

Precedes failure  
 ∴ you can tell when it's about to fail

**Shear Bands (Compression)**

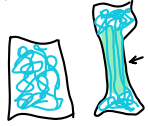
shear sliding motion of chains similar to dislocations in metals



shear bands 45°

leads to brittle fracture in tension

e.g. polyamide

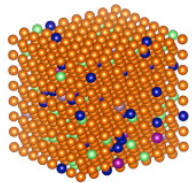


**Drawing (In tension)**

drawn, aligned molecules  
 ∴ used in Kevlar, Dyneema

drawn material ∼ 8x stronger

closer to ideal strength than metals: no crystals → fewer defects



**Alloying:** Deliberately added impurity that displace/squeeze host atoms, distorting lattice

**Polymer Deformation**

Slide over each other

**Materials**

**Origins**

**Defects** mean metal cannot achieve max strength

**Strength (Metals)**

Temp. influences strength and failure of polymers

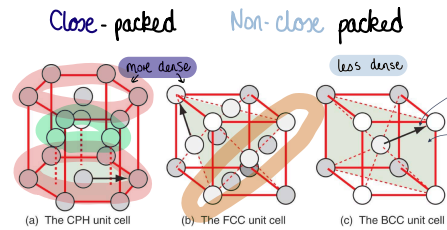
Bond broken if it has 0.1 strain (10% length)

**Metallic Bonds**

**Closed-pack hexagonal**  
 - ABAB layering of atoms  
 - All atoms in contact but A layers don't touch  
 e.g. zinc, magnesium, titanium

**Face-Centred Cubic**  
 - ABCABC layering diagonally  
 - All atoms in contact along face diagonal  
 e.g. aluminium, lead, copper

**Body-Centred Cubic**  
 - No close pack layers  
 - Atoms in contact along internal diagonal of cube  
 e.g. iron, carbon, tungsten



Can idealise bonds as **springs**

**Cohesive Energy** - measure of atomic bond strength

**Modulus (Metals)**

**Layering**

**Close-packed**

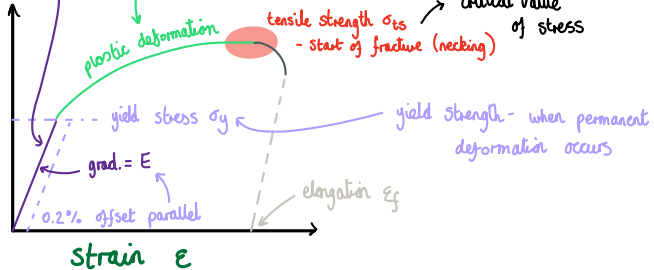
**Non-close packed**

Spring stiffness, S, of bond reflected in E  
 $E \approx \frac{S}{a_0}$

Force F pulls bonds apart from  $a_0 \rightarrow a_0 + \delta$



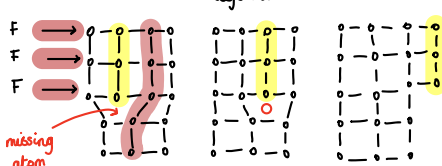
higher displacement → ↓ E



Produce tiny ( $10^{-10}$  m) displacement but millions result in large deformation

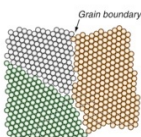
**Dislocations** → lead to plastic deformation

As force applied dislocation moves along to edge or crystal boundary



Movement of dislocation through crystal produces plastic shear strain

large crystals allow dislocations to displace more before boundary ∴ allows higher plastic deformation



Where perfect but differently oriented crystals (grains) having the same atoms meet.