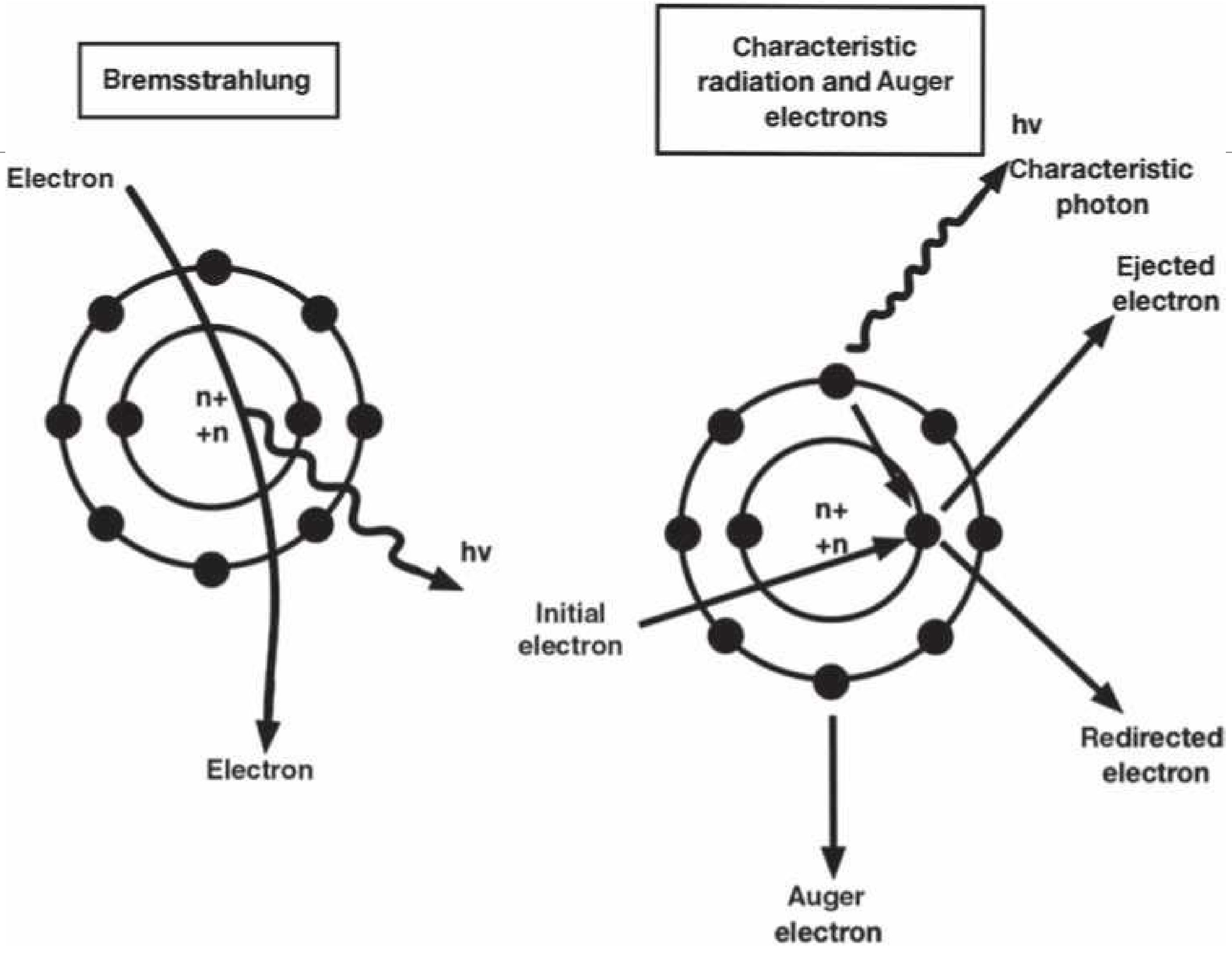
$$\Delta E = \frac{hc}{\Delta\lambda}$$

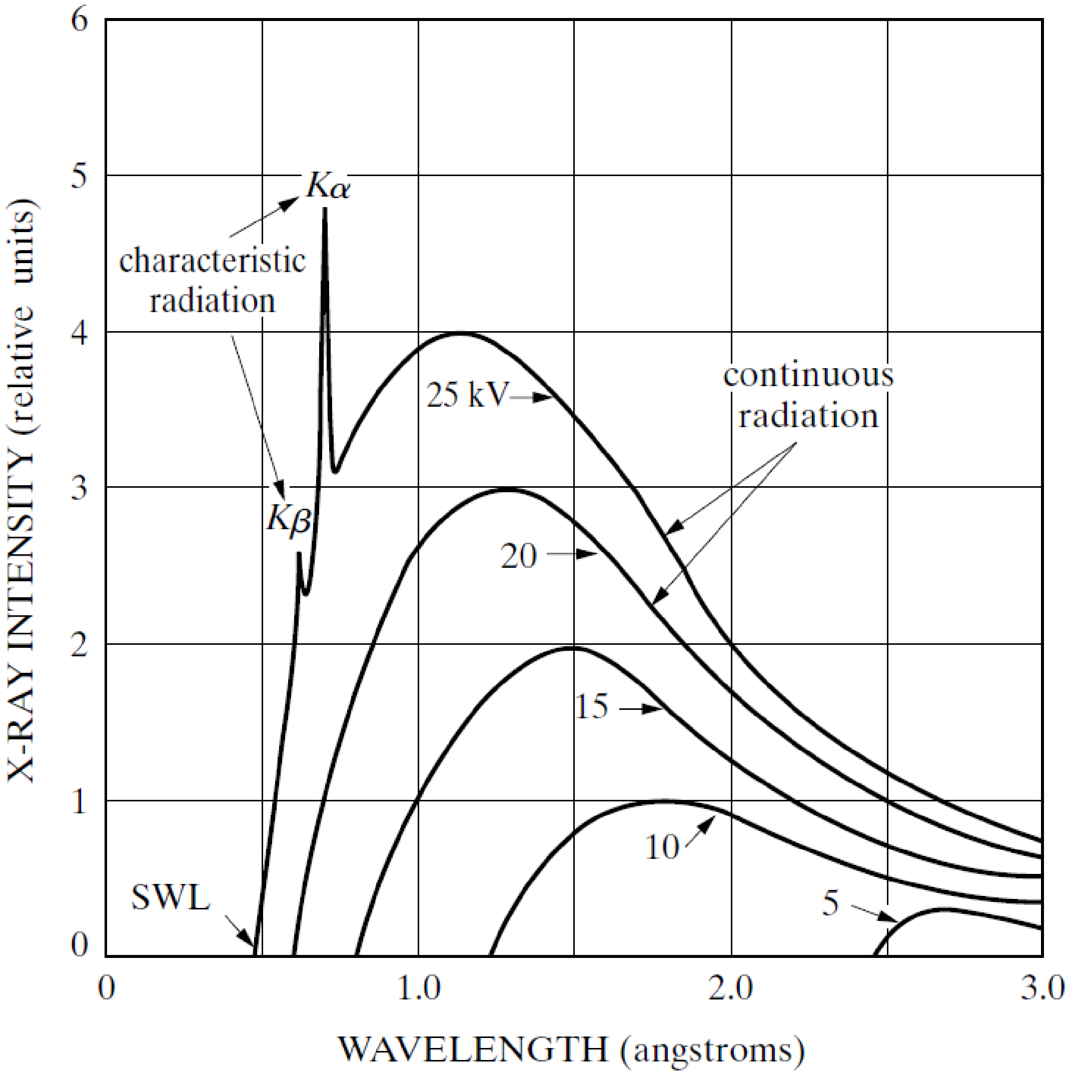
$$\Delta\lambda = \frac{hc}{\Delta E} = \frac{\left(6.63\times10^{-34}Js\times\frac{1eV}{1.6\times10^{-19}J}\right)3\times10^{8}\frac{m}{s}}{8559.3eV} = 1.45\times10^{-10}m$$

The actual wavelength (measured in the laboratory) is $1.54x10^{-10}m$.

This is about 70% from the true value!! Hmm…

تولید اشعه X


Bremsstrahlung
Electron
n+
+n
hv
Electron
Characteristic radiation and Auger electrons
hv
Characteristic photon
Ejected electron
n+
+n
Initial electron
Redirected electron
Auger electron

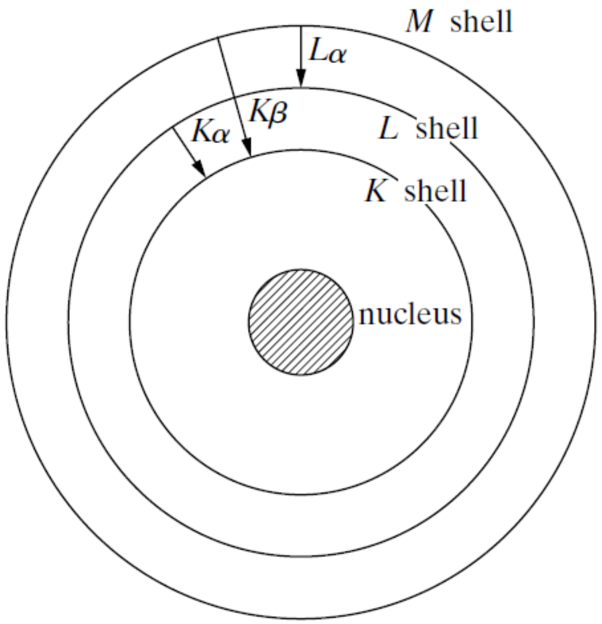


$$eV = h\nu_{\max}$$

$$\lambda_{\mathrm{SWL}} = \lambda_{\min} = \frac{c}{\nu_{\max}} = \frac{hc}{eV}$$

$$\lambda_{\mathrm{SWL}} = \frac{(6.626 \times 10^{-34})(2.998 \times 10^{3})}{(1.602 \times 10^{-19})\,V} \text{ meter,}$$

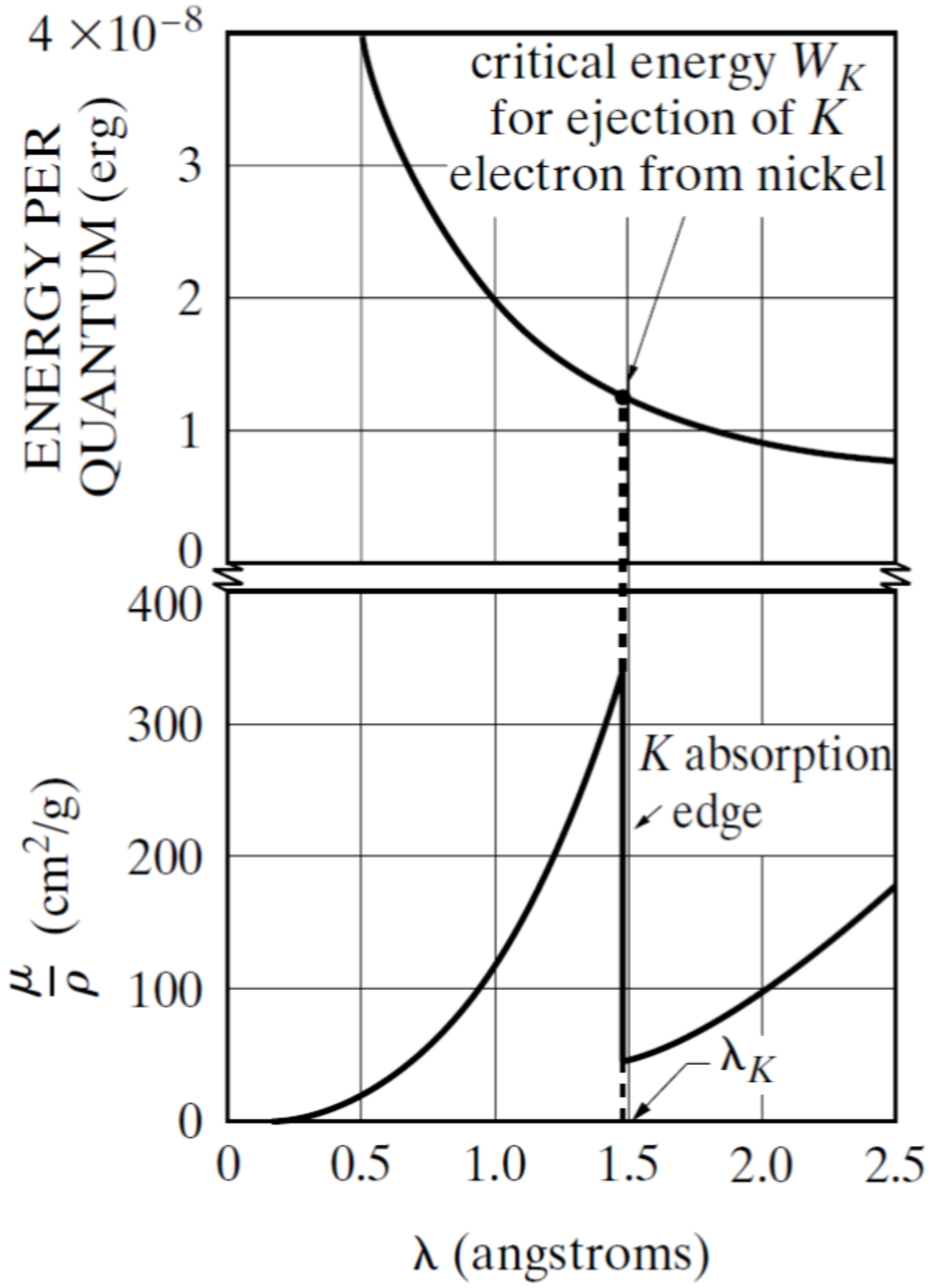
$$\lambda_{\mathrm{SWL}} = \frac{12.40 \times 10^{3}}{V}.$$

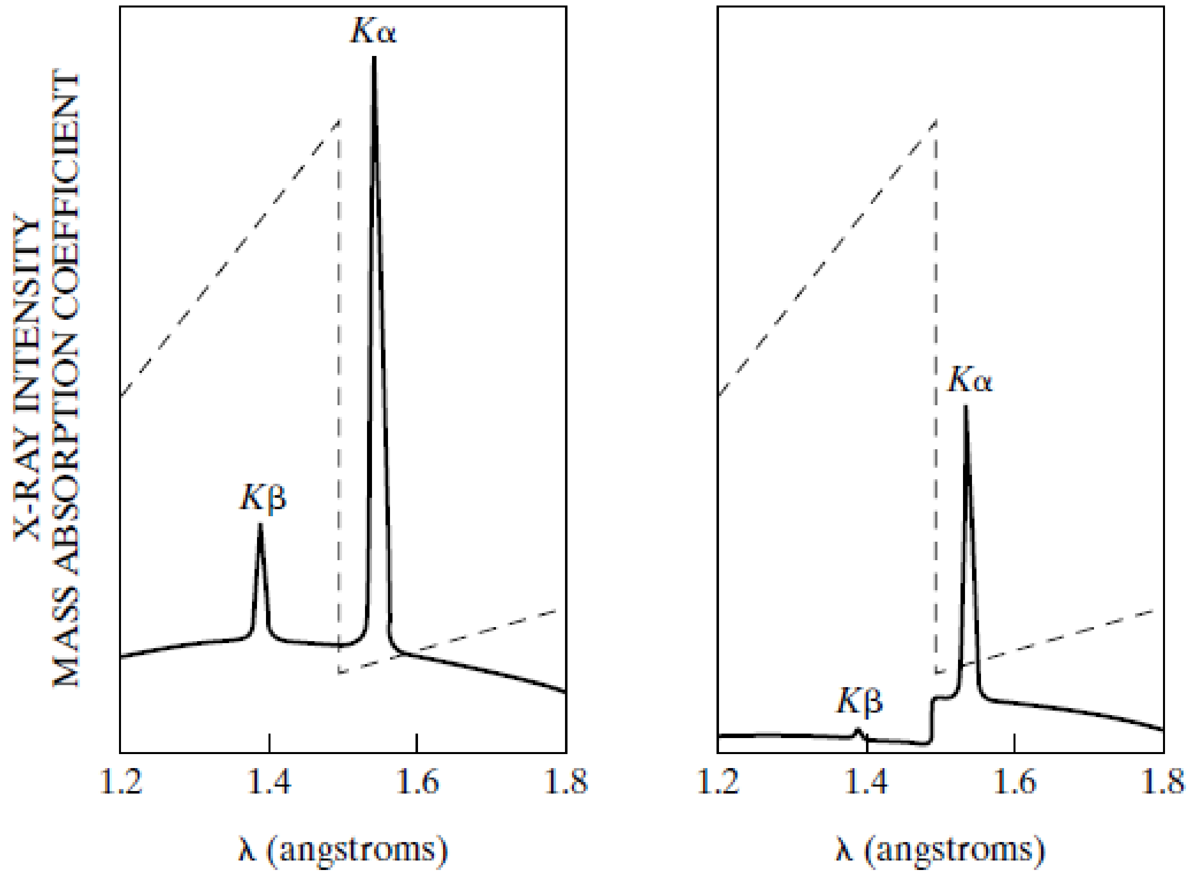


$$eV_K = W_K = h\nu_K = \frac{hc}{\lambda_K},$$

$$V_K = \frac{hc}{e\lambda_K},$$

$$V_K = \frac{12.40 \times 10^3}{\lambda_K},$$



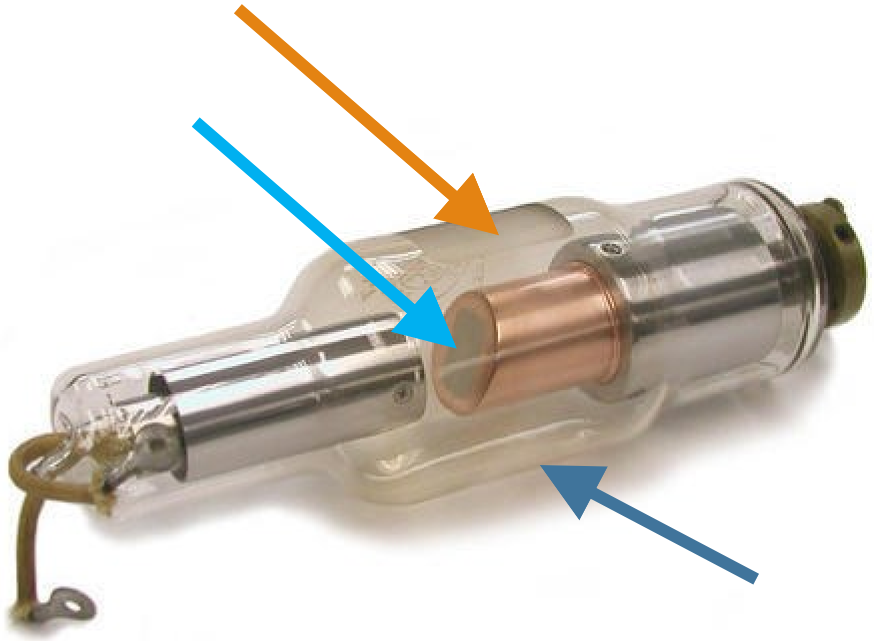


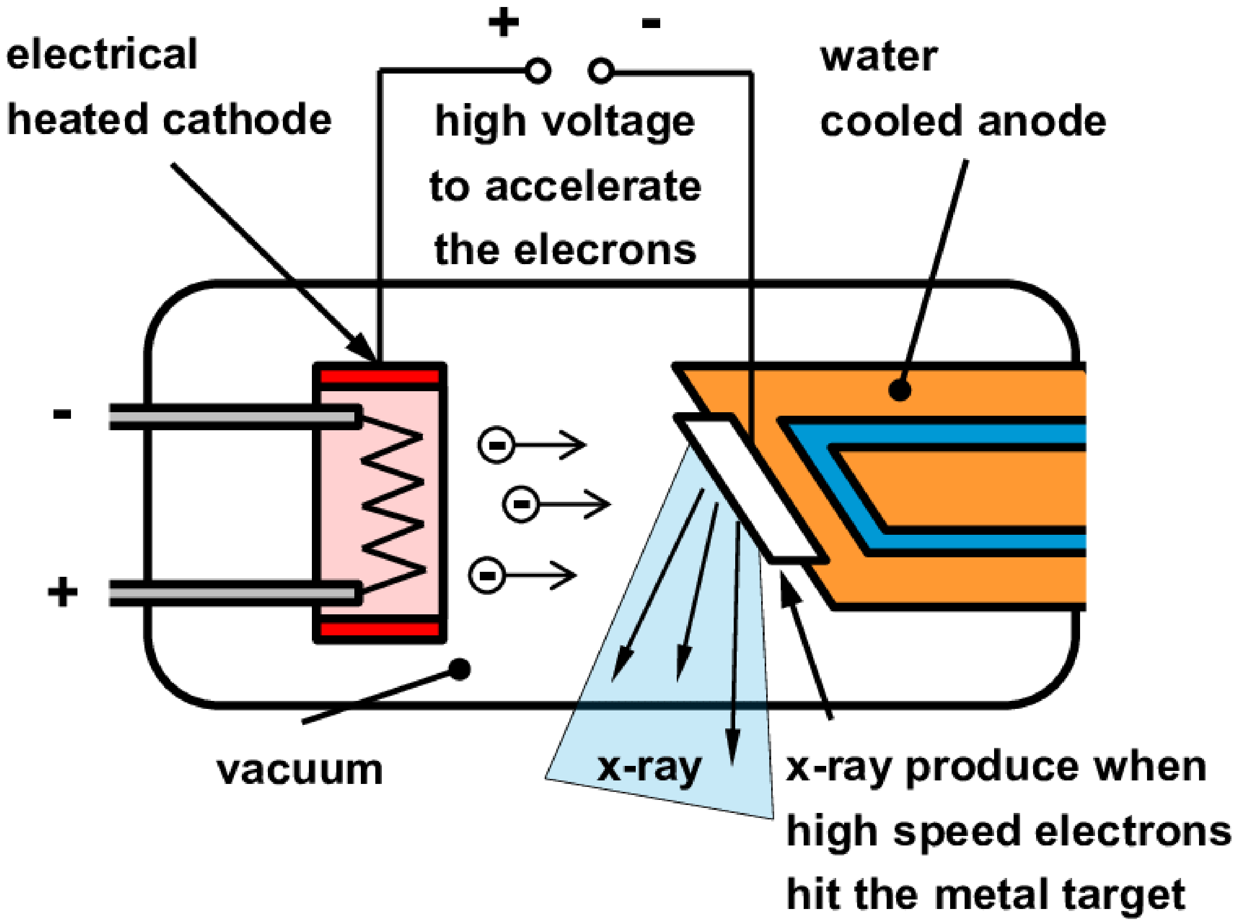
(a) No filter

(b) Nickel filter

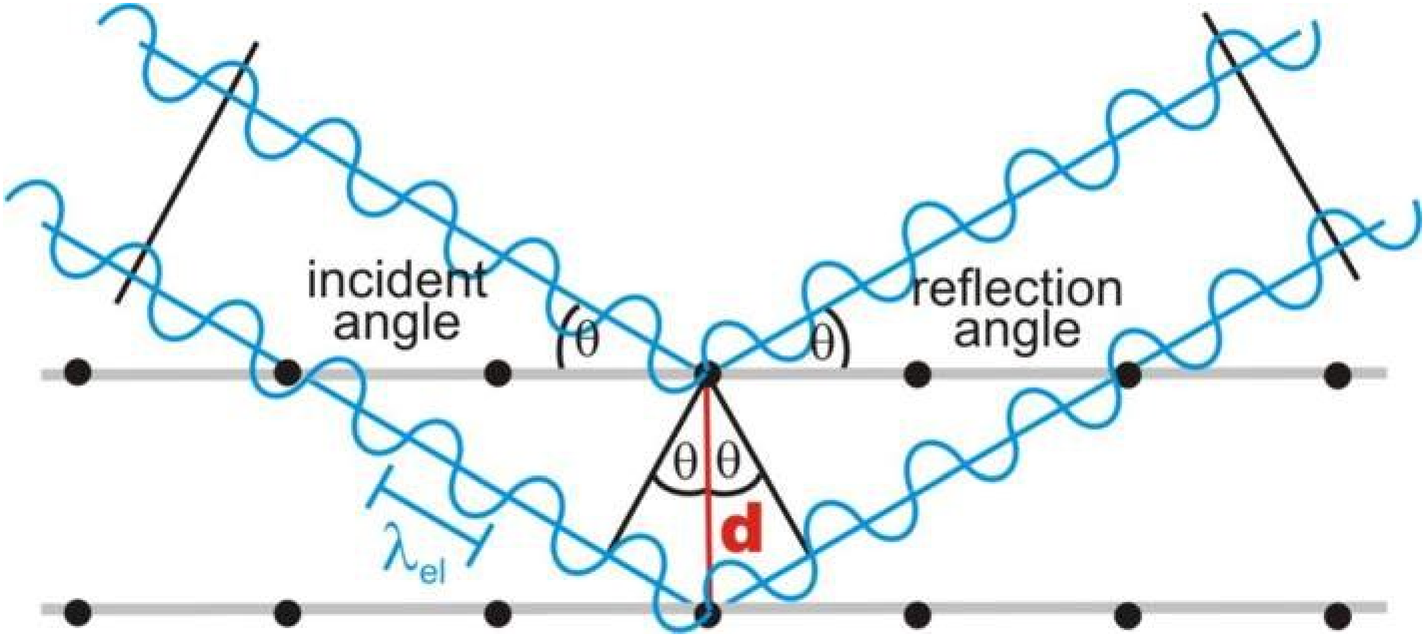
Anode	Cu	Co	Fe	Cr	Mo
Filter	Ni	Fe	Mn	V	Zr

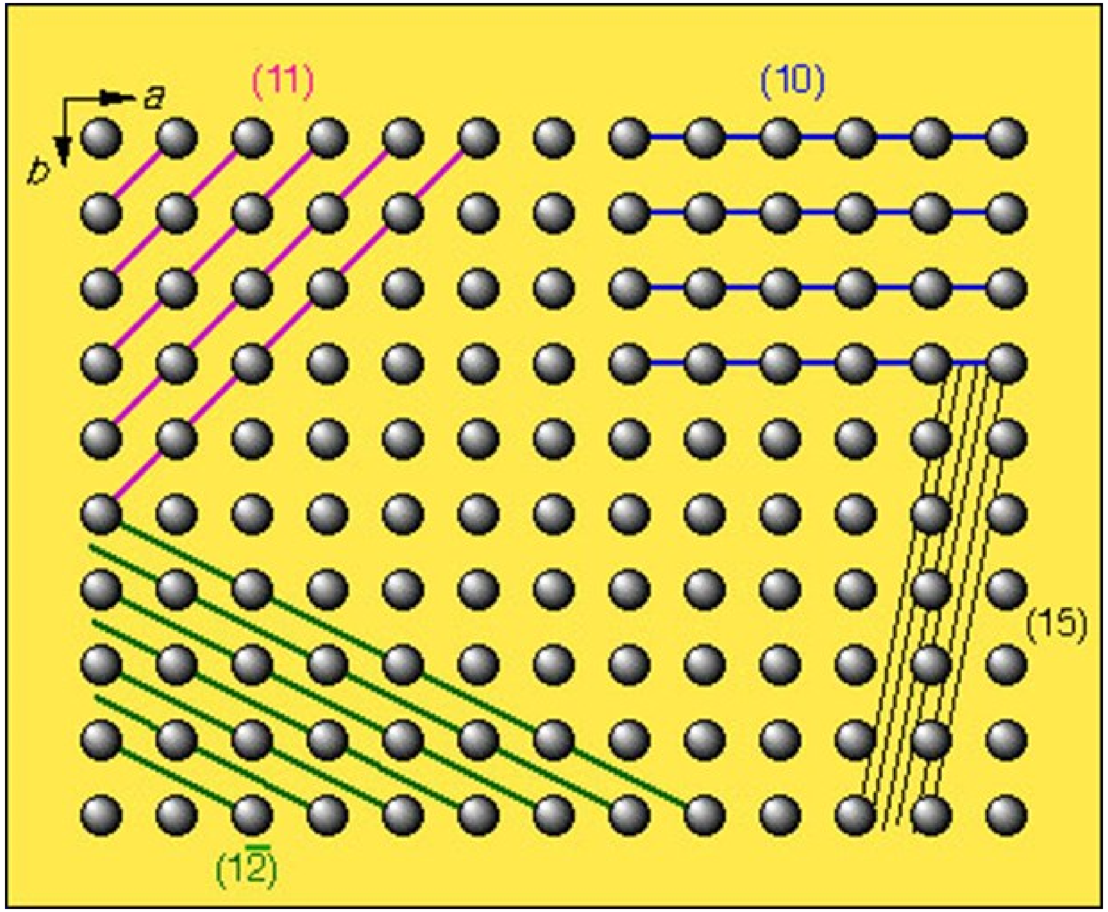
$$I_x = I_0 e^{-\mu x},$$



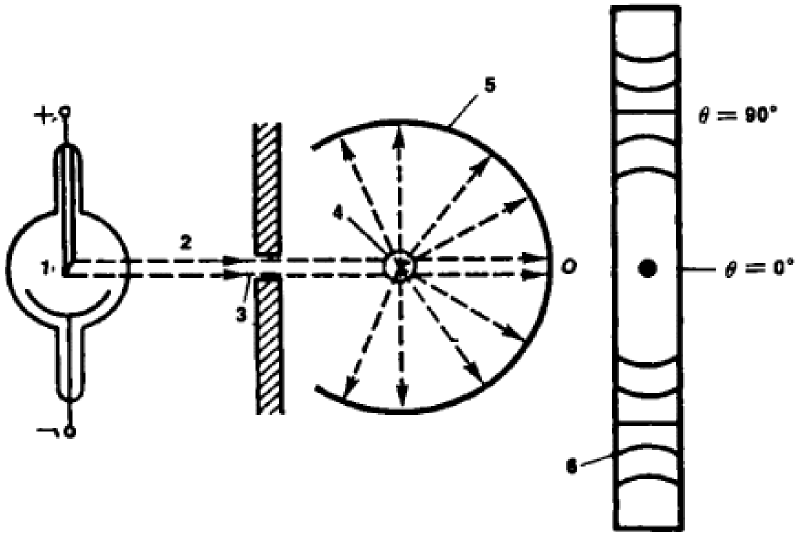

electrical
heated cathode
+
-
high voltage
to accelerate
the elecrons
water
cooled anode
-
+
vacuum
x-ray
x-ray produce when
high speed electrons
hit the metal target

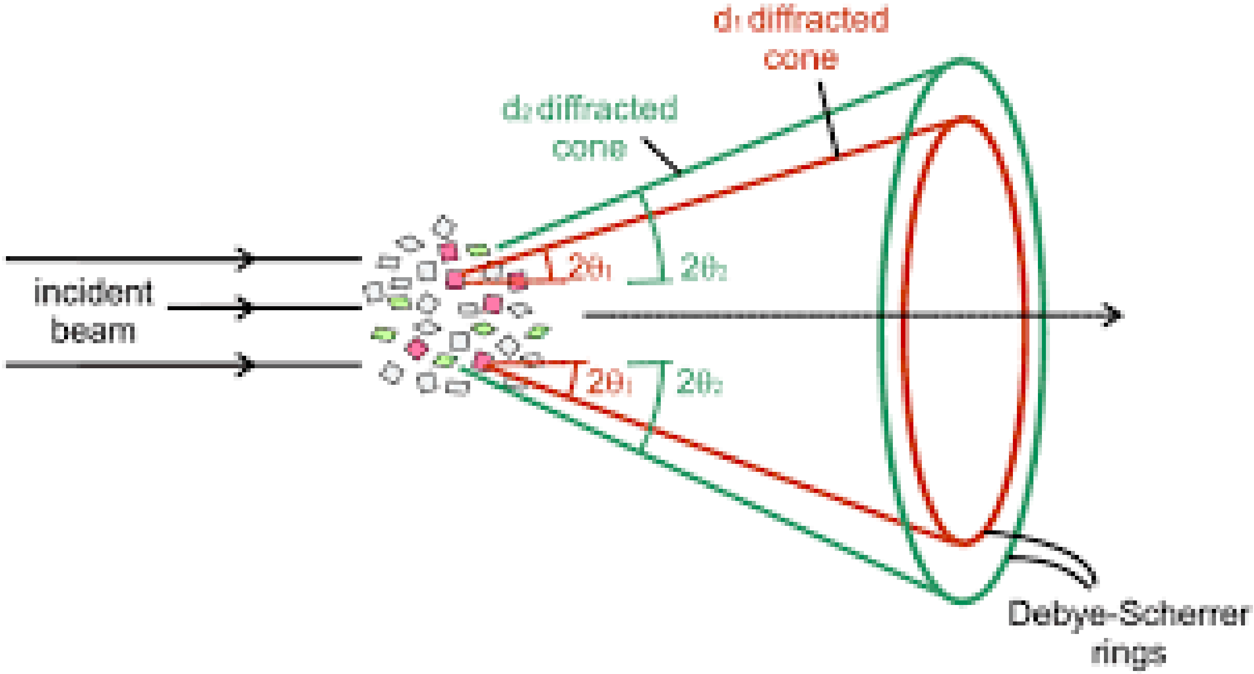
$n\lambda = 2d \sin\theta$

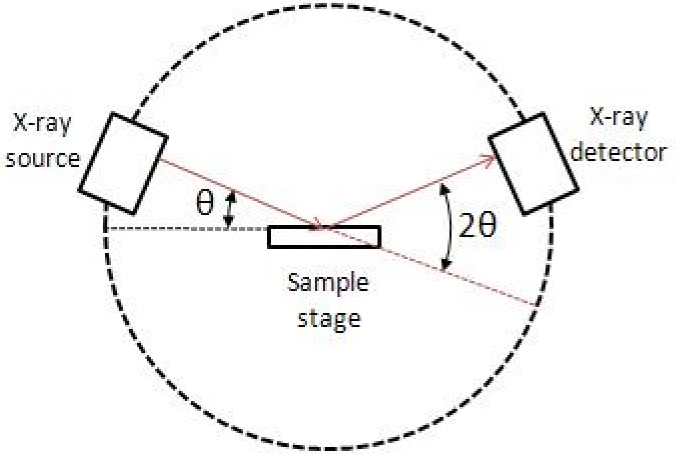



a
b
(11)
(10)
(15)
(12̄)

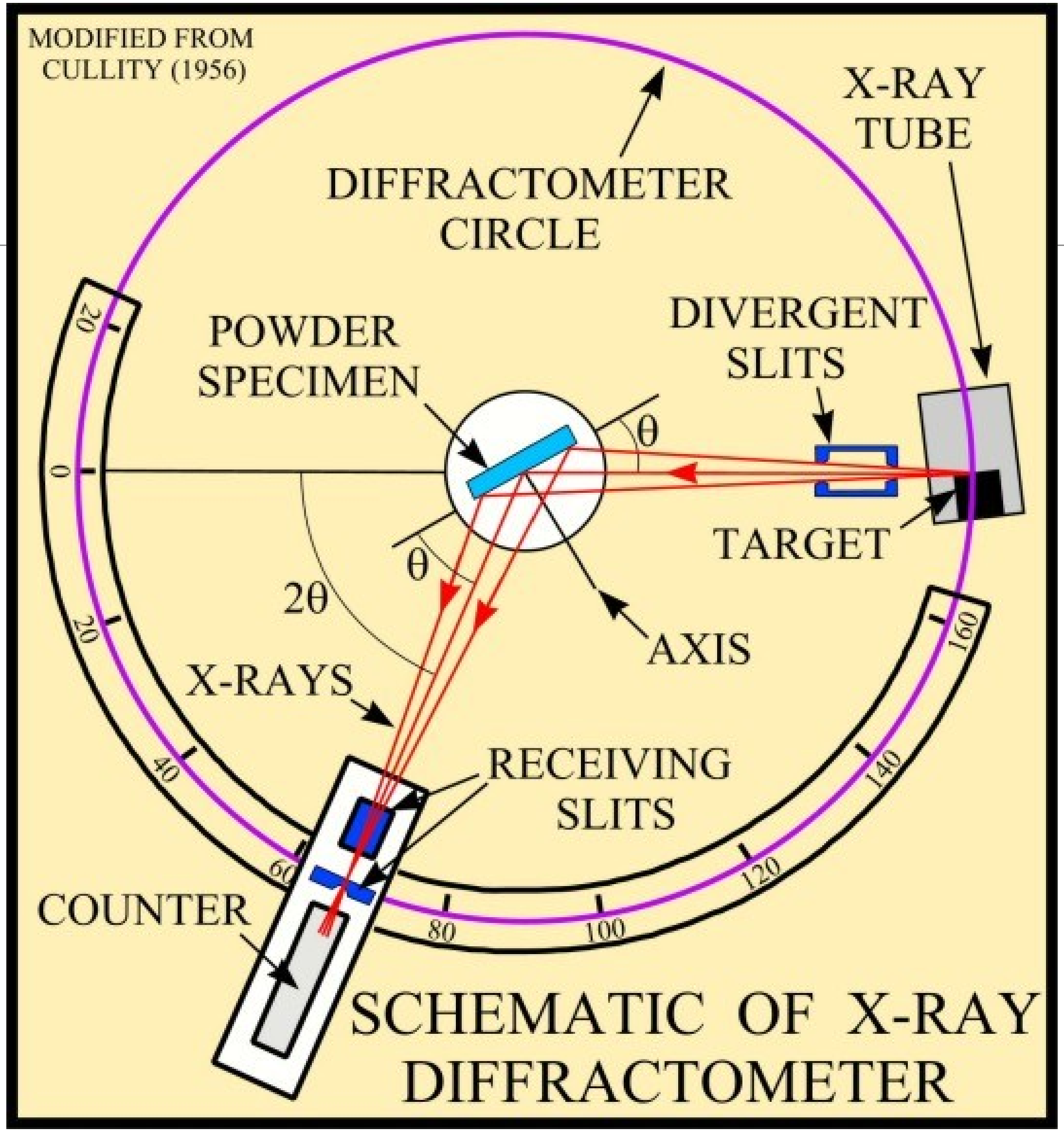
Cubic	$1/d^2 = (h^2 + k^2 + l^2) / a^2$
Tetragonal	$1/d^2 = (h^2 + k^2) / a^2 + l^2 / c^2$
Orthorhombic	$1/d^2 = h^2 / a^2 + k^2 / b^2 + l^2 / c^2$
Monoclinic	$1/d^2 = h^2 / (a^2 \sin^2 \beta) + k^2 / b^2 + l^2 / (c^2 \sin^2 \beta) - 2\, hl \cos \beta / (ac \sin^2 \beta)$
Hexagonal	$1/d^2 = 4\, (\mathrm{h}^2 + hk + k^2) / 3a^2 + l^2 / c^2$


+
1
2
3
4
5
O
6
θ = 90°
θ = 0°


d₁ diffracted cone
d₂ diffracted cone
incident beam
2θ₁
2θ₂
2θ₁
2θ₂
Debye-Scherrer rings



X-ray source
X-ray detector
θ
2θ
Sample stage



MODIFIED FROM CULLITY (1956)
DIFFRACTOMETER CIRCLE
X-RAY TUBE
POWDER SPECIMEN
DIVERGENT SLITS
θ
0
20
TARGET
θ
2θ
AXIS
X-RAYS
160
40
140
RECEIVING SLITS
60
120
COUNTER
80
100
SCHEMATIC OF X-RAY DIFFRACTOMETER

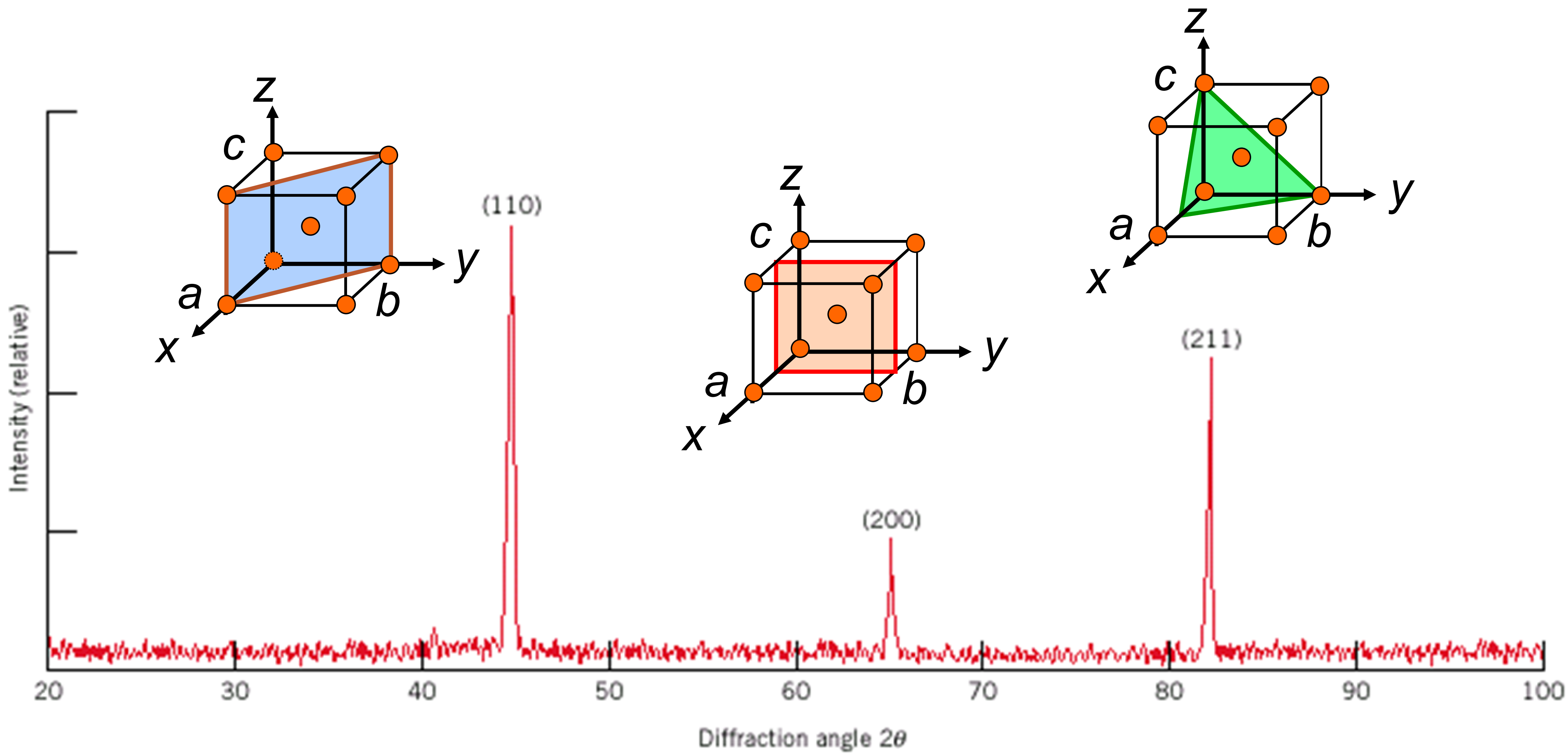


FIGURE 3.20 Diffraction pattern for polycrystalline α-iron.