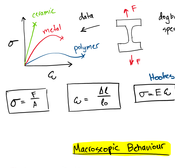
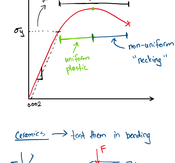
Mechanical Behaviour



$\sigma = \frac{F}{A}$ $\varepsilon = \frac{\Delta L}{L_0}$ Hookes law $\sigma = E\varepsilon$

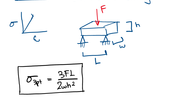
Macroscopic Behaviour

Elastic vs. Plastic



$\sigma = E\varepsilon$
↳ only true in elastic region

Ceramics → test them in bending



$\sigma_{fs} = \frac{3Fl}{2wh^2}$

Microscopic Behaviour

- how do we define structure of materials?
- how does this influence their properties?

- crystal structure
  - FCC
  - BCC
  - HCP
  - Rock salt
  - Diamond cubic

· APF
· CN (coordination #)
· density

$\rho = \frac{n \cdot A}{V_c \cdot N_A}$

Rationalize material properties by their structure

Ceramic

Metal

↓
atoms slide past each other

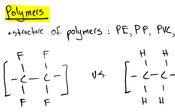
Imperfections

↳ dislocation movement

- 0-D → impurities
- 1-D → screening dislocation
- 2-D → grain boundary → to strengthen material
- 3-D → second phase particles → "cold working"

Polymers

- structure of polymers: PE, PP, PVC, PTFE



Molecular Weight

$\bar{M}_n = \sum x_i M_i$

$\bar{M}_w = \sum w_i M_i$

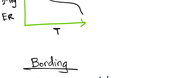
Bonding → strong intramolecular forces
→ weak intramolecular forces

Crystalline vs. Amorphous

↳ optical properties
- strength
- dissolution

↳ cross-linking → network polymers

Thermoset: 2nd ary bonds (no melting)
Thermoplastic: melts



Bonding

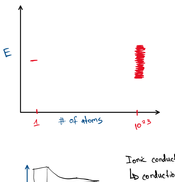
Bohr Model

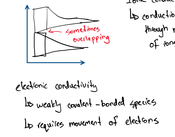
$E = \frac{nc}{\lambda}$

① Ionic → Wave Mechanical Model
② Covalent
③ Metallic

n, l, m_l, m_s

Band Theory

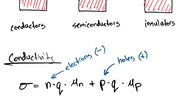




Ionic conductivity
↳ conduction occurs through movement of ions

electronic conductivity
↳ weakly covalent-bonded species
↳ requires movement of electrons

Band Gap



Conductivity

electrons (-) holes (+)

$\sigma = n \cdot q \cdot \mu_n + p \cdot q \cdot \mu_p$

① intrinsic → $n = p$ → $\sigma = n \cdot q \cdot \mu_n$
② extrinsic: n-type → pentavalent → $n \gg p$ → extra "n"
③ extrinsic: p-type → trivalent → $p \gg n$ → extra "p" → $\sigma = n \cdot p \cdot \mu_p$

↳ Optical Properties

Thermodynamics

① 2nd law $\Delta S_{universe} = \Delta S_{sys} + \Delta S_{surr} > 0$

S: entropy $\Delta S = \frac{q_{rev}}{T}$ → $\Delta G_T = -T\Delta S_{sys} + \Delta H_{sys}$

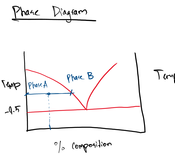
↳ 4 cases of spontaneity

② $\Delta U = 0$ isolated
$\Delta U = q + w$ closed

$\Delta H^\circ = \sum \Delta_f H^\circ_{products} - \sum \Delta_f H^\circ_{reactants}$

$q = n C_p \Delta T$

Phase Diagram



binary phase → ① phases present
② composition
③ weight of each phase

Lever Rule

$W_\alpha = \frac{\text{opposite length}}{\text{total}}$