Lesson 2: Semiconductor Basics

(Razavi 2.1.1 ~ 2.1.2
Youtube: Lec. 1, 21 min. to End
Lec. 2, Beginning to 34 min.)

What is a semiconductor?

IIB	IIIA	IVA	VA	VIA
	5 B	6 C	7 N	8 O
	13 Al	14 Si	15 P	16 S
30 Zn	31 Ga	32 Ge	33 As	34 Se
48 Cd	49 In	50 Sn	51 Sb	52 Te

Group IV elements (for example, Si) has four valence electrons

(Also for combination of
Group III and Group V elements, for example, GaAs, and
Group II and Group VI elements, for example, ZnSe)

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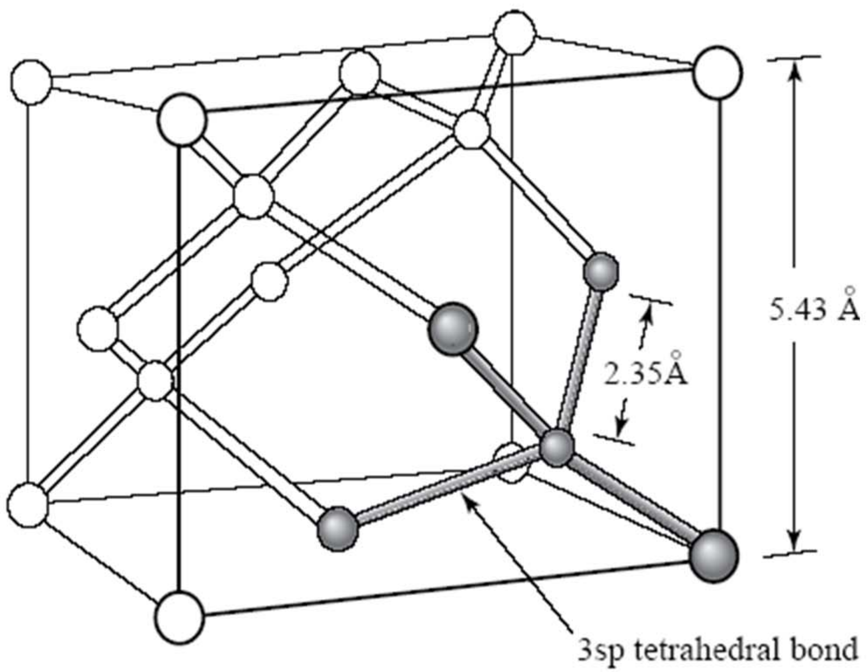
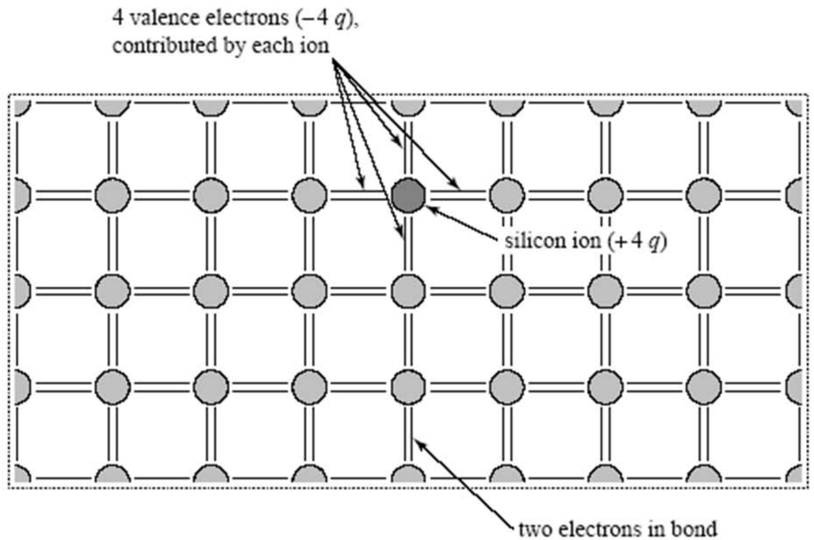
How does it look?   Diamond-like crystal structure





2-dimensional model

Can currents flow?

Si atoms share electrons with neighboring atoms

➔ each atom can have 8 electrons

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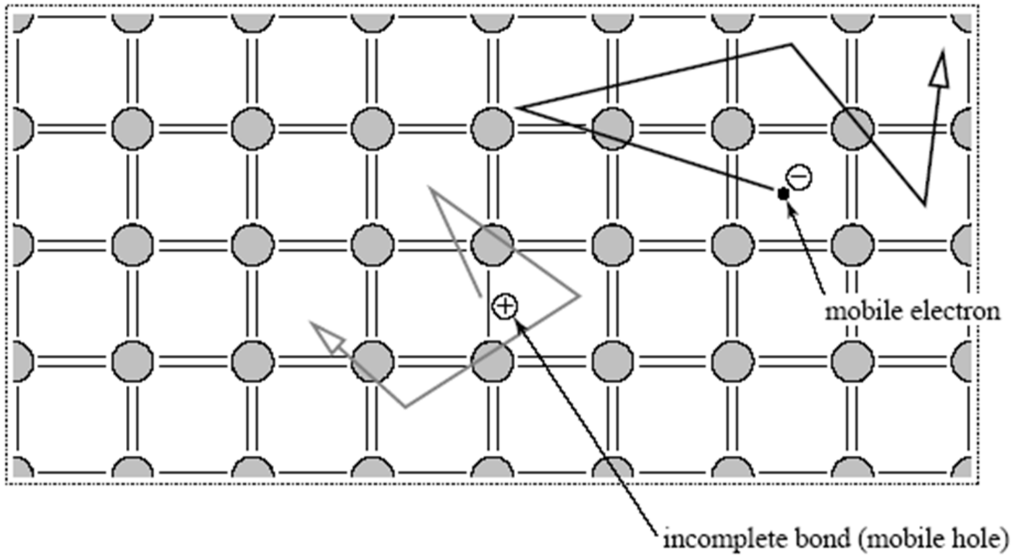
At finite temperature, some electrons escape from bonds creating mobile electrons and holes



n (density of electrons) = p (density of holes) = $5.2 \times 10^{15} \times T^{2/3} \exp(-E_g/2kT)$

➔ Current conduction due to electrons and holes

n_i at RT for Si : about 10^{10} ($1/cm^3$)   No. of Si atoms: 5×10^{22} ($1/cm^3$)

$n \times p = n_i^2$ Intrinsic semicondutor

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What happens when Group V (donor) atoms are added (doping)?

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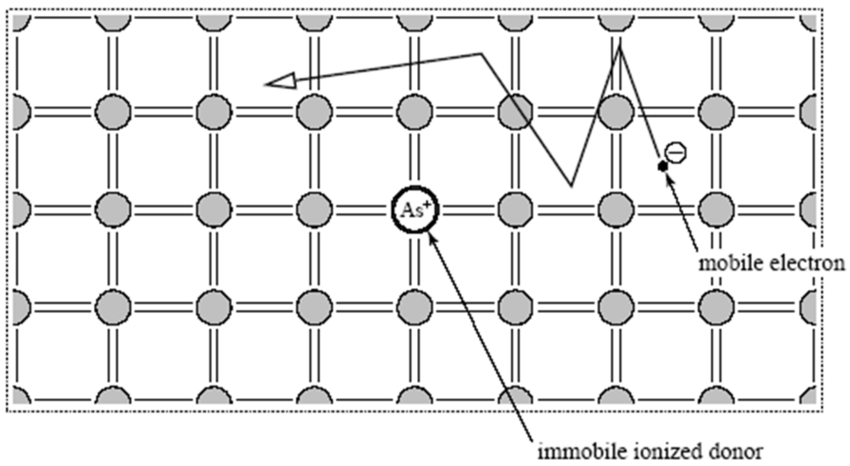

Extra electrons!

$$\text{If } N_d >> n_i, \quad n \sim N_d \text{ (majority carrier)}$$

Extrinsic semiconductor: N-type

$$p \sim n_i^2 / N_d \text{ (minority carrier)}$$

➔ More conductive (less resistive)

Prof. Woo-Young Choi

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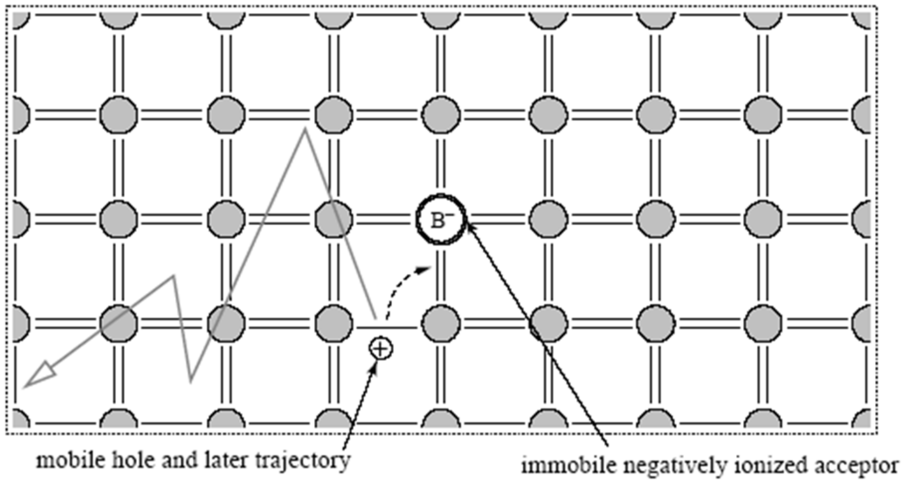
What happens when Group III (acceptor) atoms are added (doping)?

IIB	IIIA	IVA	VA	VIA
	5 B	6 C	7 N	8 O
	13 Al	14 Si	15 P	16 S
30 Zn	31 Ga	32 Ge	33 As	34 Se
48 Cd	49 In	50 Sn	51 Sb	52 Te



Extra holes!

If $N_a >> n_i,\ p \sim N_a$ (majority carrier)

$n \sim n_i^2 / N_a$ (minority carrier)

Extrinsic semiconductor: P-type

➔ More conductive (less resistive)

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For Thursday (9/3)
Razavi Youtube lectures:
Lec. 1, 21 min. to End, Lec. 2, Beginning to 34 min.

➔ Quiz 1

Quiz will start at 9 o'clock. Don't be late.