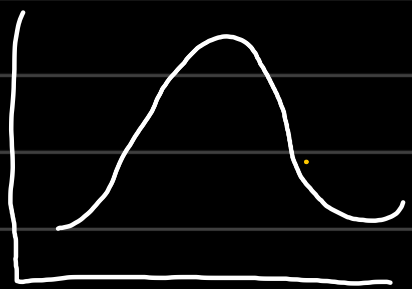
Lecture 11

Stacking Fault Energy:

↳ describes tendency to create stacking fault upon application of shear stress.



SFE
- Brass : < 10 mJ/m²
- Al : 160–250 mJ/m²
- Stainless Steel : < 10 mJ/m²

→ Stacking Fault Width: dist b/w two dislocation partials

↳ SF width describes the mode of deformation.

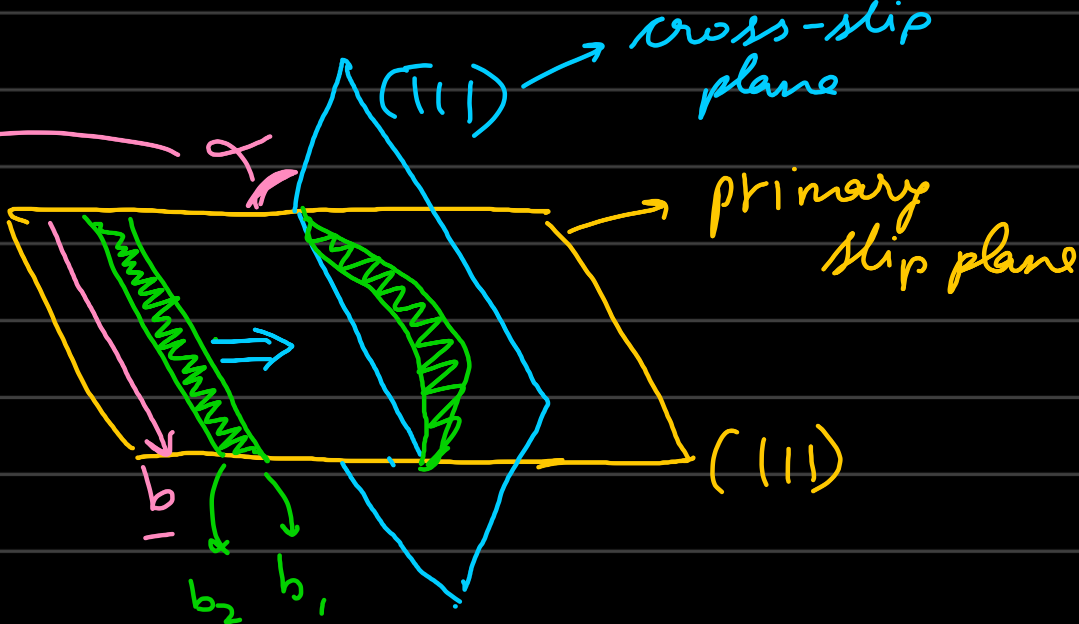
↳ Cross-slip: movement of one screw dislocation from one slip plane to another.

* $\text{SF width} \propto \dfrac{1}{\text{SFE}}$

→ low SF width → high SFE → easy cross-slip forms easily → easy deformation.

$\cos^{-1}\left(\frac{1}{3}\right)$

↳ $70.\_^{\circ}$



↳ leading partial di /

$$\frac{a}{2}[10\bar{1}] \longrightarrow \frac{a}{6}[2\bar{1}\bar{1}] + \frac{a}{6}[11\bar{2}]$$

↳ before cross-slip : partials merge back to $\frac{a}{2}[10\bar{1}]$ and then → move onto $(\bar{1}11)$ slip plane

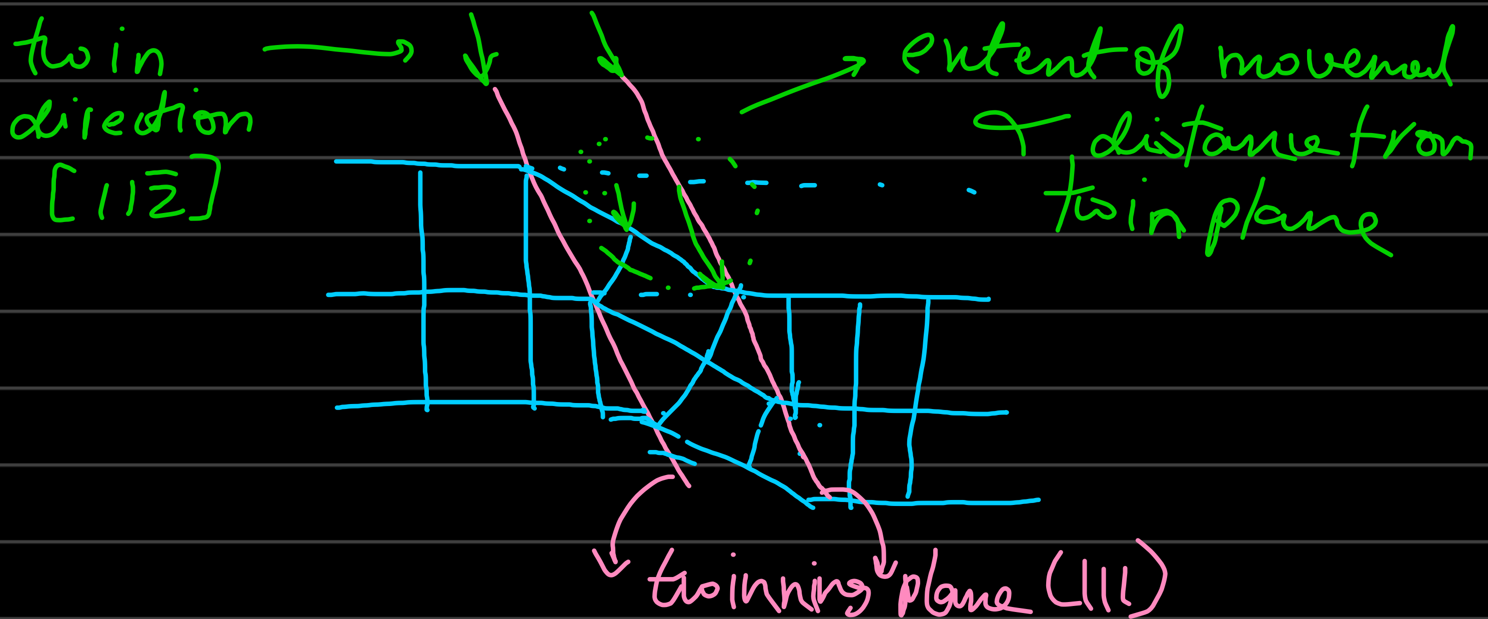
→ happens as only one partial $\frac{a}{6}[2\bar{1}\bar{1}]$ can exist over $(\bar{1}11)$, hence merging is required.

→ easy cross-slip $\propto$ SF width.

Deformation by Twinning:

- each plane move through a definite distance in the same direction.
- extent of movement of plane $\propto$ distance from twinning plane.

→ On application of shear stress:
- twin about twinning plane
- left undeformed
- right deformed.



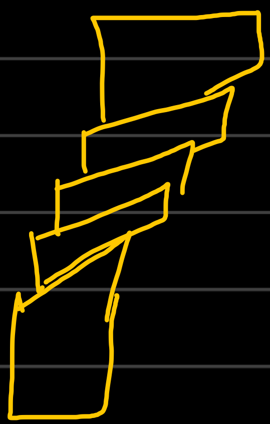
→ Crystallographic elements:

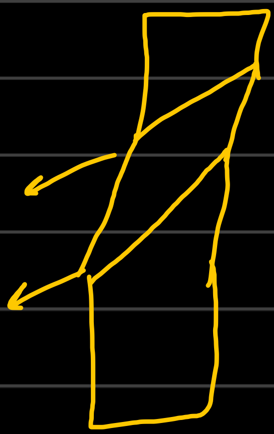
- twinning shear: $\boxed{S = 2\tan\alpha}$

→

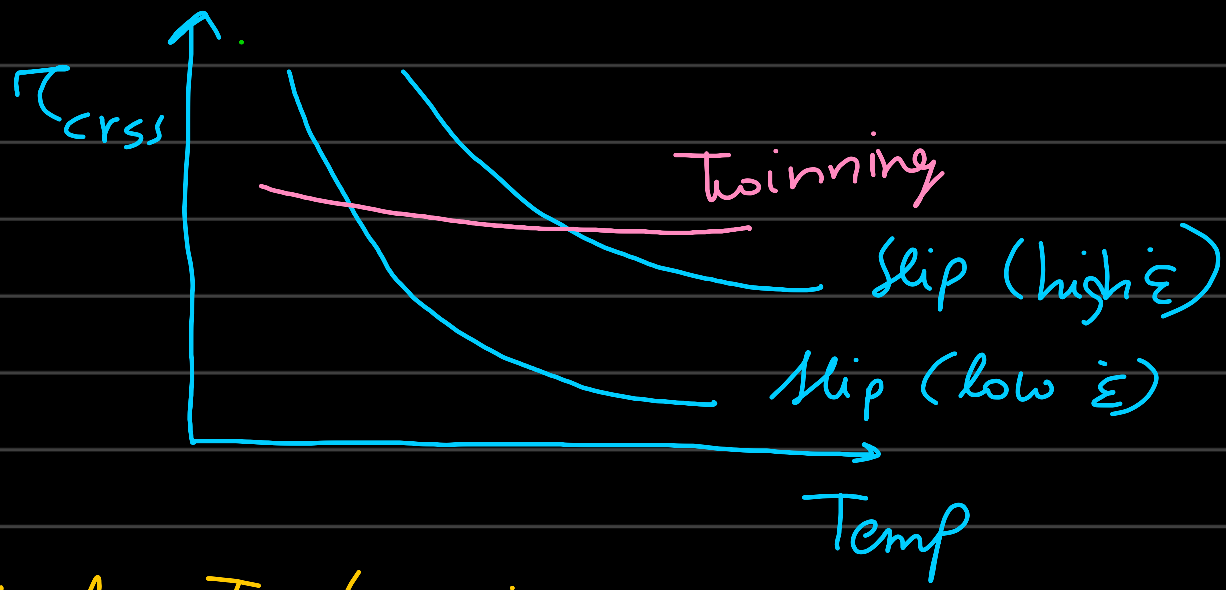
		Twin plane	Twin direction
Fe, Ta	bcc	(112)	[111]
Zn, Cd	hcp	$(10\bar{1}2)$	$[\bar{1}011]$
Ag, Au	fcc	(111)	[112]

→ Slip deformation vs Twin Deformation:





→ permanent & irreversible change.



→ at low T: twinning
at high T: slip

} low τ_{crss}

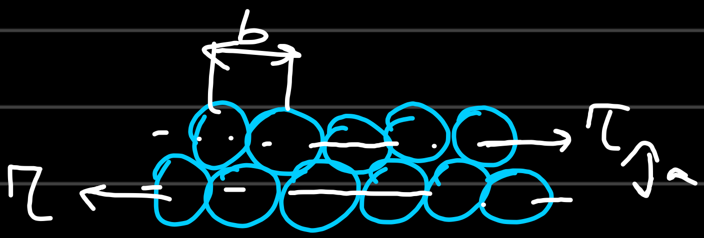
"Anything that hinders slip will deform of twinning"

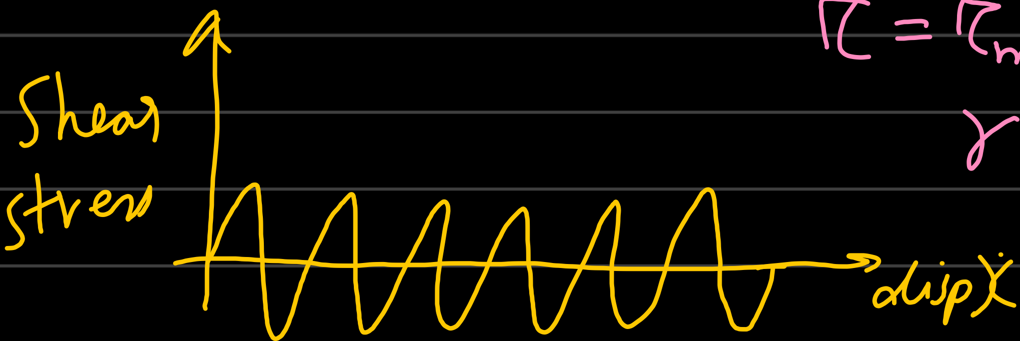
☆ Slip requires critical resolved shear stress
Twin does not require critical resolved shear stress.

→ Twin lines occur in planes.

Dislocations:

Theoretical strength of perfect crystal:





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

$$\gamma = \frac{x}{a}$$

$$\tau_{max} = \frac{Gb}{2\pi a} \approx \frac{G}{2\pi}$$ → huge value predict theoretical

$$\tau_{max} \approx \frac{G}{30}$$ → still huge compared to experimental observatio

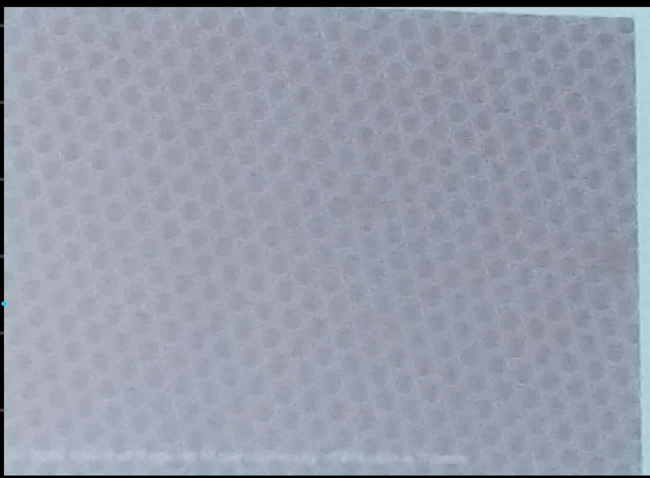
for other complicated sinusoidal variation.

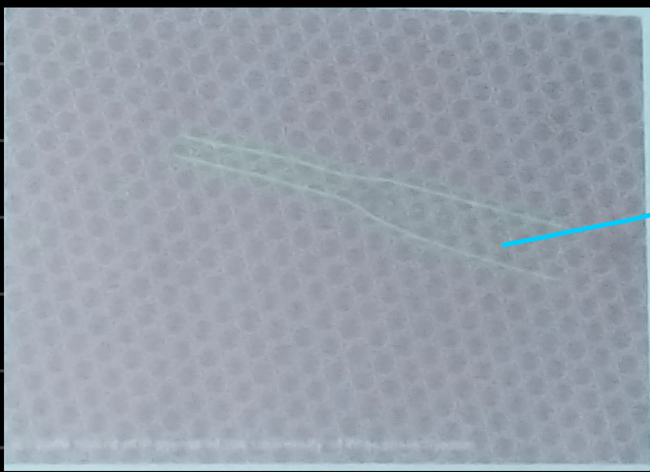
	Theoretical	Experimental
Aluminium	4200 MPa	0.7–0.8 MPa
Iron	13000 MPa	26–30 MPa
Silver	4800 MPa	0.4–0.5 MPa

"↳ Defects are present in all perfect crystals"

→

☆ 2D Bubble Raft/array:





extra plane of atoms.