

Coefficient of Thermal Expansion

- CTE = α
- $\Delta L/L_0 = \alpha(T_2 - T_1)$
- Metal CTE is higher than ceramic CTE.
- {nl} → Heat = elongation
- Cooling = contraction

Sources

[1] W.D. Callister, *Fundamentals of Materials Science and Engineering*, 5th ed. New York, NY, USA: John Wiley & Sons, 2001, pp. 33

Common Crystal Structures

	FCC	BCC	HCP
C.N.	12	8	12
total atoms/unit cell	4	2	6
APF	0.74	0.68	0.74
a	$2R\sqrt{2}$	$4R/\sqrt{3}$	td

Atomic Packing Factor

$$APF = \frac{\text{total sphere volume}}{\text{total unit cell volume}} = \frac{V_s}{V_c}$$

$$V_s = (4/3)(\pi)(R^3)$$

$$V_c = a^3$$

Theoretical Density of a Metallic Solid

$$\rho = \frac{nA}{V_c N_A}$$

n = # of atoms associated with each unit cell
 A = atomic #
 V_c = volume of the unit cell
 N_A = Avogadro's number
 (6.023×10^{23} atoms/mol)

Direction From Miller Index

1. Look at the index values and if any are larger than one, take out a factor such that none of the integer values are greater than one.
2. For example, we have a Miller index of [2 1 1], we can take out a factor of 2 to get [1 1/2 1/2].
3. Essentially we have created a new point to plot with coordinates of $x = 1$, $y = 1/2$ and $z = 1/2$.
4. Set up your unit cube and it is fine to place the origin at the lower left hand corner as shown below.
5. Plot the new point (1, 1/2, 1/2) and connect the 'dots'.

Terms

Single crystal

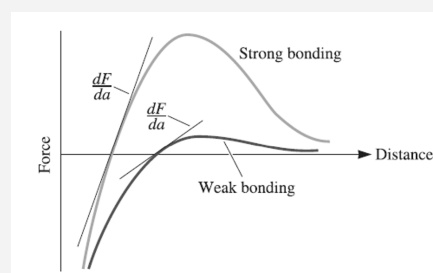
Polycrystal

Grain boundaries

Isotropic

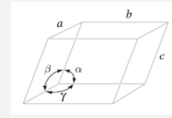
Polymorphism

Stiffness



Stiffness of a material is related to the slope of the F vs atomic separation curve (r). The stiffness (dF/da) of the material is known as the **Young's modulus, E**.

Dimensions and Angles



Lattice parameters are the dimensions a, b and c of the unit cell.

Interaxial angles are α , β , and γ .

(top to bottom) BCC, FCC, & HCP



Miller Index From Plane

1. Draw the unit cube and right handed coordinate system & be sure that the plane does not pass thru the point you've selected to be the origin.
2. Take reciprocals
3. Plot the plane.
4. **DO NOT CLEAR FRACTIONS.**

Linear and Planar Density

Linear Density

Number of atoms per unit cell whose centers are aligned in a specific direction.

LD =

#atoms/unit length

Planar Density

Number of atoms per unit area that are centered on the area of the plane.

PD =

#atoms centered on plane/area of plane

C

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