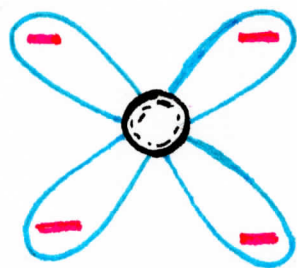


# Electrons, holes, bonds, and bands in semiconductors <sup>①</sup>



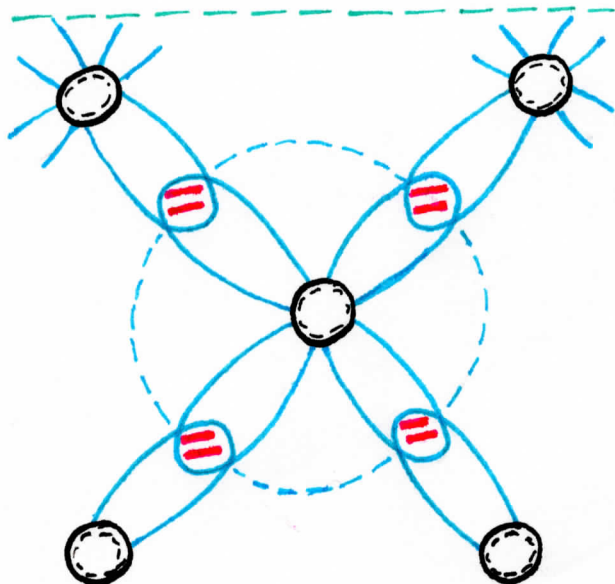
Si atom

What are valences ?

What are valence electrons ?

Si has 4 valence electrons.

Noble gases have 8 valence electrons  $\Rightarrow$  Great stability.

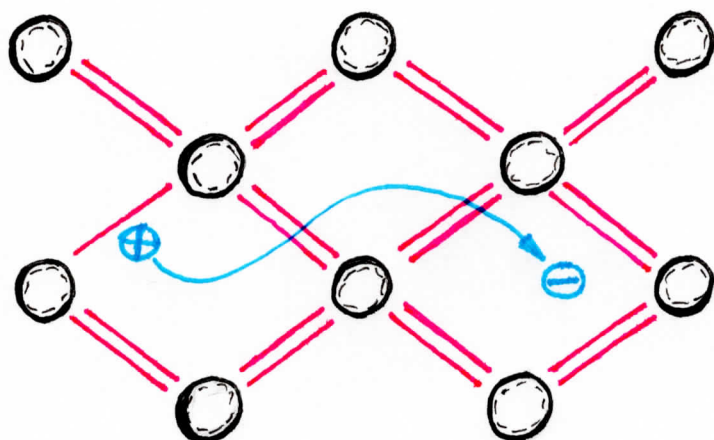


Electron sharing.

Si now has 8 electrons in its valence orbitals.

$\Rightarrow$  Noble gas configuration.

$\Rightarrow$  Great stability.



Removal of an electron from a valence bond

$\Rightarrow$  Free electron  $\ominus$

$\Rightarrow$  Free hole  $\oplus$

Electrons are mobile

Holes are mobile

$\Rightarrow$  Semiconductors are conductive due to  $e$  &  $h$ .

## Doping

Doping Si with atoms having 5 valence electrons  $\Rightarrow$  Excess electrons  $\Rightarrow$   
 $\Rightarrow$  n-type semiconductor ( $n = \text{negative}$ )

Doping Si with atoms having 3 valence electrons  $\Rightarrow$  Excess holes  $\Rightarrow$  p-type semiconductor ( $p = \text{positive}$ )

## Recombination

If an electron and a hole recombine, the electron vanishes and the hole vanishes.

## Band diagram

Atoms  $\Rightarrow$  Energy levels

Crystals  $\Rightarrow$  Energy bands

$\hookrightarrow$  A broadened energy level

③

Valence band (VB) : The band of the valence electrons

Conduction band (CB) : The band of the free electrons

