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INSPIRING CREATIVE AND INNOVATIVE MINDS

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Semiconductor materials

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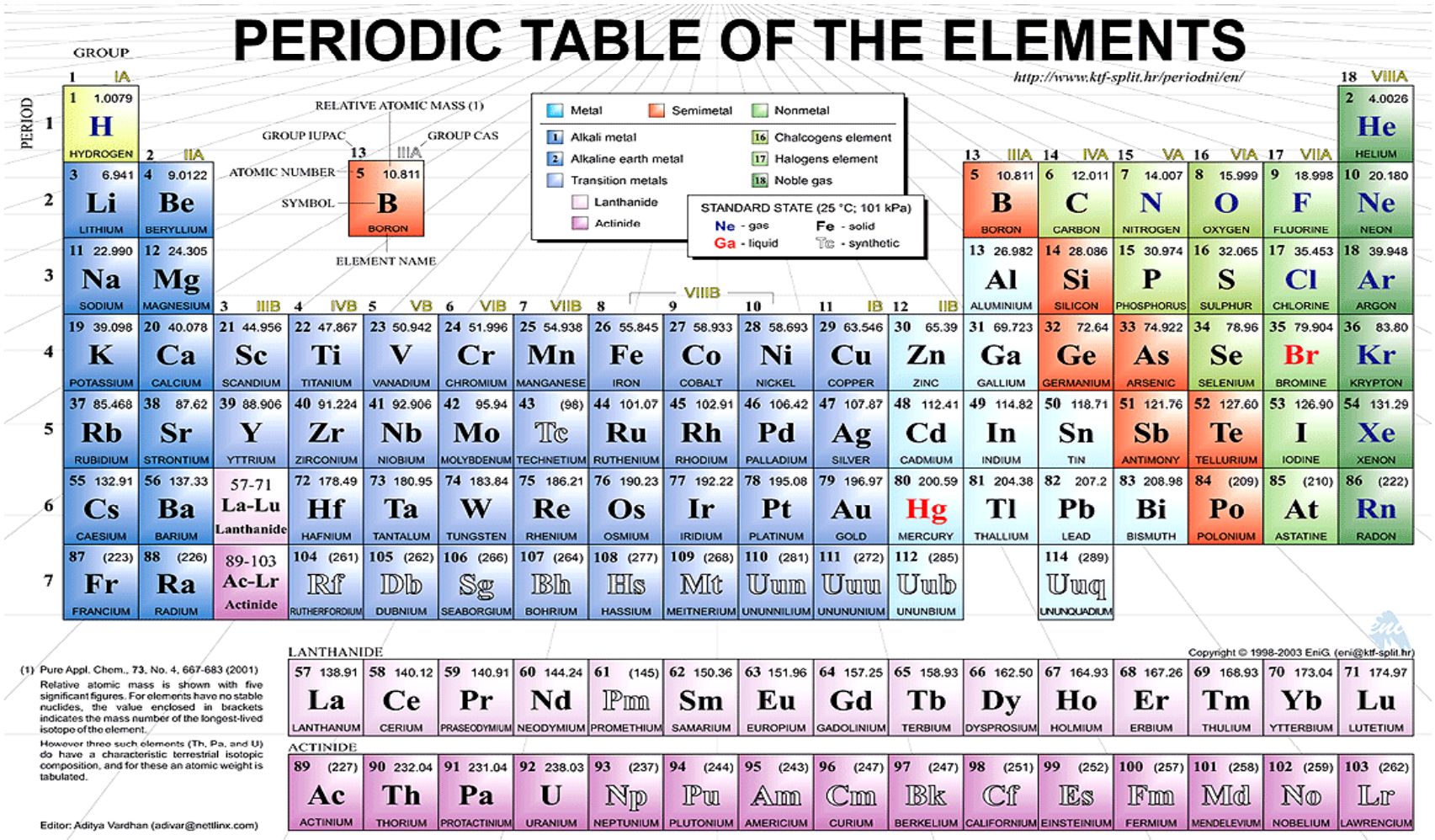
Periodic Table



INSPIRING CREATIVE AND INNOVATIVE MINDS

Conductivity

"Ability to conduct **electrical current**"

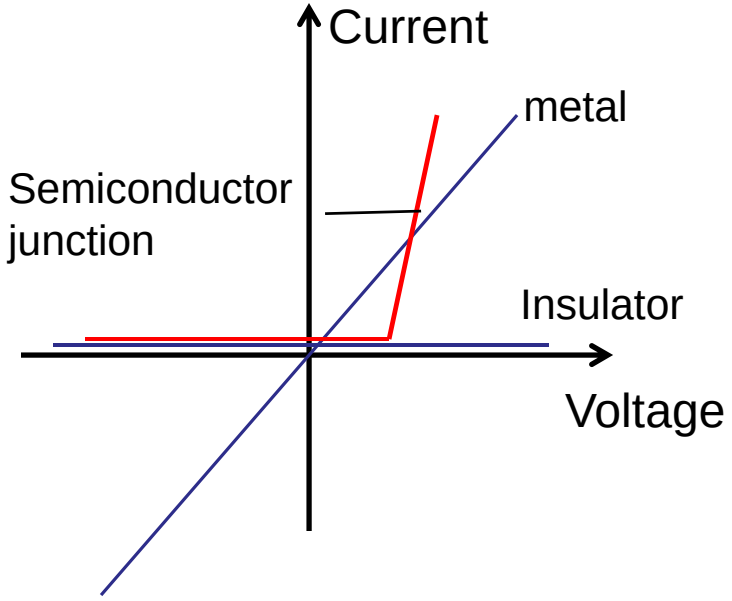
Conductor
metal (gold, platinum, copper, etc)

Insulator
glass., wood, etc

"What make the material conducts electricity?"
Existing of **charge carrier**

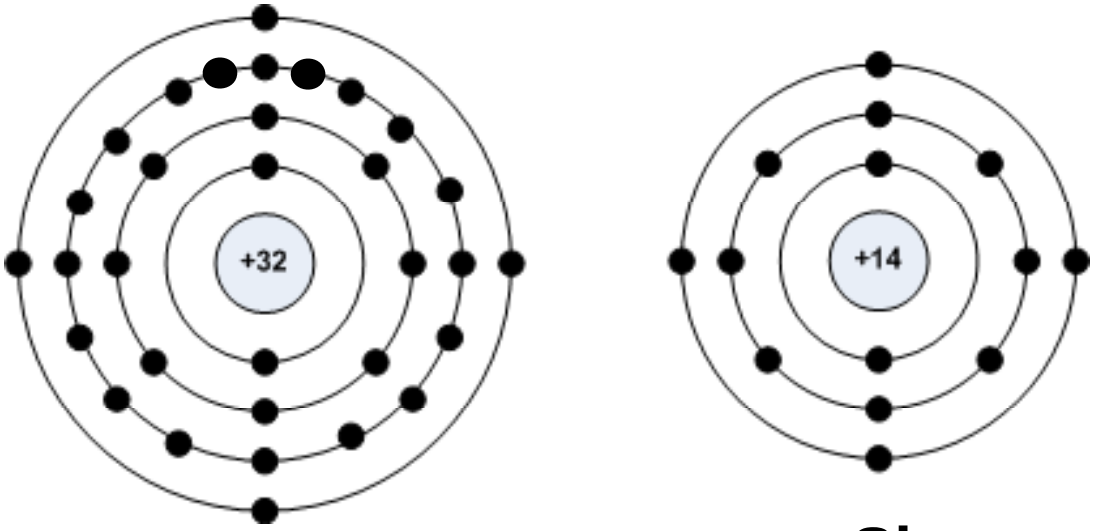
Semiconductor;

- material which has conductivity between that of conductor and insulator
- The conductivity can be controlled by adding impurities
- Using semiconductor, a structure which shows switching characteristics can be implemented



Semiconductor Materials

- Carbon (C), Silicon (Si), Germanium (Ge)
- Atomic structure of Ge and Si.

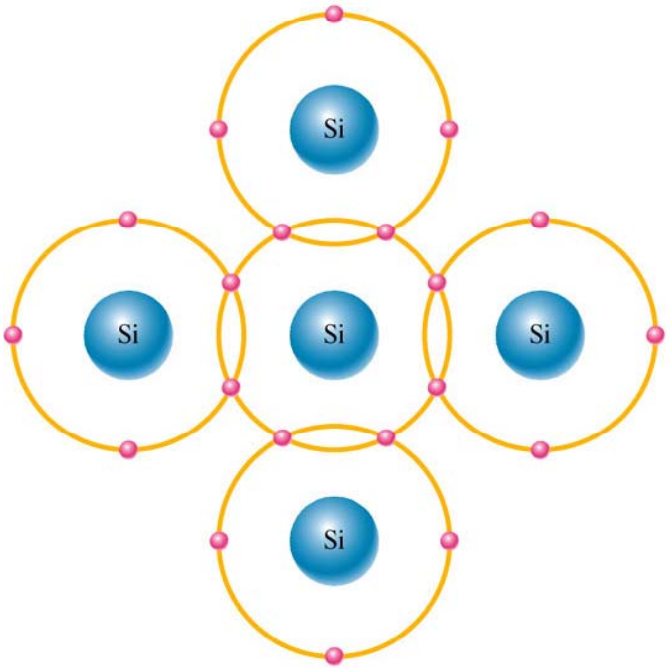


Ge **Si**

Number of electrons in band n, $N_e = 2n^2$

Semiconductor Materials

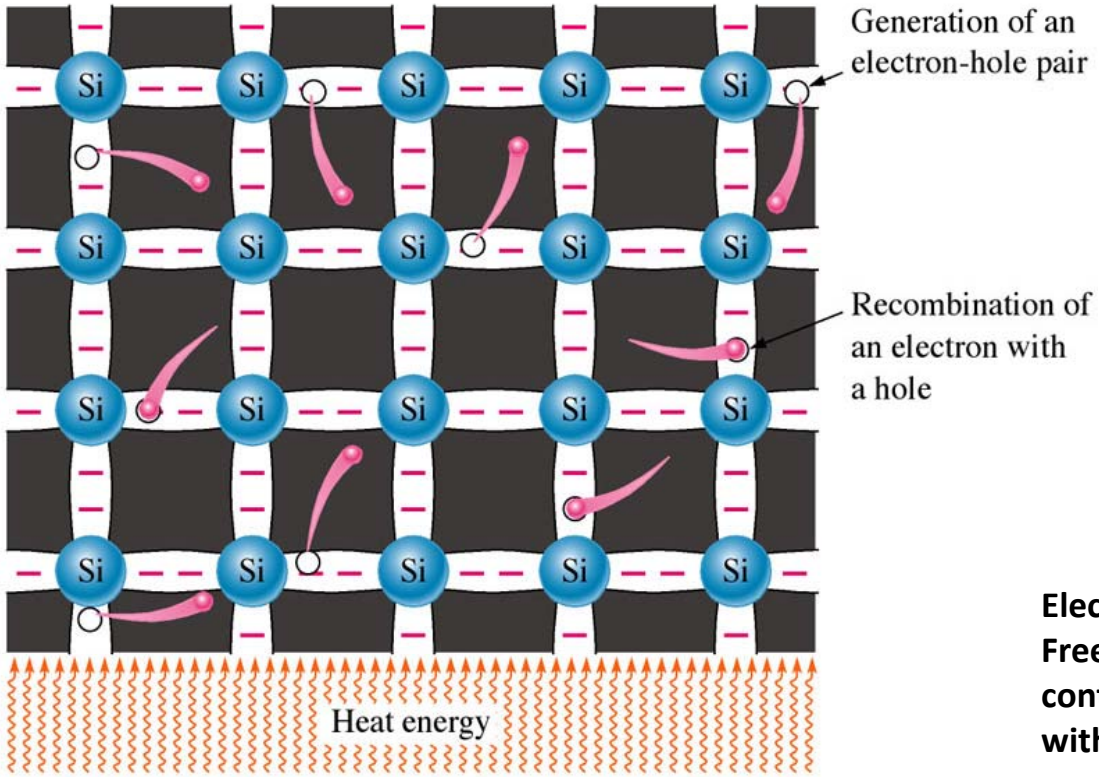
- Covalent bonding – the bonding of atoms, strengthened by the sharing electrons



The center atom shares an electron with each of the four surrounding atoms, creating a covalent bond with each. The surrounding atoms are in turn bonded to other atoms, and so on.

Semiconductor Materials

- Charge carriers in semiconductors – electron and holes



Electron-hole pairs in a silicon crystal. Free electrons are being generated continuously while some recombine with holes.

Intrinsic Semiconductor

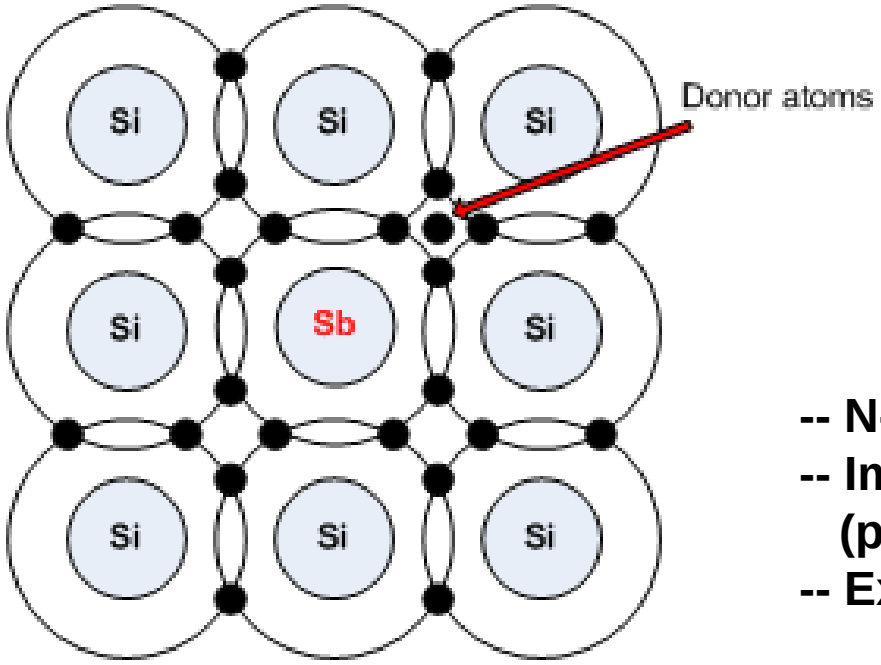
- Also known as pure semiconductor
- Eg: pure Si, Ge, C, Sn.
- Electron and hole concentrations are relatively small. Hence, very small current are possible.
- Poor conductor because the total number of charge carriers are small.

Extrinsic Semiconductor

- Also known as doped semiconductor
- Electron and hole concentrations can be greatly increase by adding controlled amounts of certain impurities into Intrinsic Semiconductor.
- This process is called doping.
- Two types – N type and P type

Extrinsic Semiconductor

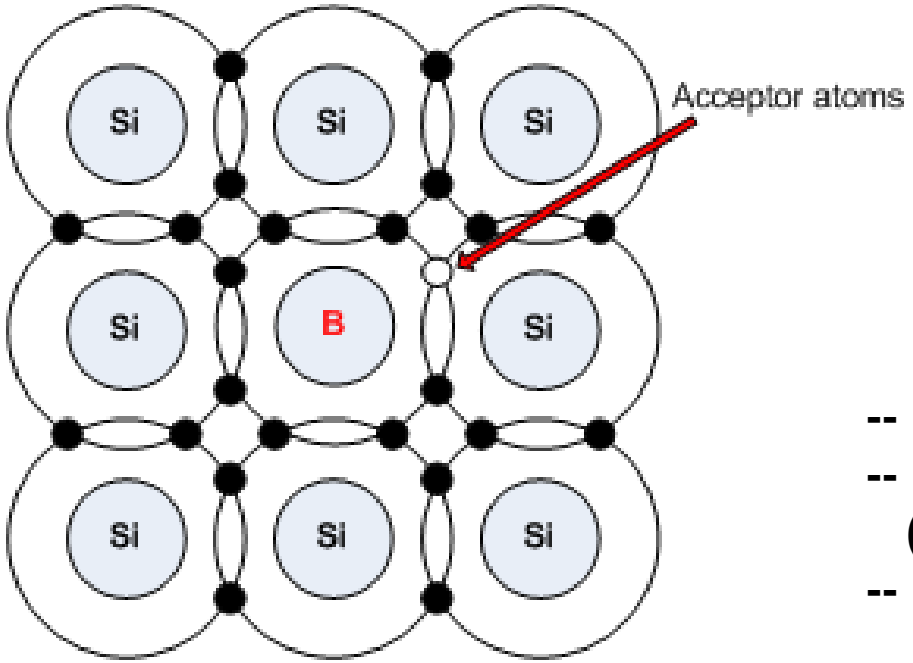
N - type



-- N-type Silicon (majority electrons)
-- Impurity with 5 valence electrons (pentavalent)
-- Example Antimony, Arsenic, Phosphorous

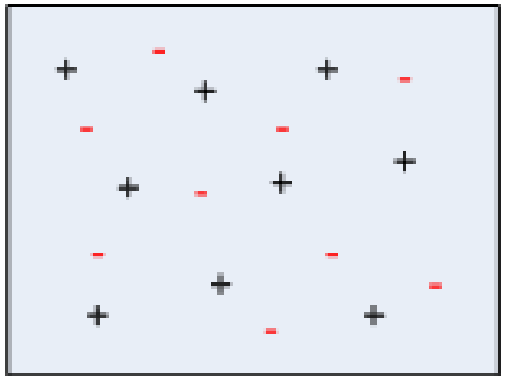
Extrinsic Semiconductor

P - type

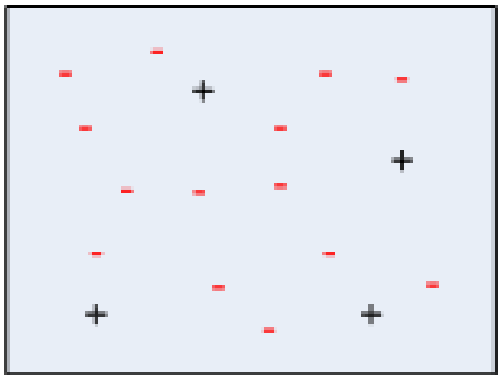


-- P-type Silicon (majority holes)
-- Impurity with 3 valence electrons (trivalent)
-- Example Boron, Galium, Indium

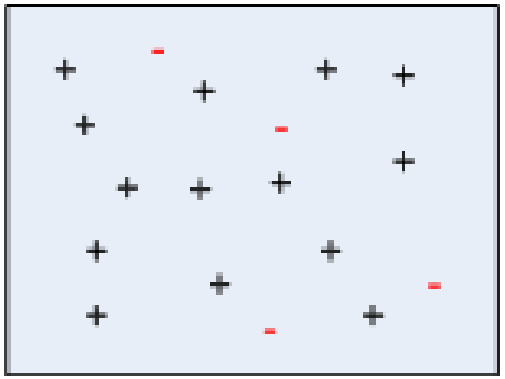
Charge Carriers



Pure Silicon
-- *almost* equal electrons and holes



N-Type Silicon
-- Majority electrons
-- Minority holes



P-Type Silicon
-- Majority holes
-- Minority electrons