# Lecture 6

Friday, April 11, 2008
12:23 PM

http://courses.washington.edu/mse170/index.shtml

**References Used:**

1. B D Cullity, **Elements of X-ray Diffraction, 2nd Edition**, *Addison Wesley*, 1978.

## Course Notes

- Figure 2.2 in your book is wrong -- slide
- First Homework is due today at 5:00 PM
- Don't forget to have it stapled with your name, section , TA name and student number on the first page
- Don't forget to turn it in on engineering paper
- To turn it in -- put it in the lockbox in the MSE170 lab (Mueller 168)
- ***There will be a reprieve this week on engineering paper requirement. However, next week -- on engineering paper only***
- No late homework will be accepted

## Review

- We talked about why metallic elements tend to have densely packed crystal structures
- We reviewed Bravais lattices
- We talked about three common Bravais lattices -- BCC, FCC, HCP
  - We talked about the close packed directions -- the vectors on which the atoms are touching
  - We talked about the coordination numbers in each of those lattices
  - We talked about the number of atoms per unit cell and the atomic packing factor
  - We talked about how to develop mathematical relationships between a (cubic lattice parameter) and R (atomic radius)
  - We talked about the stacking sequence of FCC and HCP

## Crystallographic Directions

### Algorithm for Crystallographic Directions

1. Reposition Vector to pass through origin (if necessary)
2. Read off projections in terms of unit cell dimensions *a*, *b*, and *c*
3. Adjust to smallest integer values (multiply through)
4. Enclose in square brackets, no commas [*uvw*]

- Bars over directions represent negative values
- Directions related by symmetry are called "Directions of a form"
  - A set of these are represented by the indices of one of them enclosed in angular brackets
  - For example:

    The 4 body diagonals of a cube can be represented as <111>

## Crystallographic Planes

- We are only going to deal with non-hexagonal planes in this class
- Which can be described by Miller Indices (hkl)
- English crystallographer Miller developed method to describe planes in crystals as part of his "Treatise on Crystallography" in 1839

### Algorithm for Miller Indices:

1. Plane cannot pass through the origin. If the plane passes through the selected origin, either another parallel plane must be constructed within the unit cell by an appropriate translation, or a new origin must be established at the corner of another unit cell.
2. The crystallographic plane either intersect or runs parallel to each of the 3 axes.
3. The planar intercepts are determined for each axis in terms of the lattice parameters a, b, c
4. The reciprocals of these numbers are taken.
5. A plane which parallels an axis has an infinite intercept and therefore a zero index.
6. The numbers are changed to the set of smallest integers by multiplication or division by a common factor.
7. The integer indices are not separated by commas and are enclosed within parentheses.

- Bars over directions represent negative values

- In cubic crystals planes and directions with the same indices are perpendicular to one another.
- Sets of equivalent lattice planes related by symmetry: "Planes of a form" -- enclosed in braces
- In general planes of a form have the same spacing but different Miller indices
- For example the faces of a cube are planes of a form

**Interplanar spacing for cubic systems:**

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

For Tetragonal:

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2 + (a^2 - c^2)}}$$