Slip & Twining

Engineering Materials and Metallurgy

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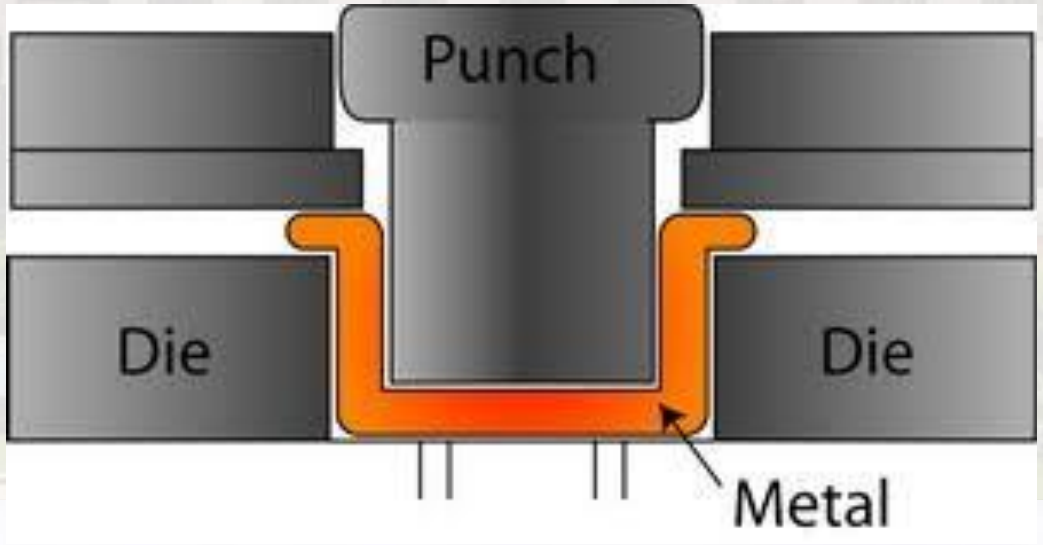
Deformation

- **Where from loads / forces?**
  - During service
  - Structure, machine, tool, etc
  - During processing
  - Forging, rolling, casting, welding etc



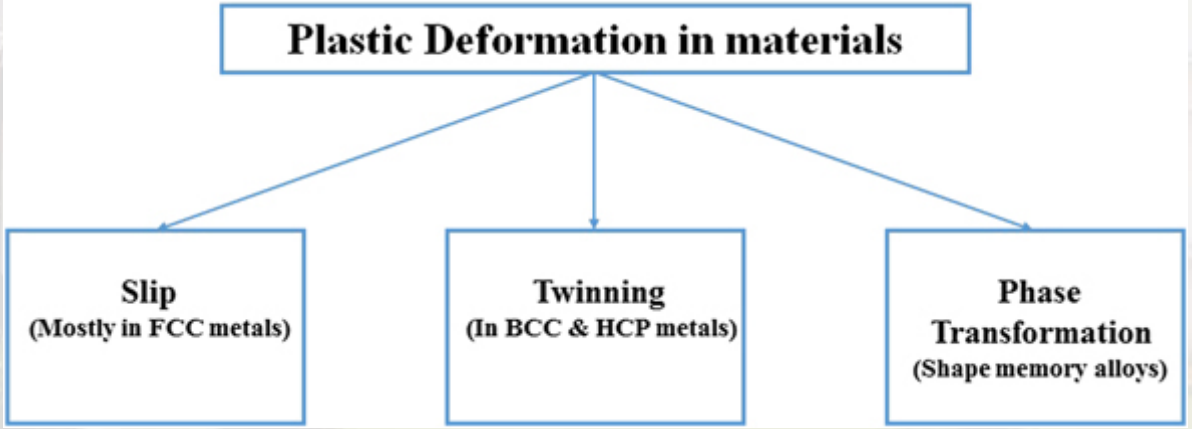
- **What are the happenings?**
  - No change in shape
  - Change in shape
  - Breaking into pieces

Deformation

- **The happenings in terms of Mechanics**

1. No deformation / minute elastic deformation
2. Excessive elastic deformation
3. Yielding / Plastic deformation
4. Fracture

} Failure



- **Are they desirable?**

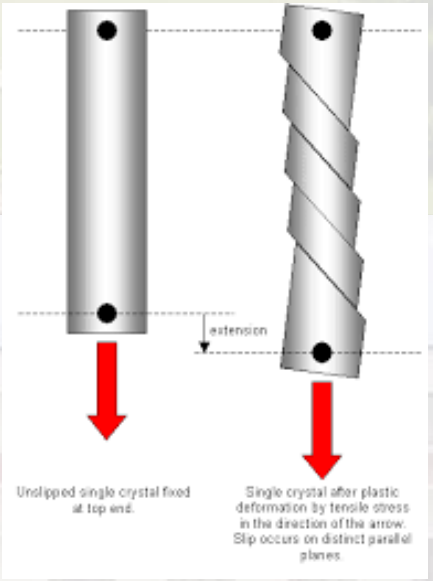
1. No deformation : Structural applications Springs
2. Elastic deformation : Metal working applications
3. Plastic deformation : Strengthening
4. Plastic deformation + Fracture : Machining, Testing

Slip Systems

- Preferred planes for dislocation movement (slip planes)
- Preferred crystallographic directions (slip directions) Slip planes + directions (slip systems)
- More no. of slip systems indicates that material is ductile
- Normally No. of slip systems > 5 termed as ductile materials
- Most of BCC materials are ductile in nature

Mechanisms of Plastic Deformation in Metals
Slip

- Two prominent mechanisms of plastic deformation, namely Slip and Twinning .
- Slip is the prominent mechanism of plastic deformation in metals.
- It involves sliding of blocks of crystal over one other along definite crystallographic planes, called slip planes.
- It is analogous to a deck of cards when it is pushed from one end.
- Slip occurs when shear stress applied exceeds a critical value.



Mechanisms of Plastic Deformation in Metals
Twinning

- ✓ Portion of crystal takes up an orientation that is related to the orientation of the rest of the untwined lattice in a definite, symmetrical way.
- ✓ The twinned portion of the crystal is a mirror image of the parent crystal.
- ✓ The plane of symmetry is called twinning plane

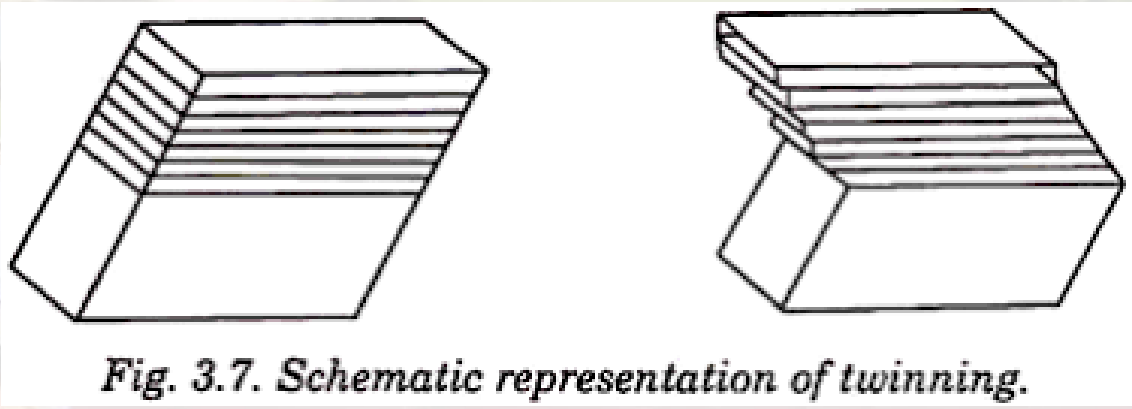
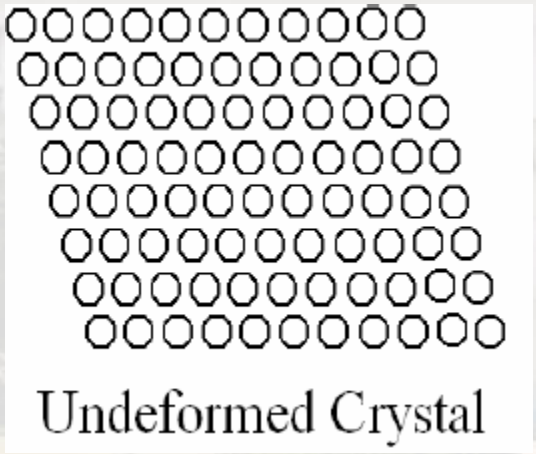
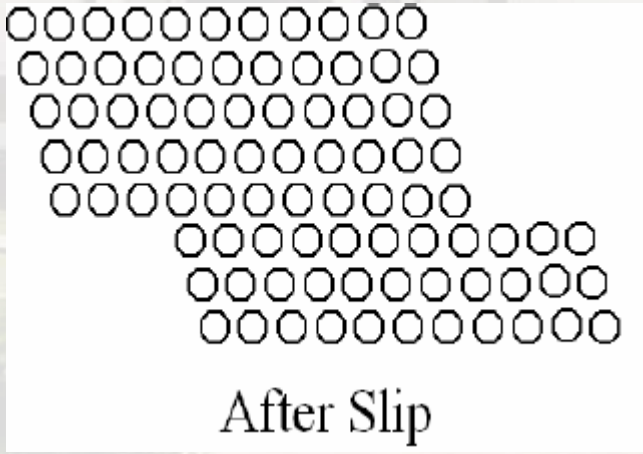


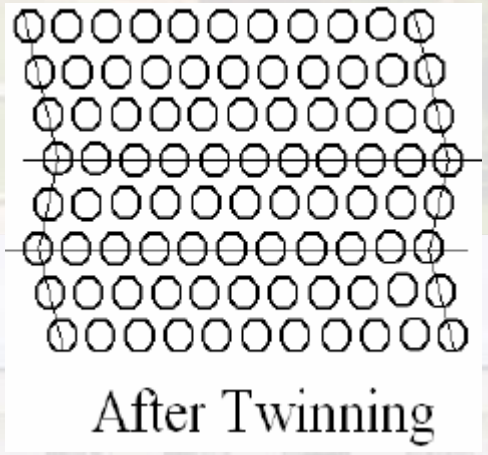
Fig. 3.7. Schematic representation of twinning.



Undeformed Crystal



After Slip



After Twinning

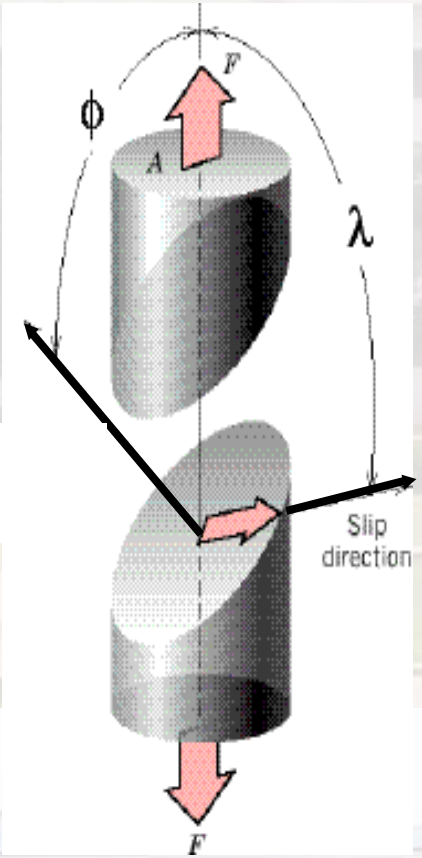
Slip in Single Crystals

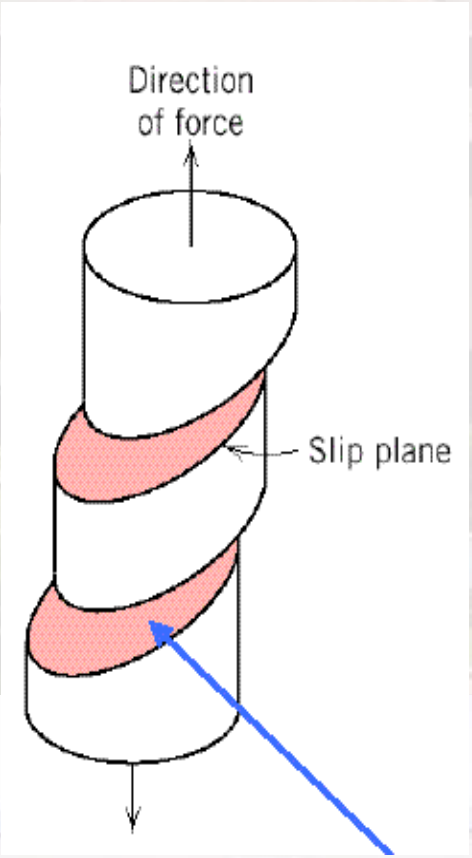
➢ Resolving the Applied Stress onto the Slip System

- ❖ Dislocations move in particular slip system in response to shear stresses applied.
- ❖ Applied stress is resolved onto the slip systems
- ❖ Resolved shear stress (τ_R)
  - ❖ Which is required to produce a plastic deformation
  - ❖ It result from application of a simple tensile stress, σ

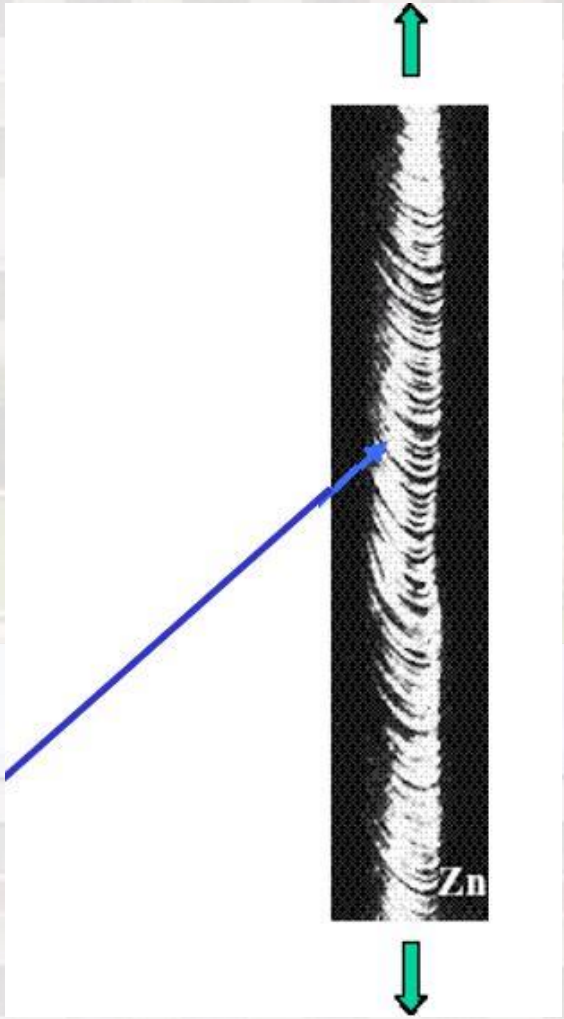
➢ Critical Resolved shear stress (τ_{CRSS})

Slip System



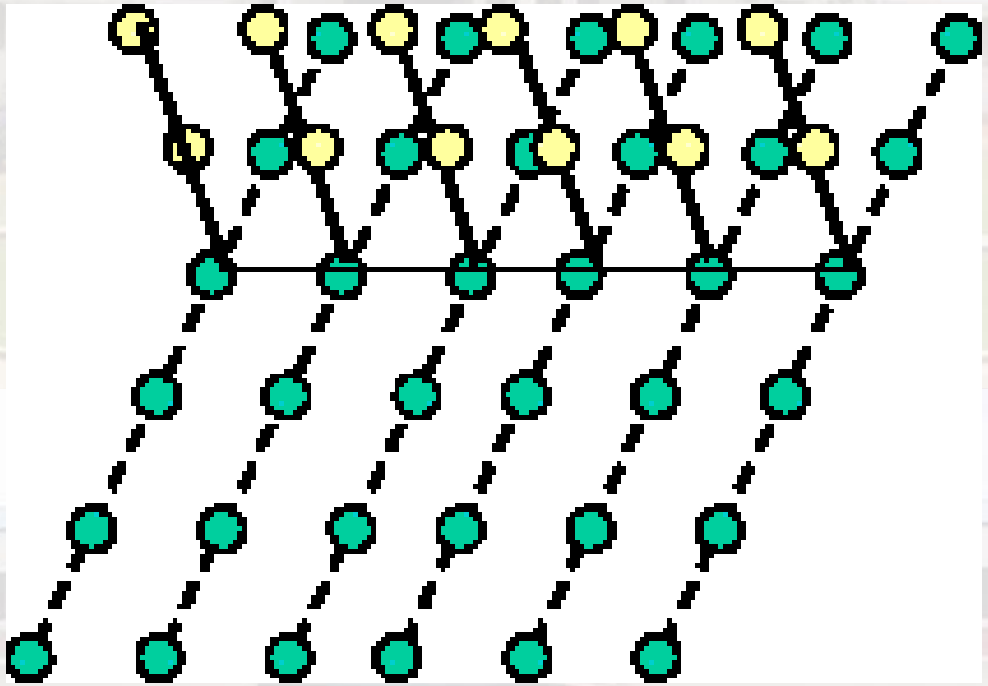


Slip bands

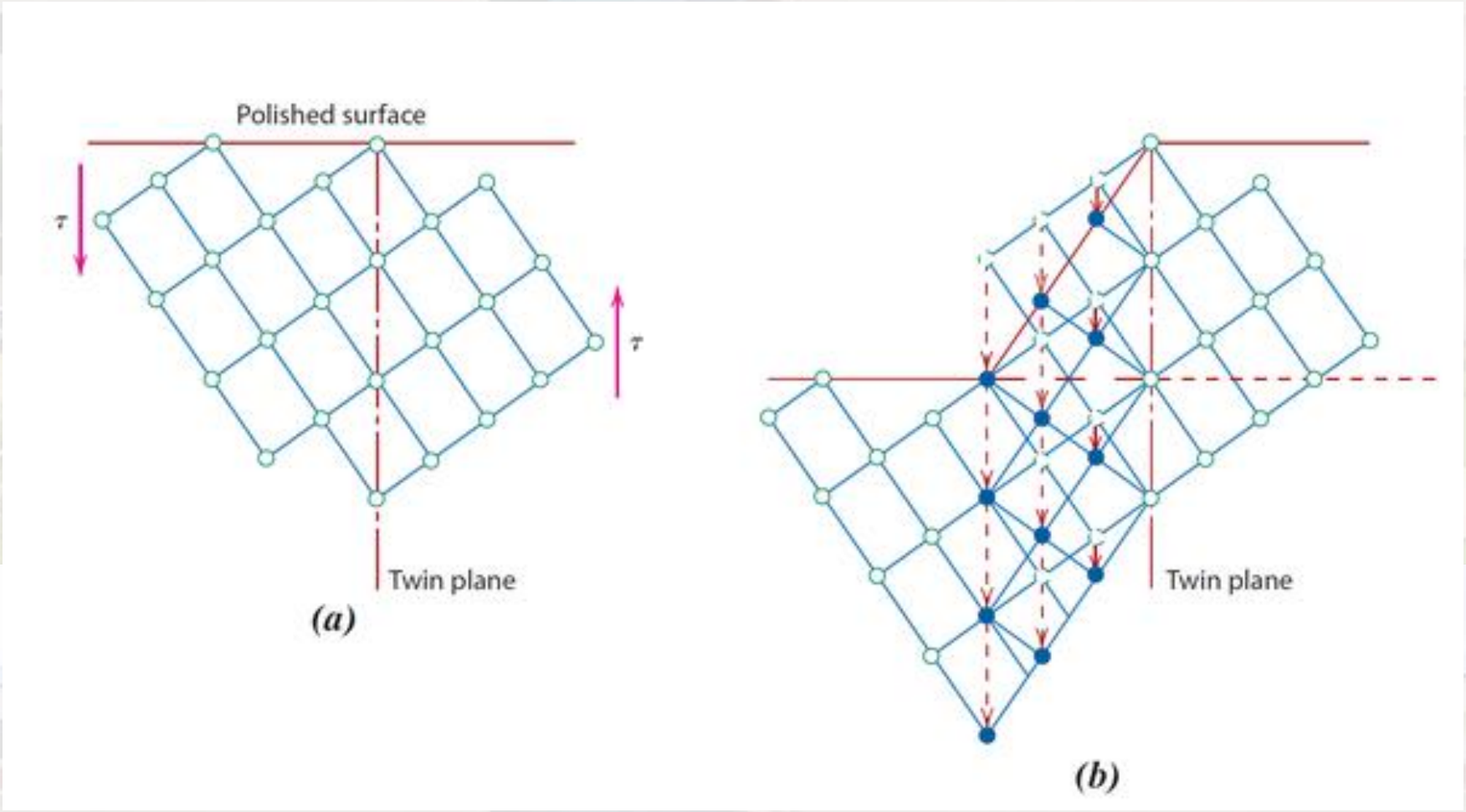


Deformation by Twinning

- ✓ Whenever slip is not possible
- ✓ Creates a deformed portion grain which is just mirror image of the rest of the parent grain

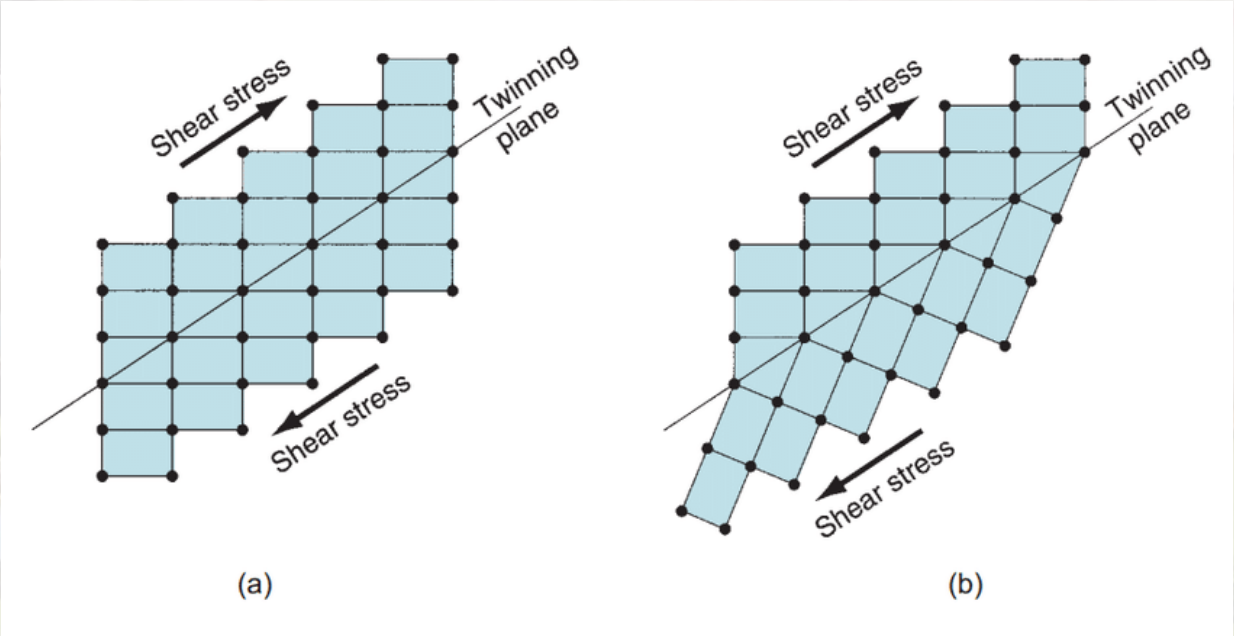


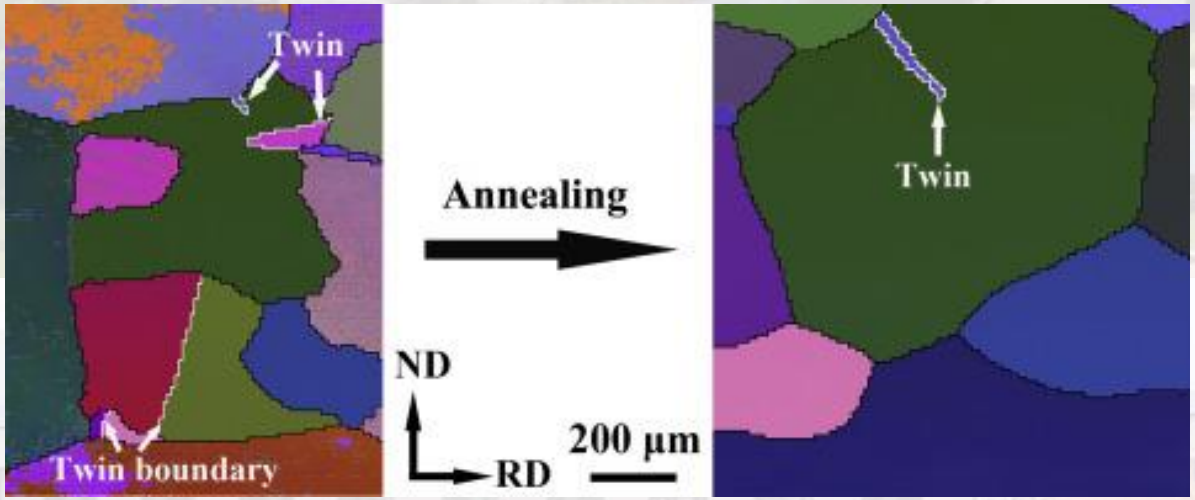
Twinning



Twin Types

- Mechanical twins → BCC and HCP
- Annealing twins → FCC





Slip Vs Twinning

Slip	Twin
Orientation across the slip plane is same	Orientation across the twin plane is different
Atomic movements are equal to atomic distances	Atomic movements are lesser than atomic distances
Atoms are moving in only one plane (slip plane)	Atoms are moving in all planes in the region of twin
Takes place in milli seconds	Takes place in less than micro seconds
Takes place at low strain rates	Takes place at high strain rates
No sound is created	A click sound (Tin cry)

THANK YOU

Assessment:

https://play.kahoot.it/v2/?quizId=7675c2a9-b7a6-4fbf-bac2-770d11fada3f