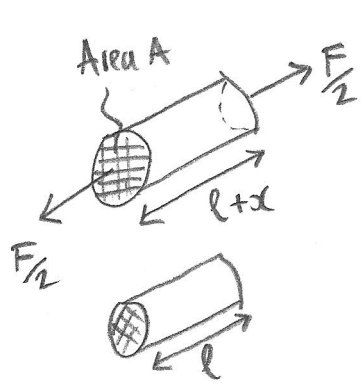


MATERIALS



**Stress**  $\sigma = \frac{force}{area}$  i.e.  $\sigma = \frac{F}{A}$

**Strain**  $\epsilon$  is  $\frac{extension(x)}{original\ length(l)}$   $\epsilon = \frac{x}{l}$

Young's modulus  $Y = \frac{\sigma}{\epsilon} \Rightarrow \sigma = \epsilon Y$

If a material is elastic and obeys **Hooke's law**  $F = kx$

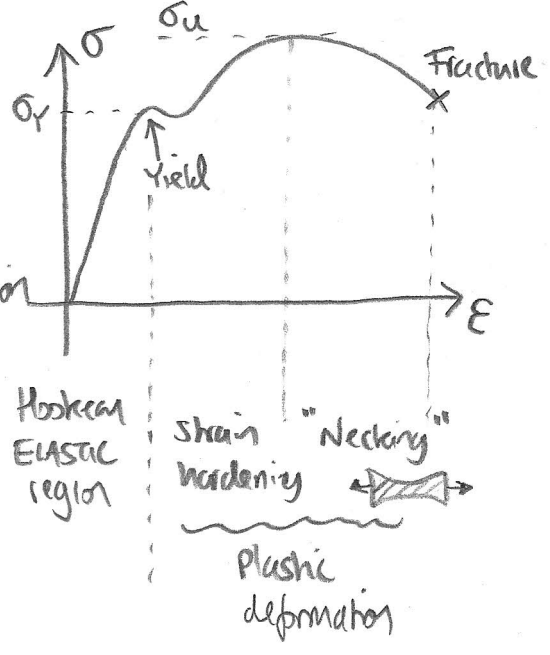
Elastic strain energy  $E = \frac{1}{2} kx^2$

Strain energy density  $u = \frac{E}{Al} = \frac{1}{2} \left( \frac{kx}{A} \right) \left( \frac{x}{l} \right) = \frac{1}{2} \sigma \epsilon$

*(Note:  $\frac{kx}{A}$  is original stress,  $\frac{x}{l}$  is original strain)*

$u = \frac{1}{2} Y \epsilon^2$

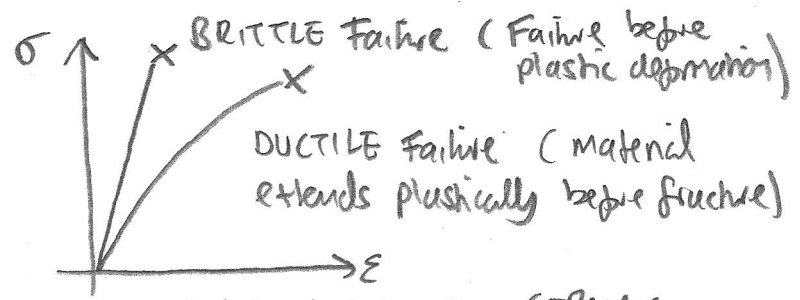
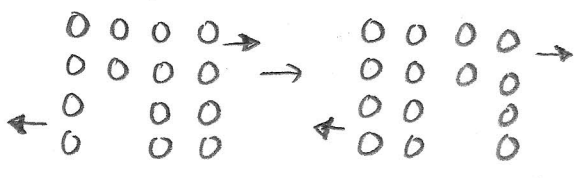
Most materials follow the **stress-strain curve**



- $\sigma_y$  Yield stress - lowest stress for permanent deformation
- $\sigma_u$  Ultimate stress - stress which leads to DUCTILE or BRITTLE failure

- $Y$  is constant during Hookean region.
- when load is removed in elastic region material returns to original shape
- in plastic deformation region, material is permanently deformed.

**FRACTURE** results from the propagation of cracks. The latter originate from **DISLOCATIONS** in the atomic structure, i.e. a slip of one plane of atoms over another



NOT ALL MATERIALS YIELD e.g. CERAMIC

