Dislocation theory:

Strain to move dislocation:

Q) $b = 1 A^\circ$ of $1cm \times 1cm \times 1cm$ cube:

$$\gamma = \frac{b}{h} = \frac{10^{-10}}{10^{-2}} = 10^{-8}$$

$\gamma \downarrow$ shear strain

Q) Suppose i dislocation moves by distance x.

Single dislocation: $\gamma = \frac{x_i}{l}\frac{b}{h}$

Multiple dislocation: $\gamma = \frac{1}{l}\frac{b}{h}\Sigma x_i$

→ If N dislocations move mean dist $\bar{x}$

$$\gamma = \frac{N\bar{x}}{l}\frac{b}{h}.$$

dislocation density : $\rho = \frac{N}{lh} = \frac{\#\text{ dislocation lines}}{\text{area}}$

→ also equals = $\dfrac{\text{Total length of dislocation}}{\text{volume}}$.

Universal strain.

$$\boxed{\gamma = \rho_e\, b\, \bar{x}}$$

b: burgers's vector or interatomic spacing

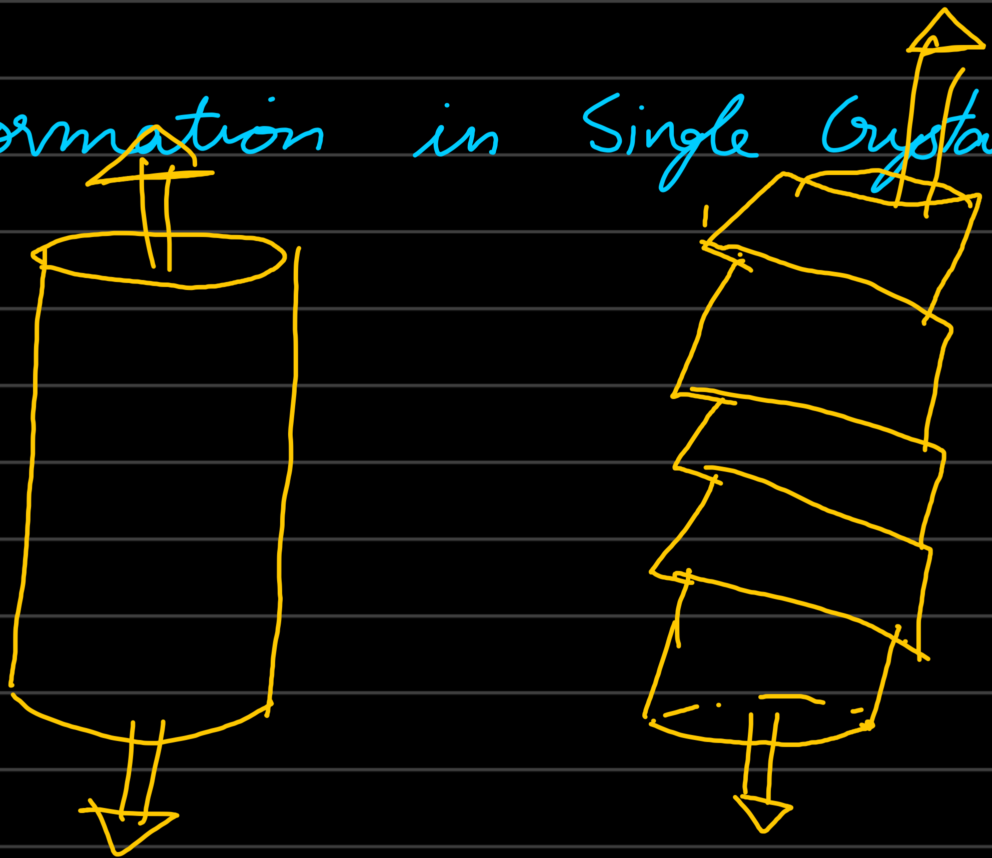
$\bar{x}$: mean distance moved

Strain rate: $\dfrac{\partial \gamma}{\partial t} = \rho_e\, b \dfrac{\partial \bar{x}}{\partial t} = \rho_e\, b\, \bar{v}$

$\bar{v}$: dislocation velocity

* **Taylor–Orowan relation.**

→ Deformation in Single Crystal:



→ Slip System = Slip planes + Slip direction

→ Slip occurs by dislocation motion.

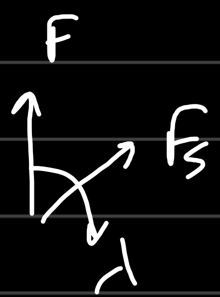
↳ Piels-Navarro stress.

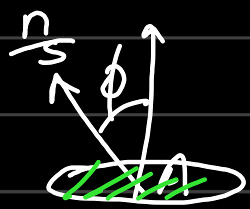
→ Slip occurs when shear strain reaches critical value to move dislocations.

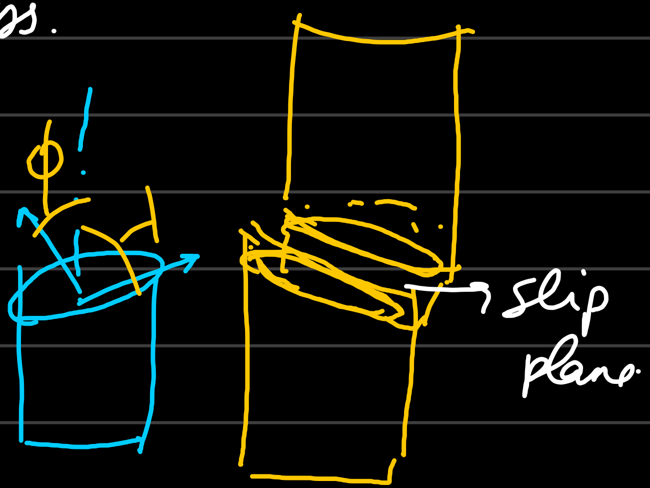
→ Schmidt factor & resolved shear stress.

↳ applied Tensile stress can lead to Resolved Shear Stress.

$$\tau = \frac{F_s}{A_s}$$

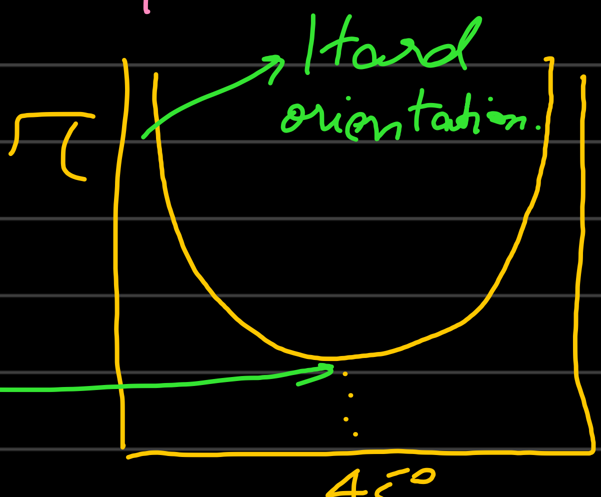






$$\tau_R = s\sigma n = \sigma\cos\phi\cos\lambda$$

$$\sigma = \frac{\tau_c}{\cos\phi\cos\lambda}$$



Soft Orientation.

Stress & Dislocation Motion → Schmid factor.

$$\tau_R = \sigma \cos\lambda \cos\phi$$

Schmid's Law: $\tau_R > \tau_{CRSS}$.

↳ condition for slippage to occur.

τ_{CRSS} : stress required to initiate slip in a single crystal.

→ intrinsic property of material.

* The stress required to cause slip on the primary slip system is the yield stress of the single crystal.

→ The primary slip system will have the largest Schmidt factor (M).

Q) Tensile $\sigma = 5\,kPa$; parallel to [432]

In cubic crystal.

Find τ on the [11$\bar{1}$] plane in [011] direction.

16
9
4

$$\cos\lambda = \frac{4+3-2}{\sqrt{5}\sqrt{29}} \qquad \cos\phi = \frac{3+2}{\sqrt{2}\sqrt{29}}$$

$$\tau_{CRSS} = \sigma \cos\lambda \cos\phi$$

$$= \frac{5\times \quad \times 5 \times 5}{3\times 29} = \underline{\underline{1.76\,kPa}}$$