I Physical metallurgy

1 Classes and properties

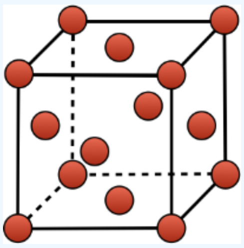
Material classes and typical properties

Class	Typical properties
Metal Alloys	1) Thermal + electric conductivity 2) Ductility 3) Castable 4) Reflective
Ceramics	1) High T resistance (High E, low α) 2) High compression strength 3) Thermal + electric insulator 4) Wear resistance
Polymers	1) Cheap 2) Thermal + electric insulator 3) Corrosion resistance 4) Moldable

1.1 Structural model of metals

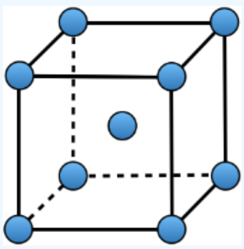
$$\phi = \frac{\text{Volume occupied by atoms in unit cell}}{\text{Total volume of unit cell}}$$

1.1.1 FCC (Face-centered cubic)



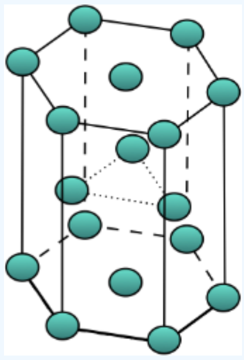
- Packing efficiency:
  $\phi \approx 74\%$
- Many slip systems (12)
- Closest pack direction

1.1.2 BCC (Body-centered cubic)



- Packing efficiency:
  $\phi \approx 68\%$
- Many slip systems (6)
- Not closest pack direction
- Cottrell atmosphere

1.1.3 HCP (Hexagonal close-packed)

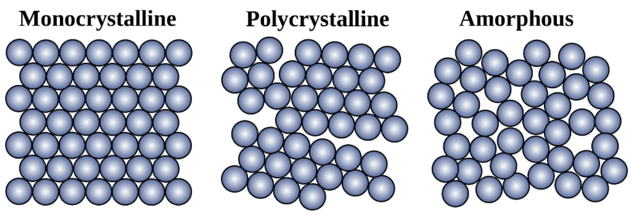


- Packing efficiency:
  $\phi \approx 74\%$
- Very few slip systems (3)
- Closest pack direction

1.2 Structural odel of ceramics

- Ionic bonding, complex crystal structures (ceramics), amorphous (glasses)
- Brittle, but high chemical and thermal resistance
- Insulators
- Wear-resistant (e.g. ferro-/piezoelectricity)

1.3 Amorphous and crystalline materials



1.3.1 Amorpohus materials

- No crystal lattice (e.g. quartz glass, polymers)
- Atomic distances defined by chemical bonds
- Bond angles are variable

1.3.2 Crystalline materials

- Crystal lattice (e.g. metals, ceramics, quartz)
- Atomic distances and bonding angles are defined

1.4 Directionals depenence

1.4.1 Anisotropy and Isotropy

Anisotropic:
properties depend on the direction
Isotropic:
properties do not depend on direction
Quasi-isotropic:
properties microscopically depend on the direction but not macroscopically

1.4.2 Miller indices for crystal directions