Day – 21

→ Higher dimensional defects

↓

Defects have an excess energy

Surface energy
G.B. energy } Estimate to 1st order

Interactions between NN

(order of magnitude estimates)

→ 1D defects – DS

Geometry, movement

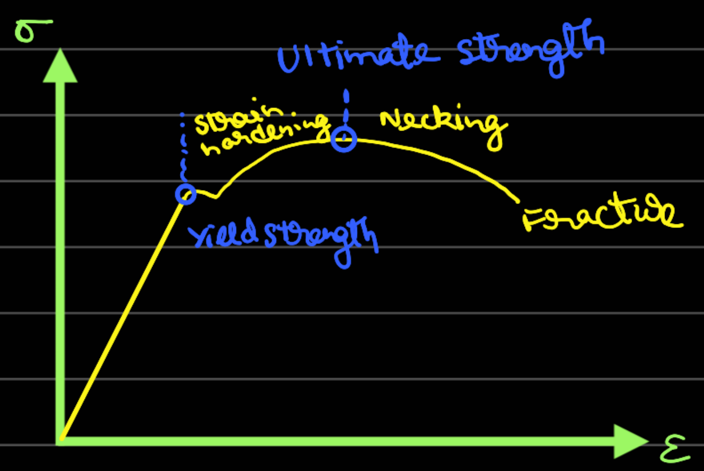
→ Response of a material to shear stress

(mechanical properties of a material)

↓

Crystal growth, dendrite growth, transport

→ Stress-strain curve :



very small stress ⇒ very small strain

↓

elasticity
(hooke's law)

Plastic deformation $\longrightarrow$ irreversible

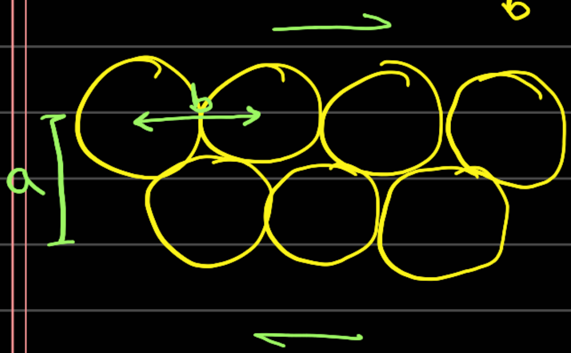
$\sigma = E\varepsilon$ (only true for isotropic materials)

$E \rightarrow$ 4th ranked Tensor

$\sigma \rightarrow [\sigma_1 \; \sigma_2 \; \sigma_3]$

$\sigma, \varepsilon \rightarrow$ 2nd ranked tensors

$\tau = \tau_{max} \sin \frac{2\pi x}{b}$ (approximation)



(Shear stress)

$(x << b)$

$\Downarrow$

$$\tau = \tau_{max}\left(\frac{2\pi x}{b}\right)$$

Hooke's law : $\tau = G\frac{x}{a}$

$G \rightarrow$ Shear modulus

$$\frac{G}{a} = \frac{2\pi\tau_{max}}{b}$$

$$\Longrightarrow \boxed{\tau_{max} = \frac{Gb}{2\pi a}}$$

experimentally determined

Usually, $b \sim a$,

so $\tau_{max} = \frac{G}{2\pi}$

$\downarrow$

Stress needed to effect large permanent deformation in the material.

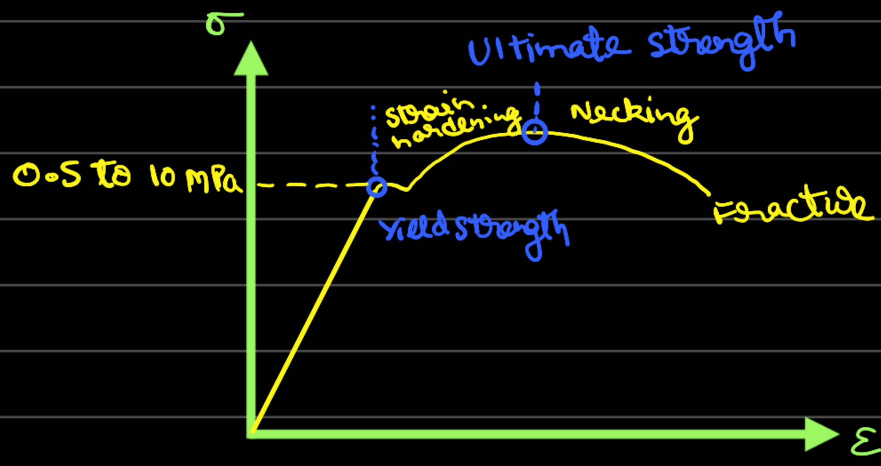
$\downarrow$

Yield stress in stress-strain diagram

G_{metals} = 20 GPa To 150 GPa $(1 GPa = 10^9 Pa)$

If $\tau_{m,\,theory} = 0.1\,\tau_m$

$\hookrightarrow$ is 0.32 GPa to 2.39 GPa



→ Ds mechanism of plastic deformation

Extra half-plane of atoms

Defected region

↓

There is no perfect registry

→ Dislocation –

Two vectors → Line and Burgers

↓

Convention

Angle between line and burgers vector
(Nomenclature of dislocations)

$\theta = 90^\circ$ (edge)

$\theta = 0^\circ$ (screw)

$\theta \neq 0^\circ, 90^\circ$ (mixed)