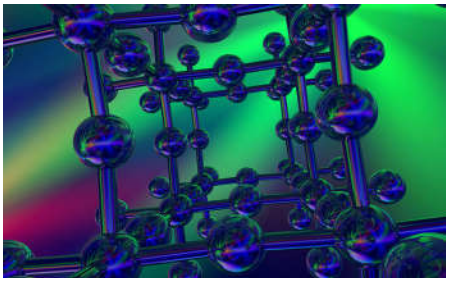
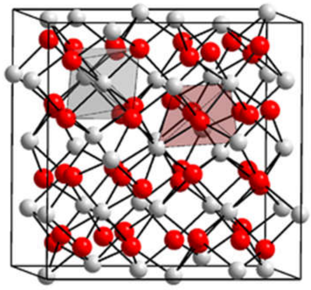
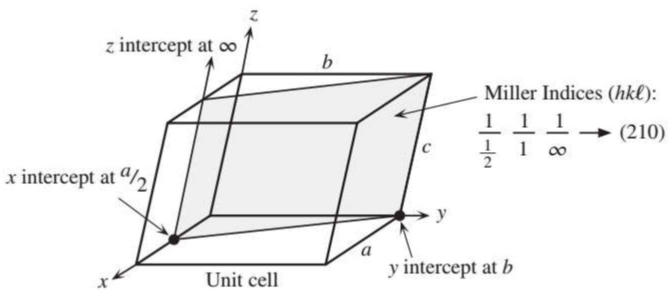
CRYSTAL PLANES





1

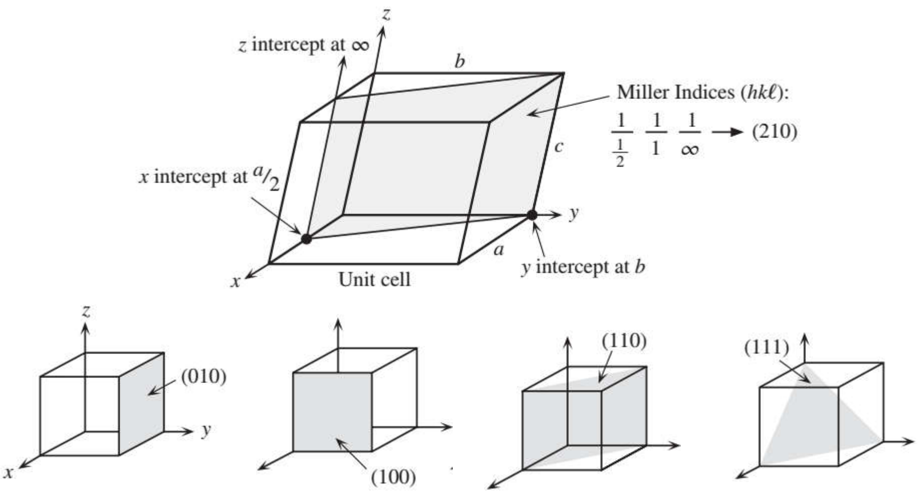
Crystal Planes



- We need to describe a particular plane of a crystal → Miller indices.
- Take any plane, note the x, y, z intercepts in terms of lattice parameters a, b, c.
- Invert the numbers – you get the Miller indices → $(hkl) = (a^{-1}b^{-1}c^{-1})$
- A bar is used for a negative integer due to a negative intercept.
- [hkl] direction is always perpendicular to the (hkl) plane.

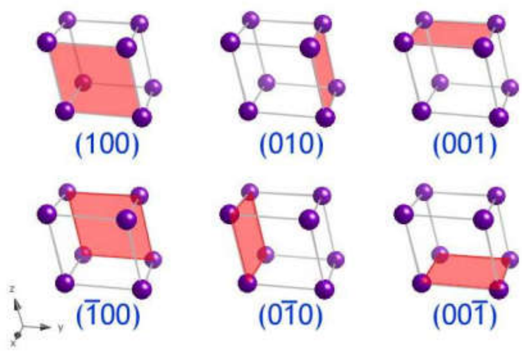
2

Miller Indices



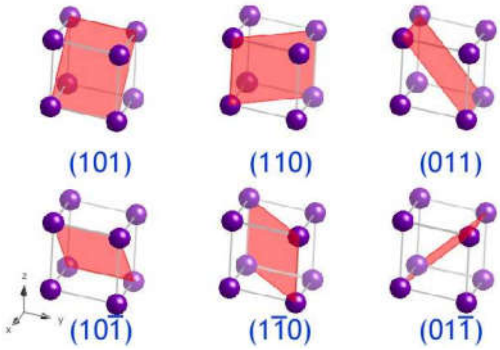
Family of Planes

- Family of planes is represented by curly braces as **{100}**: (100), (010), (001), $(\bar{1}00)$, $(0\bar{1}0)$, $(00\bar{1})$



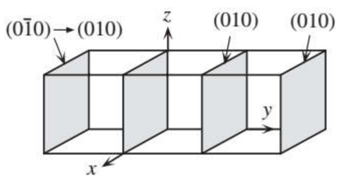
Family of Planes

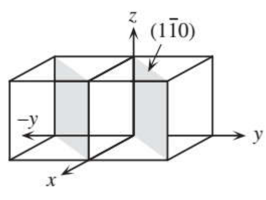
- Family of planes **{110}**: (110), (101), (011), $(\bar{1}10)$, $(\bar{1}01)$, $(0\bar{1}1)$, $(1\bar{1}0)$, $(10\bar{1})$, $(01\bar{1})$, $(\bar{1}\bar{1}0)$, $(\bar{1}0\bar{1})$, $(0\bar{1}\bar{1})$



Equivalent Planes

- Planes can have the same (*hkl*) only if they are separated by a multiple of lattice parameters.

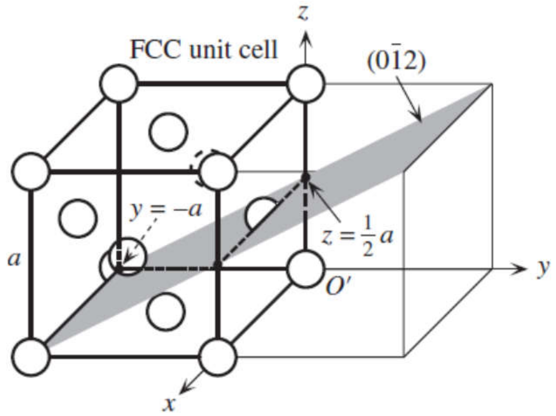




- (010) plane is not identical to the (020) plane, even though they are geometrically parallel

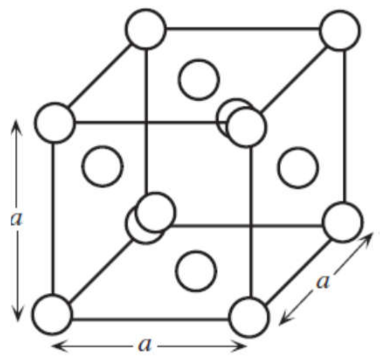
Planar Concentration

- Frequently, we need to know the number of atoms per unit area (planar concentration) on a given plane (*hkl*).
- For example, if the surface concentration of atoms is high on one plane, then that plane may encourage more rapid oxide growth.



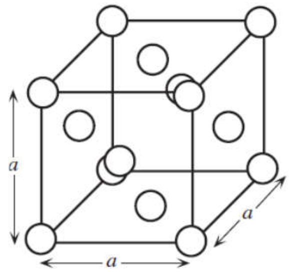
Planar Concentration

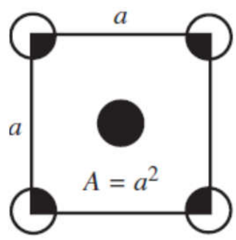
Among the {100}, {110}, and {111} planes in FCC crystals which one is the most densely packed?



FCC: (100) Plane

Consider the Cu FCC crystal with a = 0.3620 nm





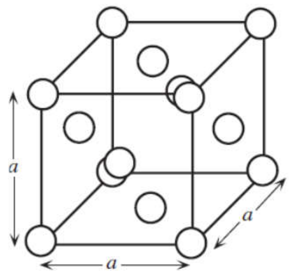
Area, $A = a^2$

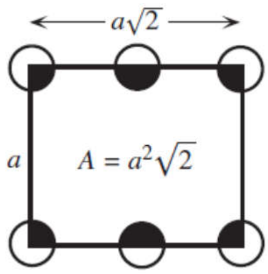
Number of atoms in A = (4 corners) × ($\frac{1}{4}$ atom) + 1 atom at face center = 2

Planar concentration n_{100} of (100) is

$$n_{(100)} = \frac{4\left(\frac{1}{4}\right)+1}{a^2} = \frac{2}{(0.3620\times10^{-9}\text{ m})^2} = 15.3 \text{ atoms nm}^{-2}$$

FCC: (110) Plane





Area, $A = (a)(a\sqrt{2})$

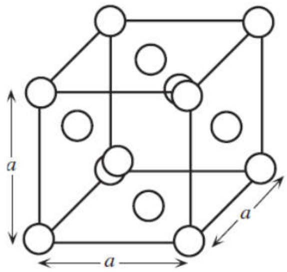
Number of atoms in A = (4 corners) × ($\frac{1}{4}$ atom) + (2 face diagonals)× ($\frac{1}{2}$ atom at diagonal center) = 2

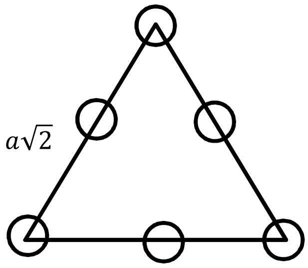
Planar concentration n_{110} of (110) is

$$n_{(110)} = \frac{2}{a^2\sqrt{2}} = \frac{\sqrt{2}}{(0.3620\times10^{-9}\text{ m})^2} = 10.8 \text{ atoms nm}^{-2}$$

FCC: (111) Plane

$n_{(111)} = ?$





Area, $A = \frac{1}{2}(a\sqrt{\frac{3}{2}})(a\sqrt{2})$

Number of atoms in A = (3 corners) × ($\frac{1}{6}$ atom) + (3 face diagonals)× ($\frac{1}{2}$ atom at diagonal center) = 2

Planar concentration n_{111} of (111) is

$$n_{(111)} = \frac{2}{a^2\sqrt{3/4}} = \frac{4}{\sqrt{3} \times (0.3620 \times 10^{-9}\ \mathrm{m})^2} = 17.6 \text{ atoms nm}^{-2}$$

Class Test – 1

Day: 15 May 2019

Syllabus: Lectures 2–4