Chapter 4　Dislocations in Crystals

4.1　Perfect dislocations

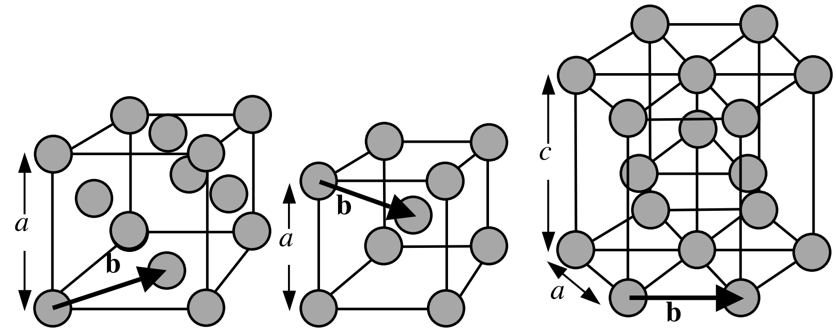
・ $E_0 = \alpha \mu b^2$　(2.7)　$\rightarrow$　$|\mathbf{b}|$: as small as possible

・No change in crystal structure before and after the motion of dislocations

　　$\rightarrow$　**b** : lattice translation vector

$$\Downarrow$$

b : primitive translation vector

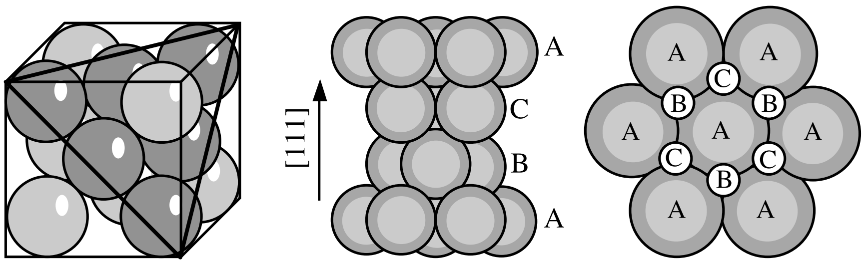


$\mathbf{b} = \frac{a}{2}\langle 110 \rangle$　　$\mathbf{b} = \frac{a}{2}\langle 110 \rangle$　　$\mathbf{b} = \frac{a}{3}\langle 11\bar{2}0 \rangle$

(a) fcc　　(b) bcc　　(c) hcp

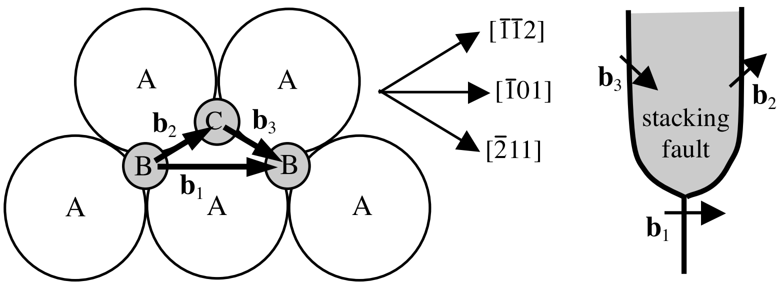
Fig. 4.1　Burgers vectors of perfect dislocations

4.2　Partial dislocations and stacking faults



(a)　　(b)　　(c)

Fig. 4.2　Rigid sphere model of fcc and stacking of the (111) planes.



(a)　　(b)

Fig. 4.3　(a) perfect dislocation ($\mathbf{b}_1$) on fcc (111) and two Schockley partials ($\mathbf{b}_2$, $\mathbf{b}_3$), (b) extended dislocation made of two Schockley partials and a stacking fault.

$\mathbf{b}_1$: translation vector (perfect dislocation)

$\mathbf{b}_2$, $\mathbf{b}_3$: non-translation vector (partial dislocation) $\rightarrow$ <u>Schockley partials</u>

Burgers vector conservation law: $\mathbf{b}_1 = \mathbf{b}_2 + \mathbf{b}_3$

$$\boxed{\begin{array}{ccccc} \frac{a}{2}[\bar{1}01] & \rightarrow & \frac{a}{6}[\bar{1}\bar{1}2] & + & \frac{a}{6}[\bar{2}11] \\ \mathbf{b}_1 & = & \mathbf{b}_2 & + & \mathbf{b}_3 \end{array}} \tag{4.1}$$

A pair of partial dislocations + stacking fault = extended dislocations

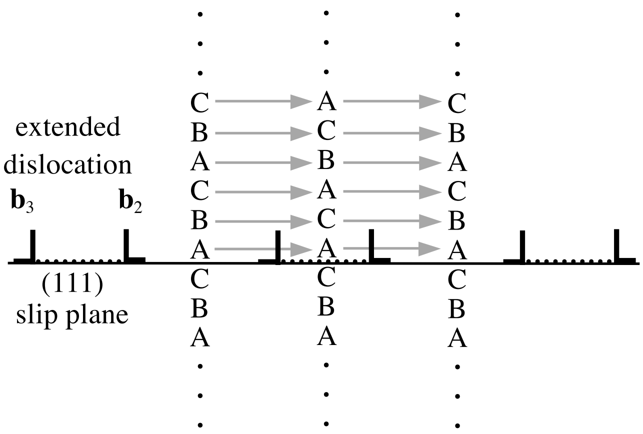


Fig. 4.4 Motion of an extended dislocation and creation of stacking fault.

Table 4.1

Stacking fault energy	(mJ/m^2)	
Cu	Al	Fe
40	200	1000

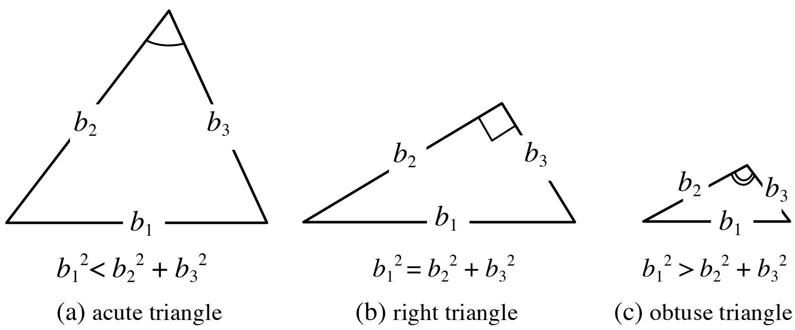


Fig. 4.5 If $\mathbf{b}_1$ dissociates into $\mathbf{b}_2$ and $\mathbf{b}_3$, only the case (c) is possible.

Problem 4.1

(a) What kind of stacking is realized when one of the Schockley partials, say, $\mathbf{b}_2 = a[\bar{1}\bar{1}2]/6$, run on every parallel (111) fcc plane?

(b) The same question as above but on every other parallel (111) fcc plane?

4.3 Twinning (Formation of twinned structure)

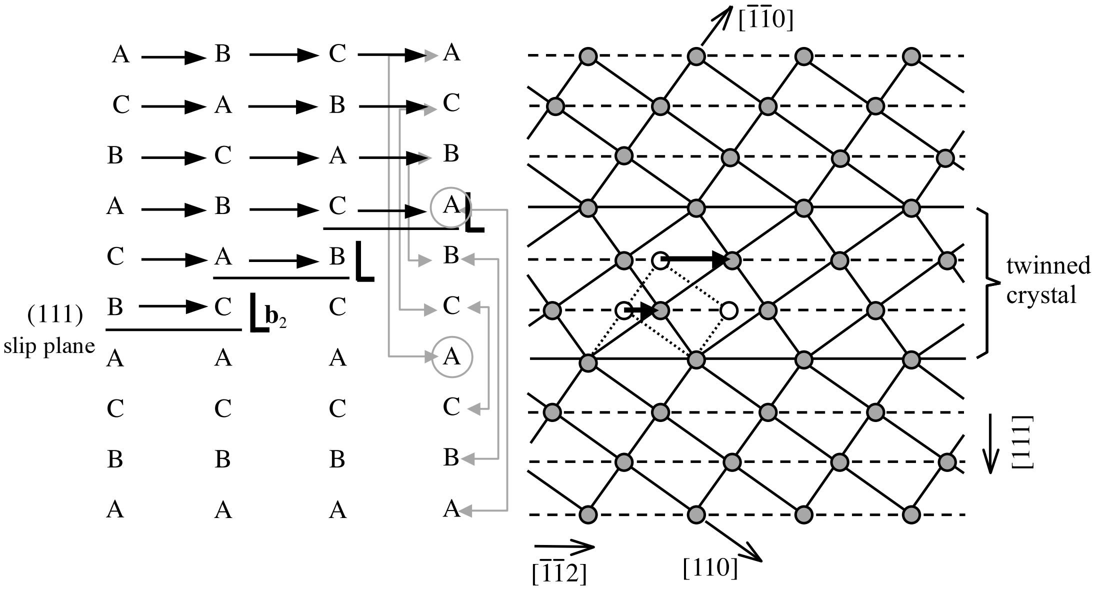


Fig. 4.6 Formation of three-layered twinned crystal by the motion of $\mathbf{b}_2$ Schockley partials on every parallel (111) plane of fcc.

4.4 Cross slip and climb motion

(a) screw dislocation : **b** // **t**

b and **t** do not determine a unique slip plane.

For cross slip to occur

An extended dislocation must constrict.

⇩

Cross slip is more difficult in metals with smaller stacking fault energy.

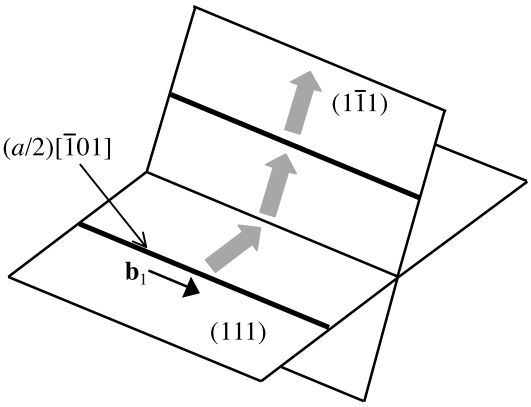


Fig. 4.7 Cross slip of a screw dislocation.

(b) edge dislocation: **b** ⊥ **t**

b and **t** determine a unique slip plane.

⇩

Changing slip planes is possible only when atoms either come from or go to somewhere else.

⇩

Non-conservative motion of dislocations

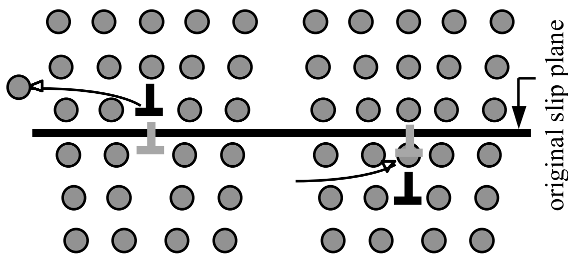


Fig. 4.8 Climb motion of an edge dislocation.