Partial Dislocations - II

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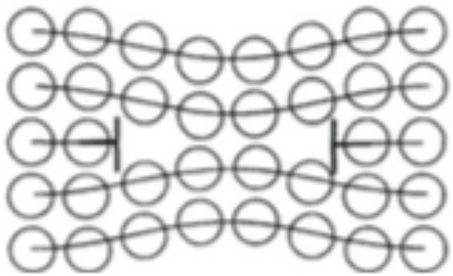
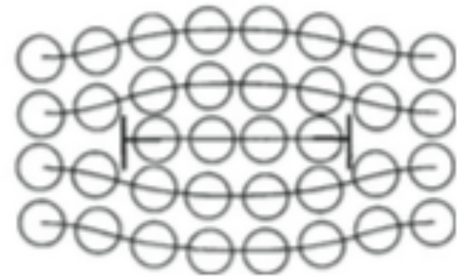
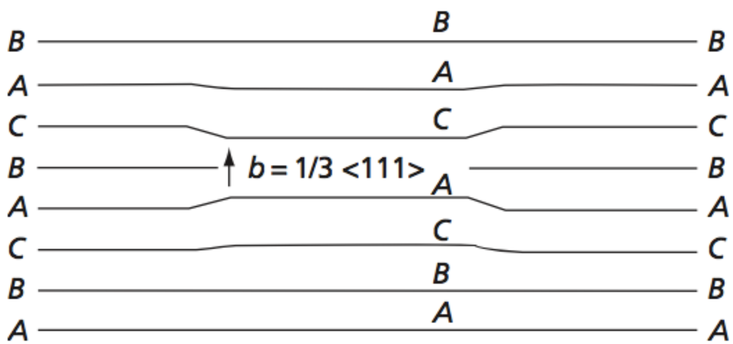
Fall 2015

Intrinsic and Extrinsic Stacking Faults

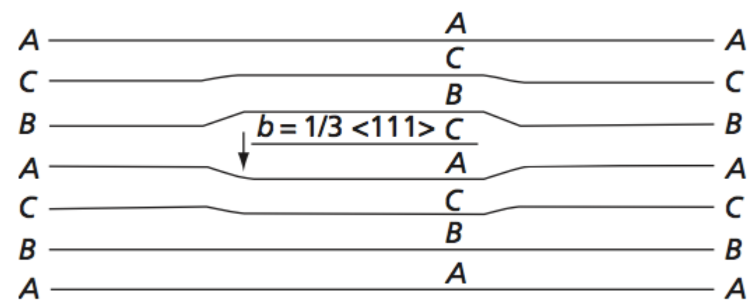




[Hull & Bacon]



Intrinsic Stacking Fault



Extrinsic Stacking Fault

…ΔΔΔΔ∇ΔΔΔ…

Negative Frank Dislocation
S-Frank partial dislocation:
S = single fault

…ΔΔΔΔ∇∇ΔΔΔ…

Positive Frank Dislocation
D-Frank partial dislocation:
D = double fault

Remarks

- The Burgers vector of Frank partials is:

$$\vec{b} = \frac{1}{3}\langle 111 \rangle$$

- **b** is normal to {111}
- Frank partials are pure edge dislocations.
- Frank partials are sessile and can move only by climb

- Atoms are in wrong sequence in vicinity of stacking fault. There is a stacking fault energy (intrinsic or extrinsic).

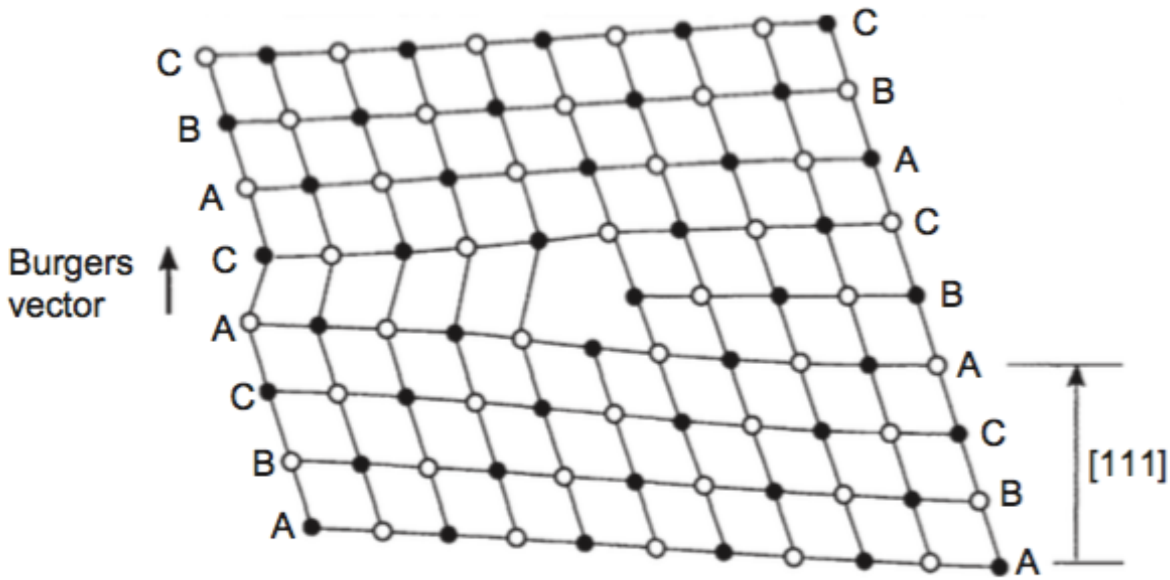
- Stacking fault energy is only a local distortion of atomic layers. It is smaller than the grain boundary energy or surface energy.

- Stacking fault between Shockley partials is intrinsic SF.

Shockley Partial vs Frank Partial

- A partial dislocation whose Burger vector lies on the plane of the fault is called a *Shockley partial dislocation*.
- A partial dislocation whose Burgers vector is not parallel to the fault is called a *Frank partial dislocation*.
- Energy of a Shockley partial is approximately 1/3 of the energy of total dislocation.
- Energy of a Frank partial is 2/3 of the energy of total dislocation
- Shockley partials are glissile but Frank partials are sessile

Frank Partial Dislocations



[Read]

The fault will be removed if the crystal above it is sheared such that:

C→B, A→C, B→A, etc.

This ½ <112>displacement corresponds to the glide of a Shockley partial.

Removal of Frank Partials

- To remve an intrinsic fault, one Shockley partial is required

- To remove an extrinsic fault, two Shockley partials are required.

$$\frac{1}{6}[\bar{1}2\bar{1}] + \frac{1}{6}[2\bar{1}\bar{1}] + \frac{1}{3}[111] \rightarrow \frac{1}{2}[110]$$

αC + αD + αA → BA

Twin

- Atoms move by less than a translational vector (< 1 lattice vector)
- We define twinning dislocation with the Burgers vector b*

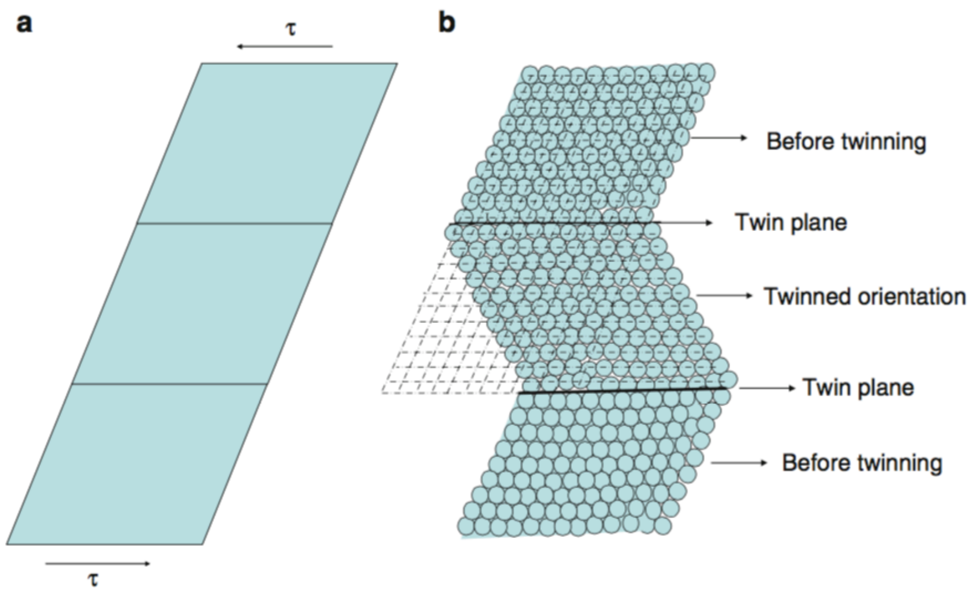
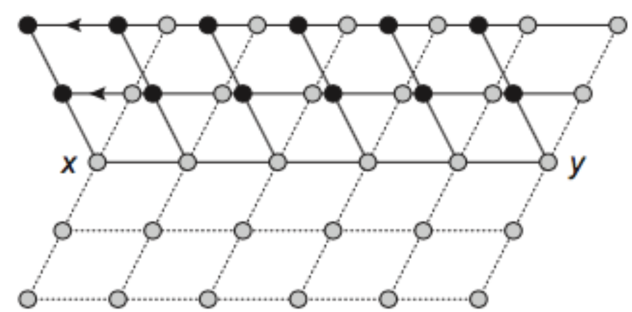
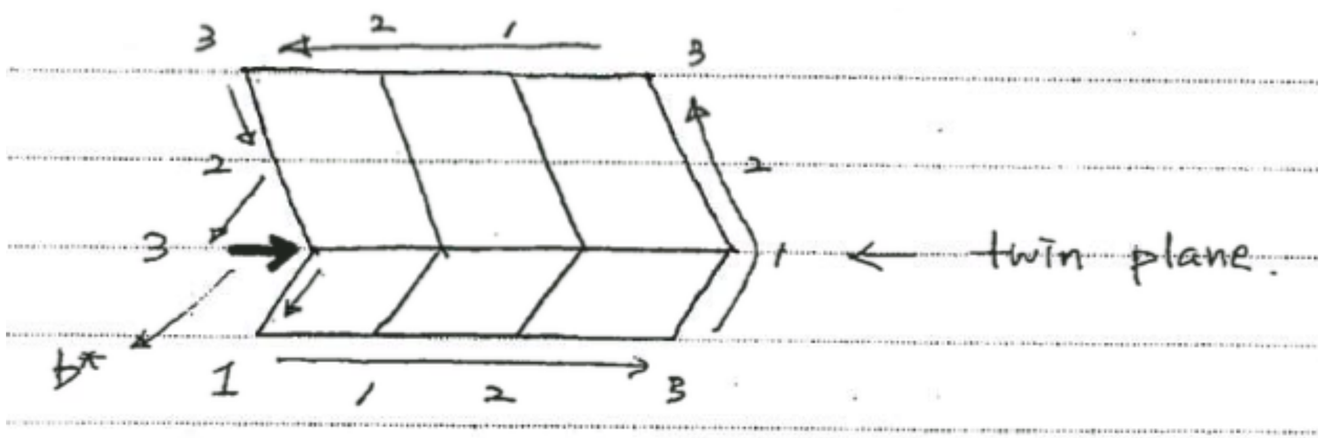


Fig. 3.10 Schematic illustration of a twinned region in the material: (**a**) before application of shear τ and (**b**) after twinning deformation. Note that the twinned region is a mirror image of the crystal part before twinning



Burgers Vector for Twinning

- To define b* for twin:
  - Start on twinning plane
    Twining plane divides the mirror-image into 2 parts
  - Make circuit of n step
  - Last step is parallel to the first step
  - b* lies in twining plane
- b*=translation needed on each plane to restore perfect crystal



Twin

- Twin plane in fcc = {111}
- Twin direction in fcc = <112>

- Twin is an imperfect dislocation

$$\vec{b}^* = \frac{a}{2}[\bar{1}\bar{1}2]$$

- Distance moved by each layer is proportional to distance from twin plane

Frank's Index for Twin

layer #		w/o twining	w twining	Fank's Index	structure
-2		B	B		
				△	
-1		C	C		FCC
				△ - - - -	
1	twin plane	A	A		
				▽	H.C.P.
2		B	C	- - -	
				▽	F.CC.
3		C	B		
				▽	
4		A	A		

- Single layer of atoms having hcp stacking

Energy of Twin

- $\gamma_E \approx \gamma_I \approx 2\gamma_T$

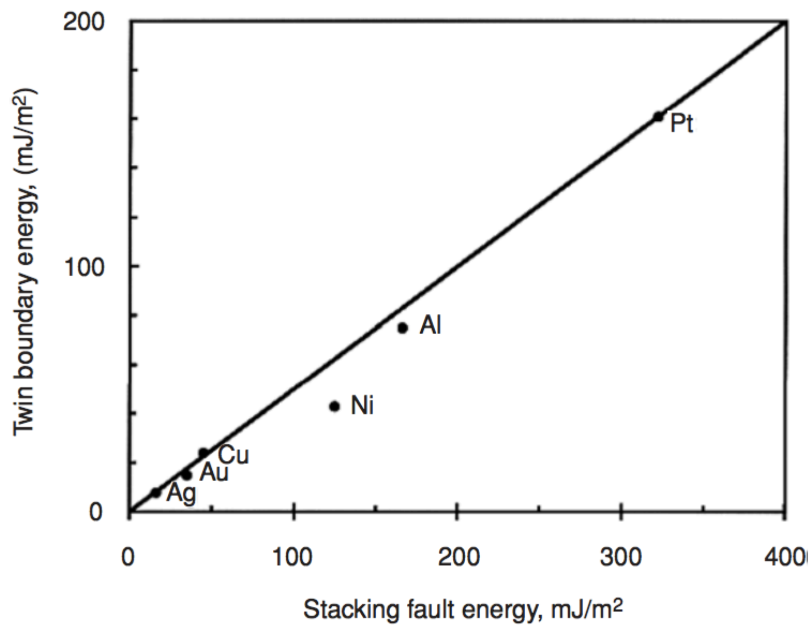
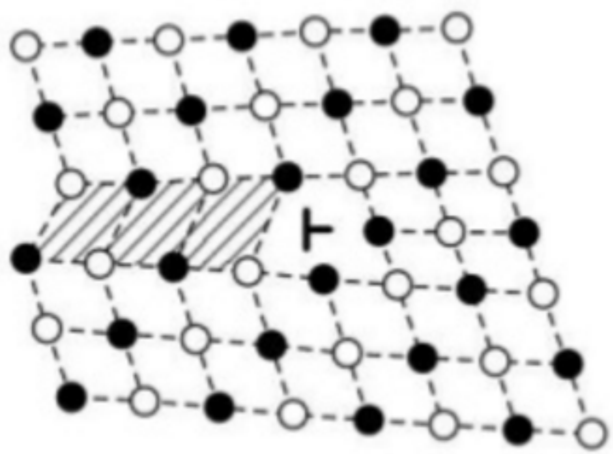


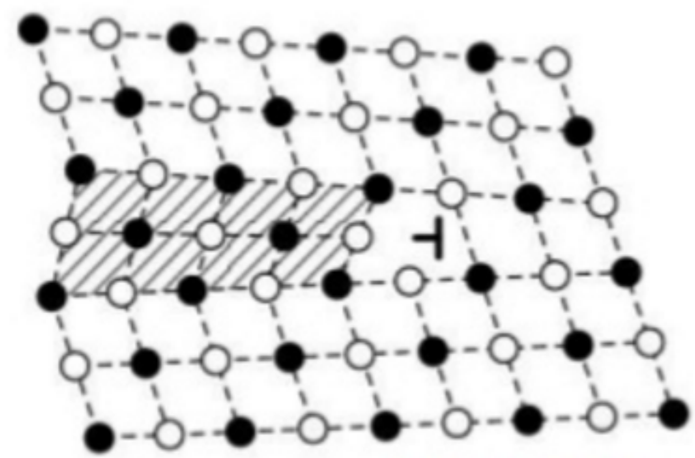
Figure 9.24. The relationship of stacking fault energy and twin boundary energy. The line represents $\gamma_{\text{stacking fault}} = 2\gamma_{\text{twin}}$.

Stacking Fault and Twinning

- The negative Frank partial has one late twin on tension side
- The positive Frank partial has a two layer twin on compression side



Intrinsic Stacking Fault



Extrinsic Stacking Fault