ELEKTRONIKA

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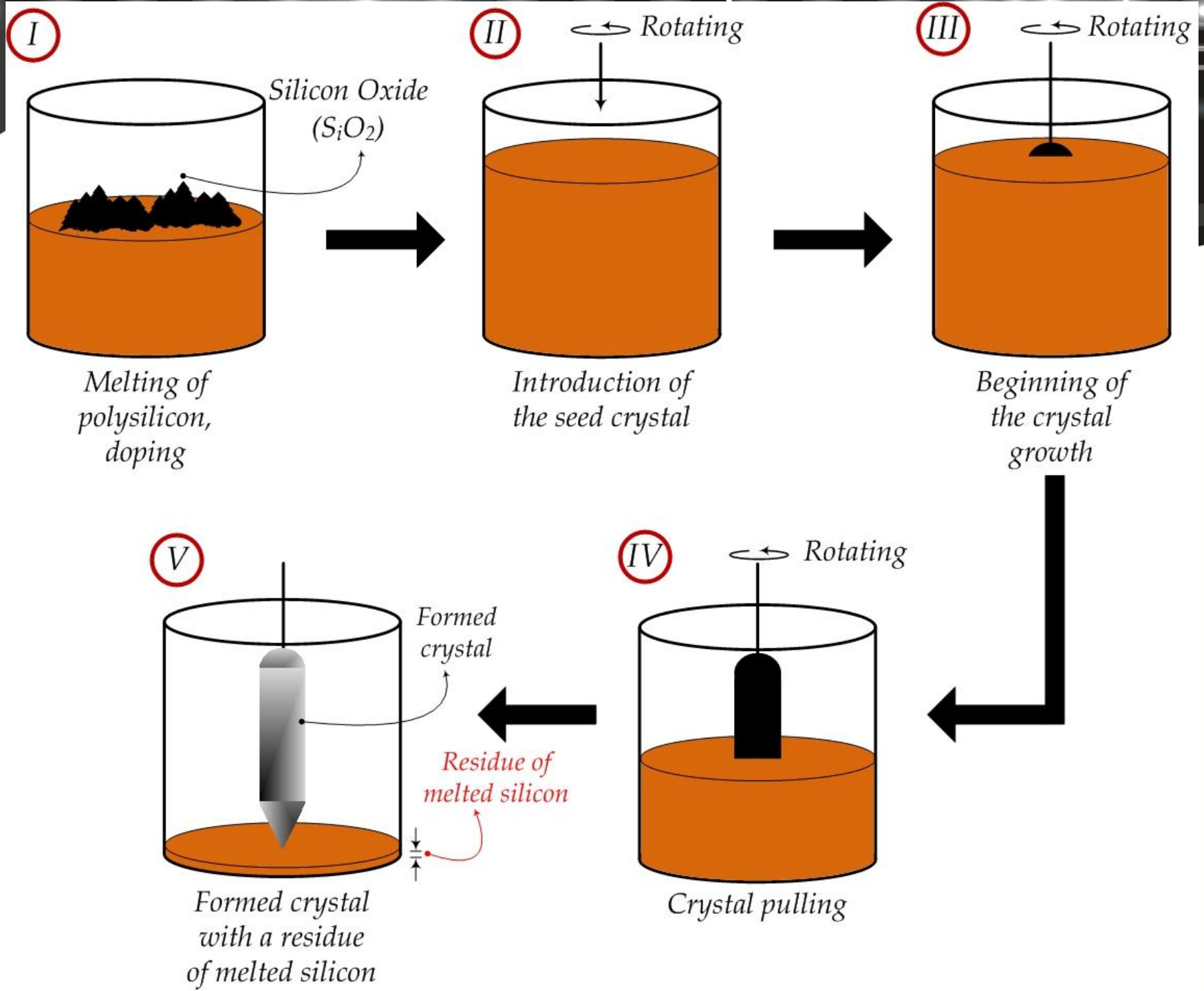
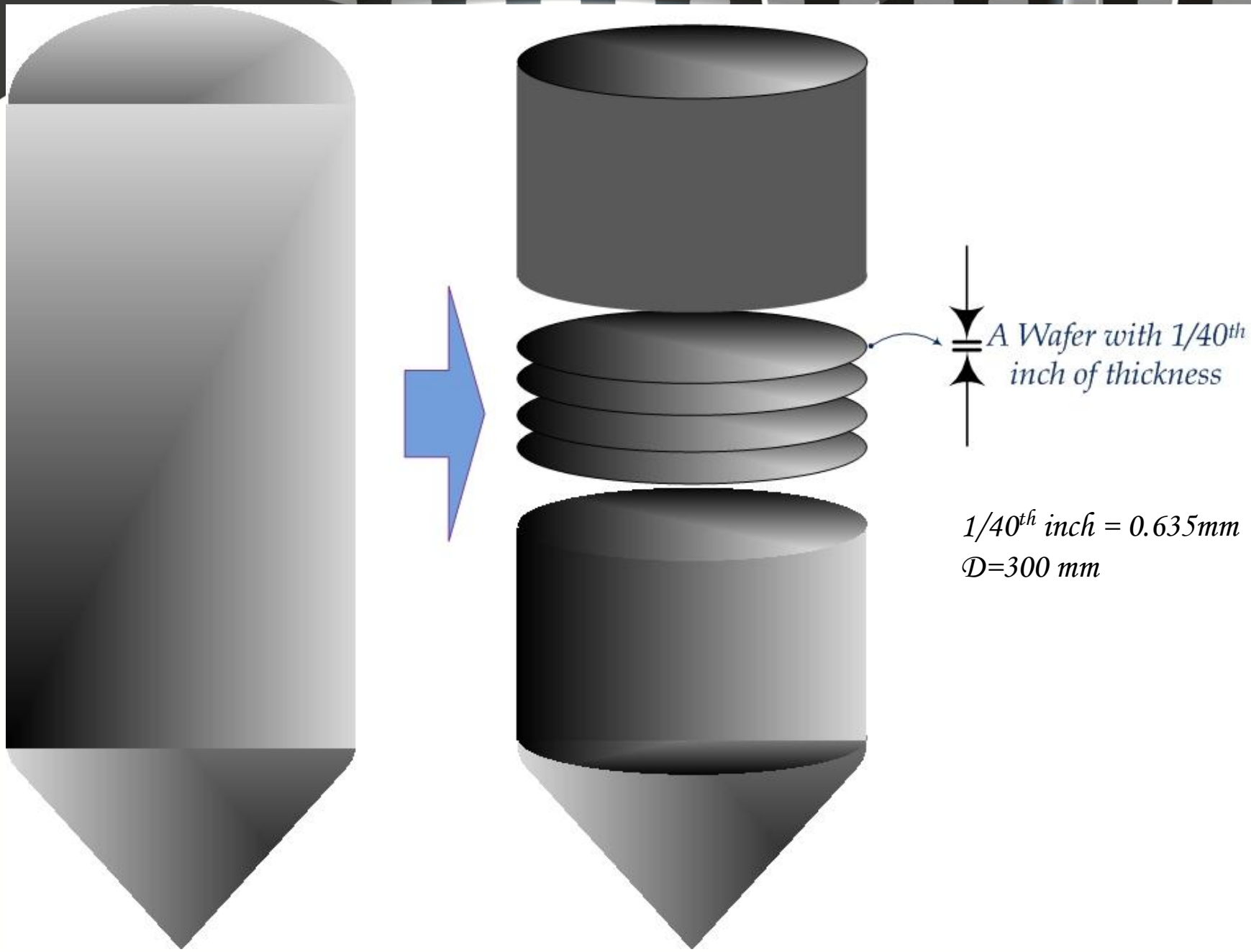
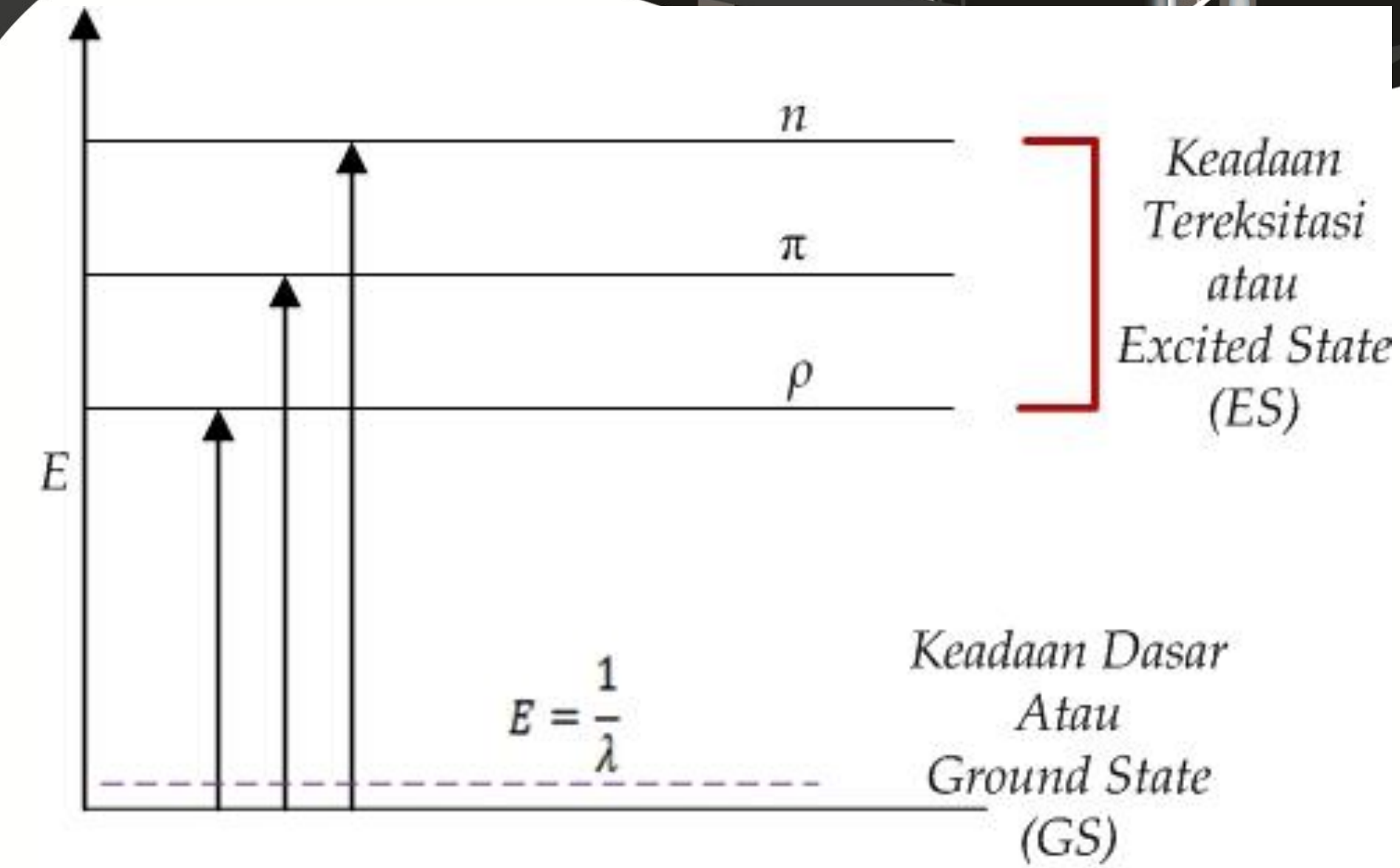
Semiconductor Materials


I
Silicon Oxide
(S_iO_2)
Melting of
polysilicon,
doping
II
Rotating
Introduction of
the seed crystal
III
Rotating
Beginning of
the crystal
growth
IV
Rotating
Crystal pulling
V
Formed
crystal
Residue of
melted silicon
Formed crystal
with a residue
of melted silicon

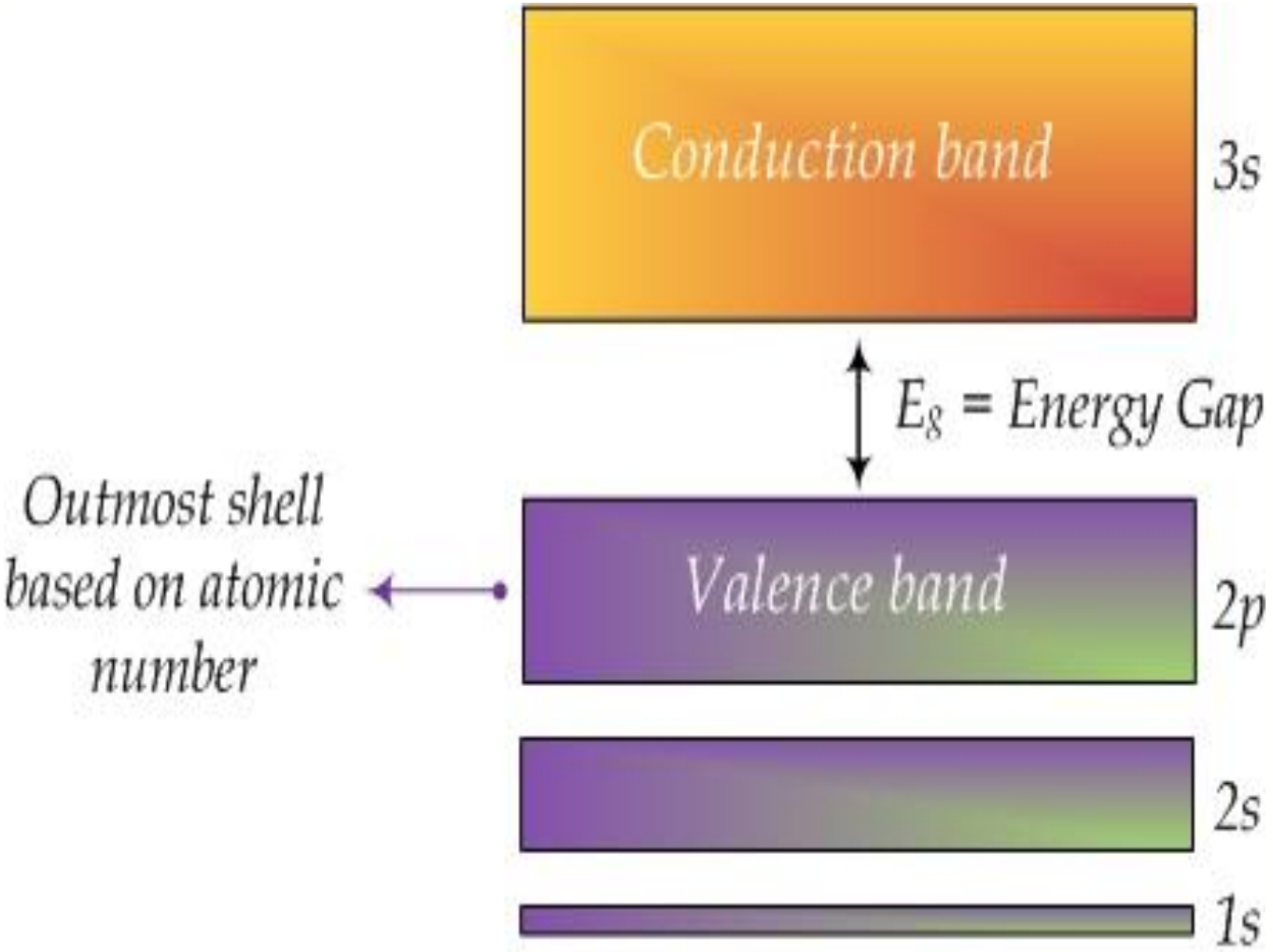


$1/40^{th}$ *inch* = 0.635*mm*

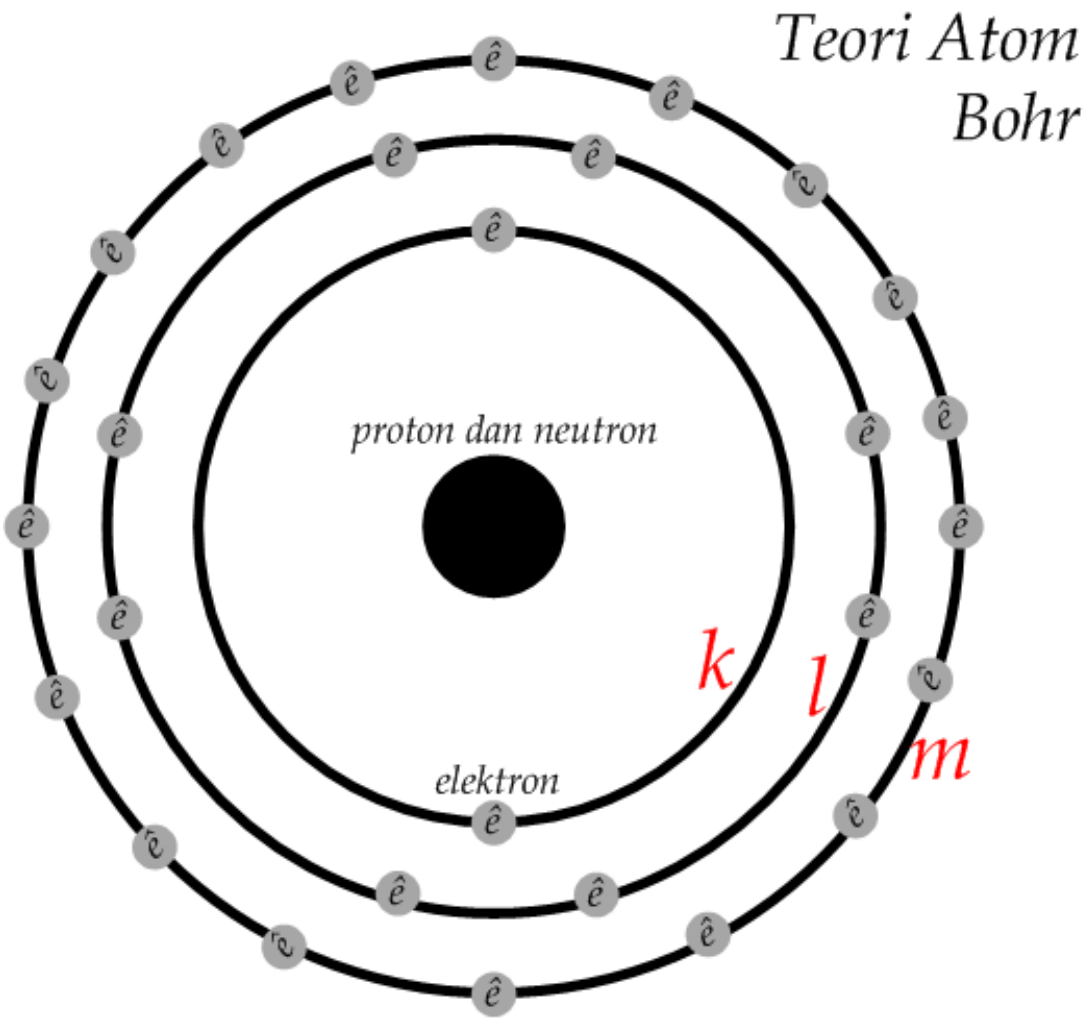
$\mathcal{D}$=300 *mm*


n
π
ρ
E
Keadaan
Tereksitasi
atau
Excited State
(ES)
$E = \frac{1}{\lambda}$
Keadaan Dasar
Atau
Ground State
(GS)

Electron Configuration

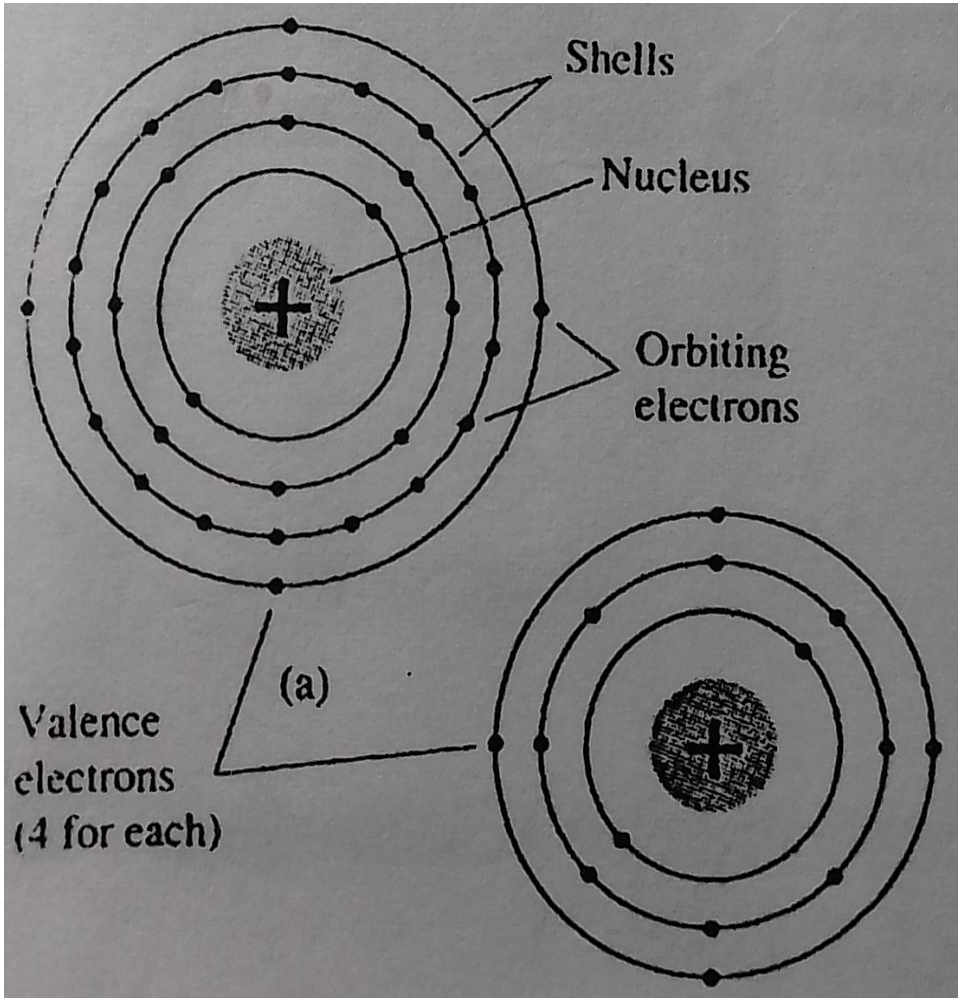


Electron Configuration

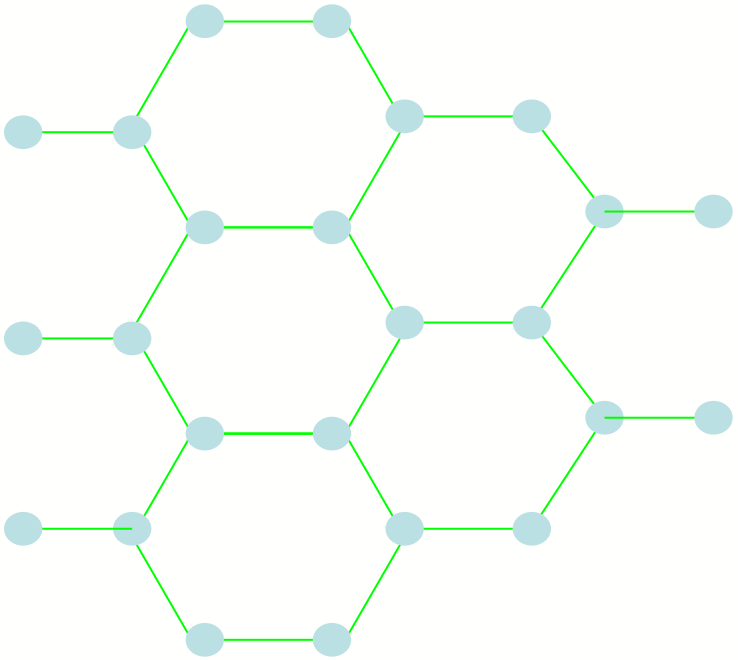


Intrinsic Material

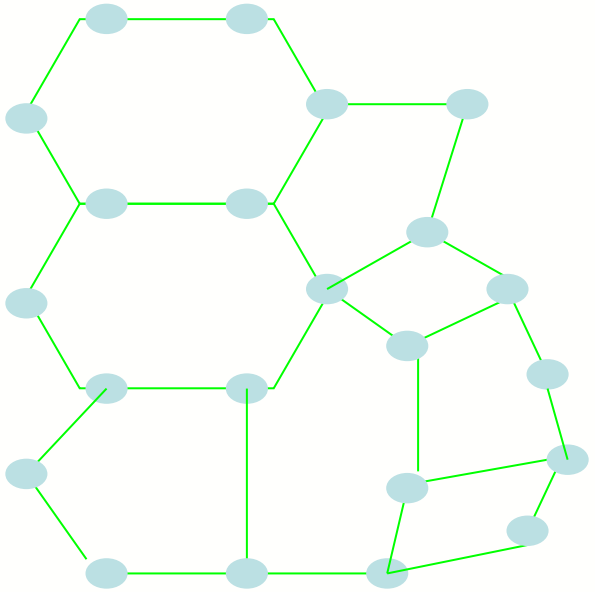
- G_e *and* S_i *are tetravalent atoms because they each have* ***4*** *valence electrons*
- *A bounding of atoms strengthened by the sharing of electrons is called covalent bonding*



Atomic Structure of Crystal And Amorf

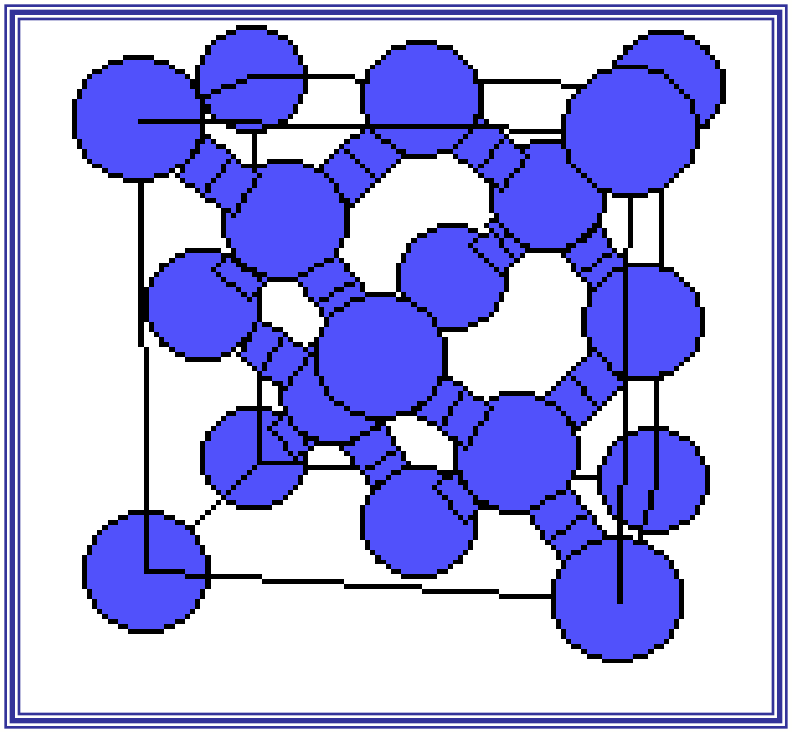


Crystal

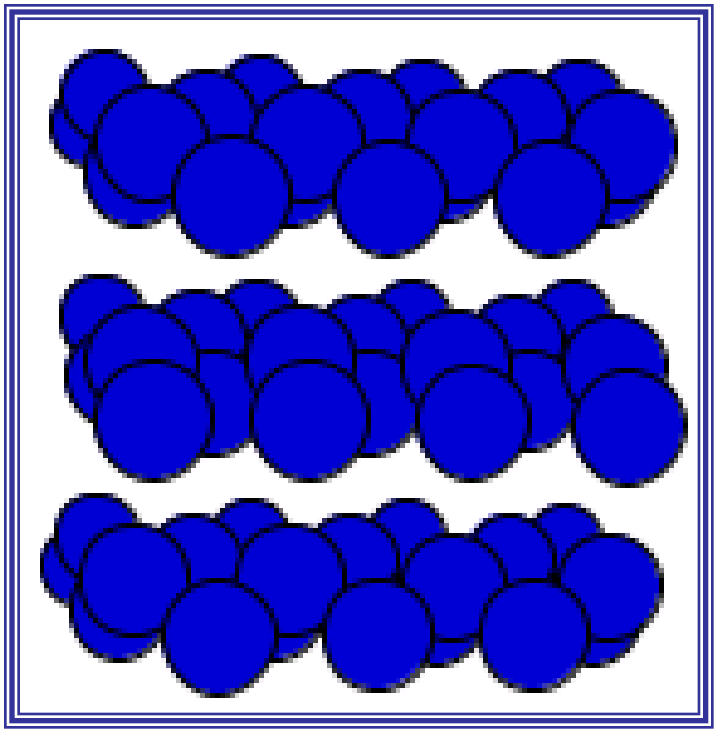


Amorf

Intrinsic Material



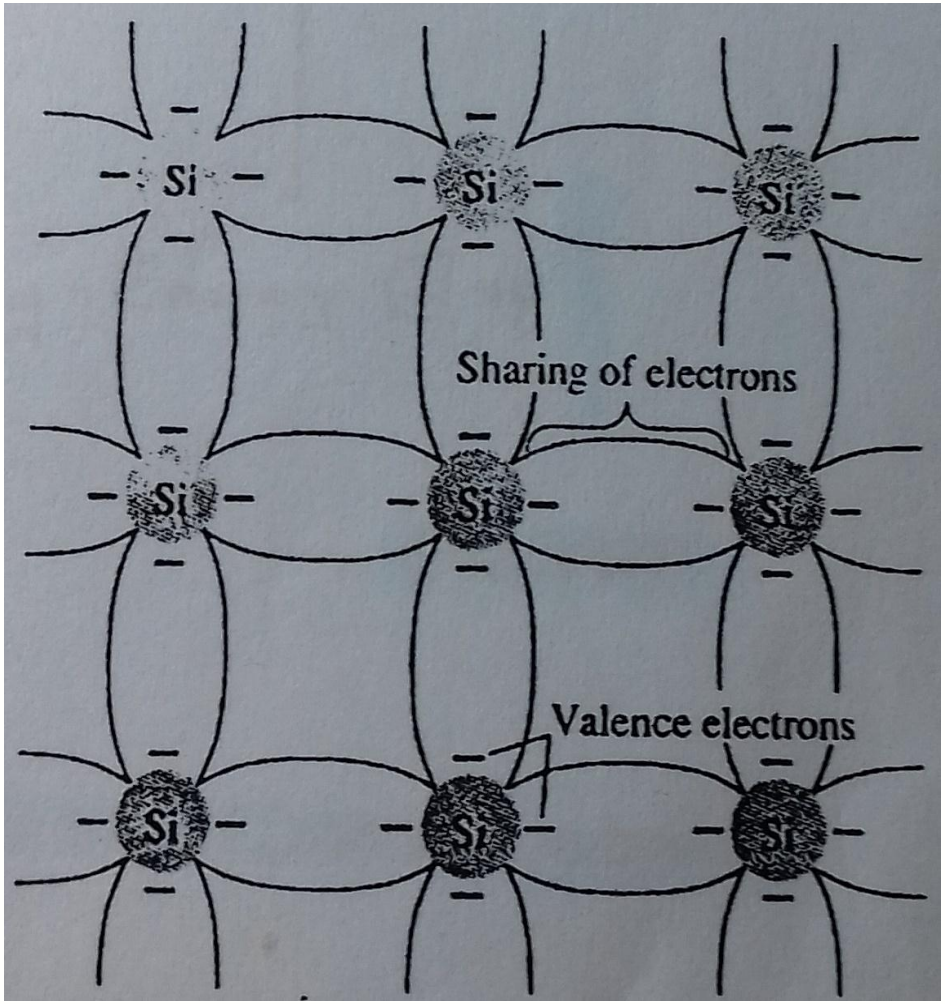
Intan



Arang

Intrinsic Material

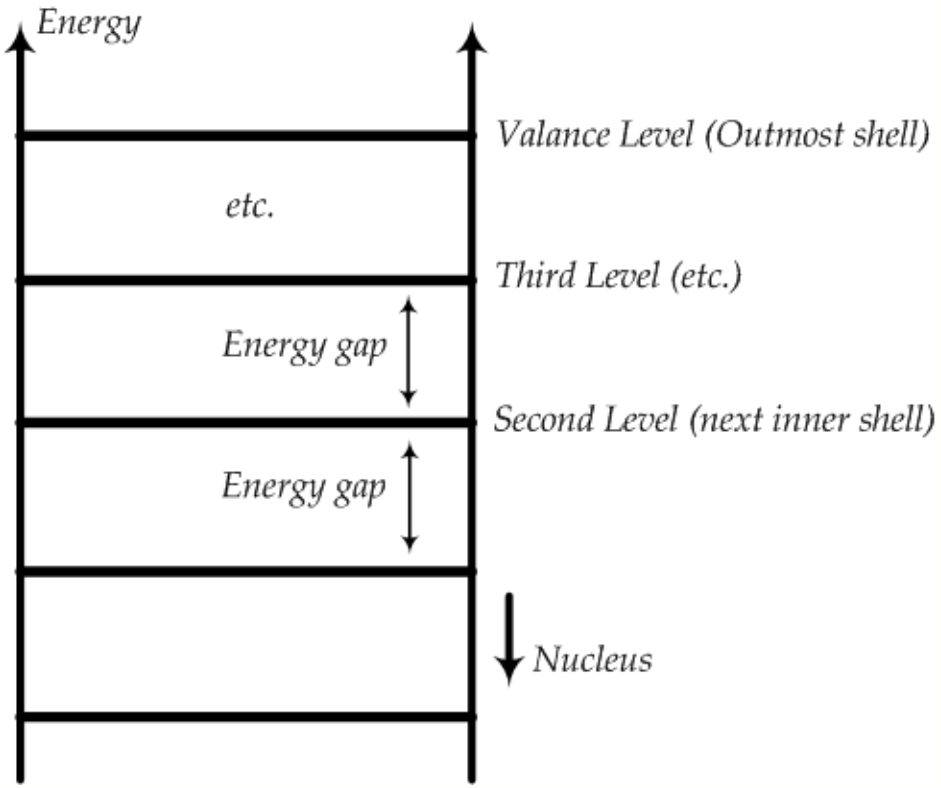
- *Although the covalent bond will result in stronger bond between the valence electrons and their parent atom, it's possible for valence electrons to absorb sufficient kinetic energy from natural (electric fields, light energy. thermal energy) cause to break the covalent bond and assume the "free" state*



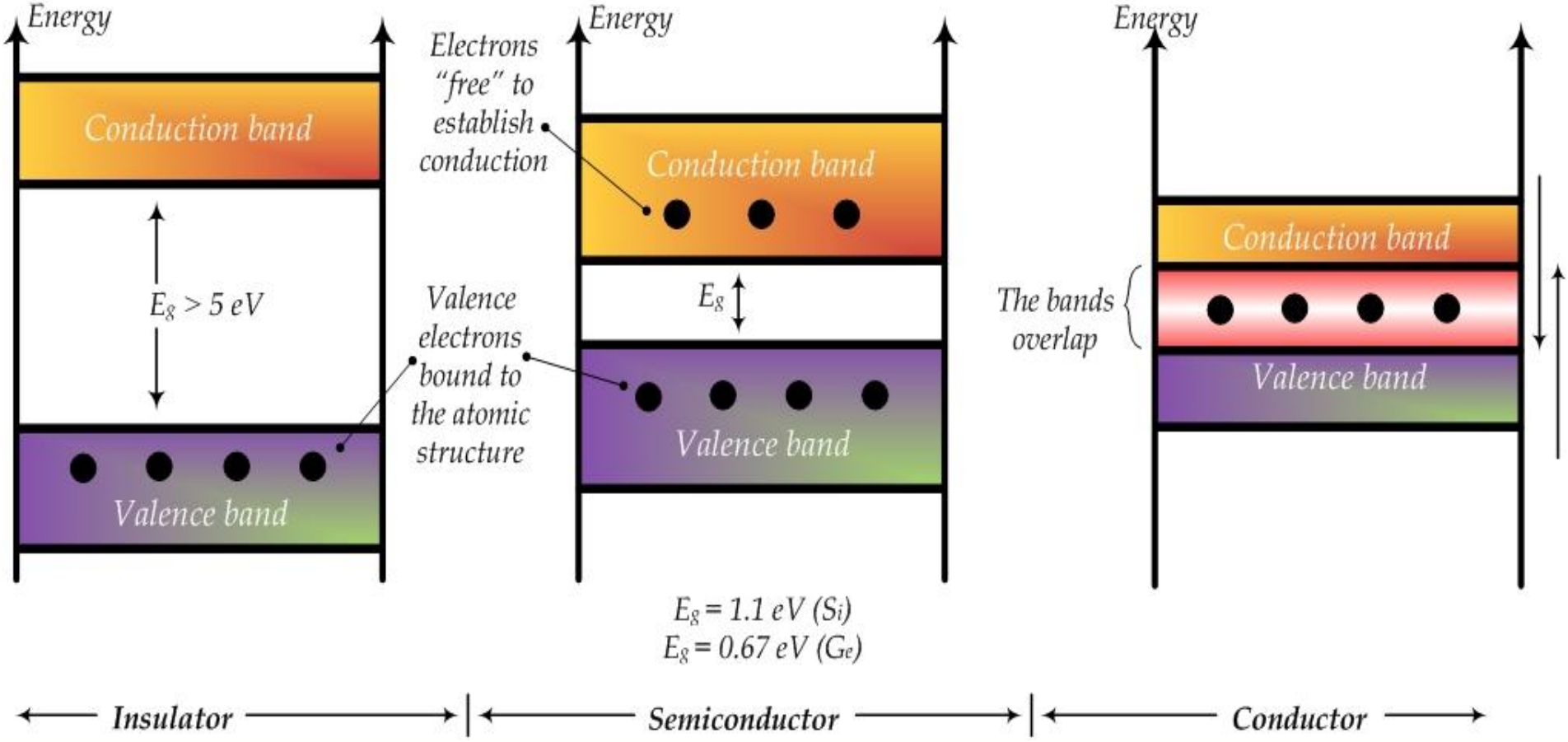
Intrinsic Material

- *The more distant the electron from the nucleus, the higher the energy state*
- *Any electron that has left its parent atom has a higher energy state than any electron in atomic structure*

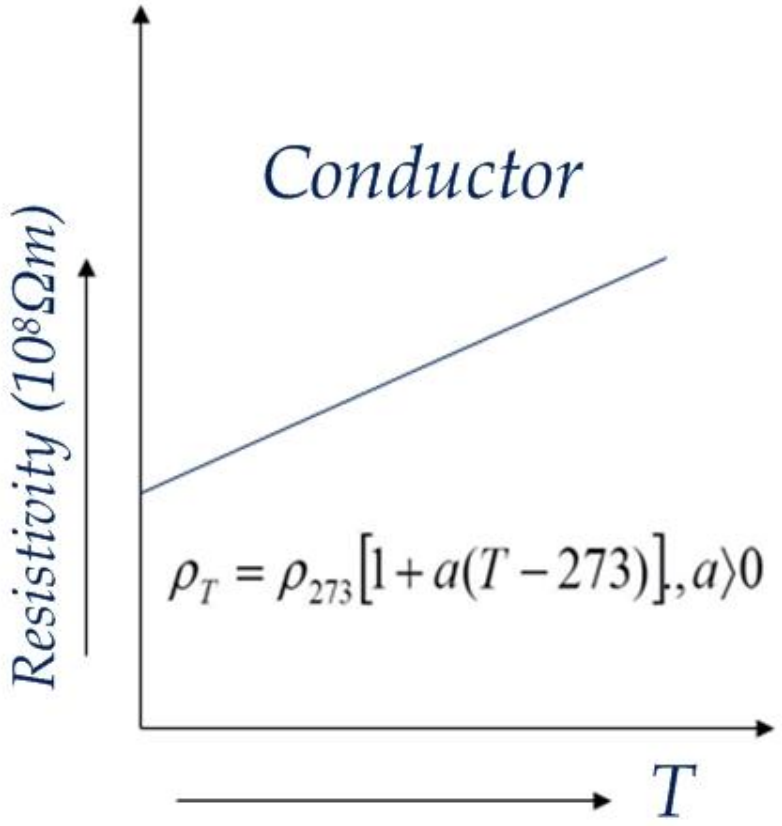
$1\ eV = (1.6 \times 10^{-19} C)(1V) = 1.6 \times 10^{-19} J$

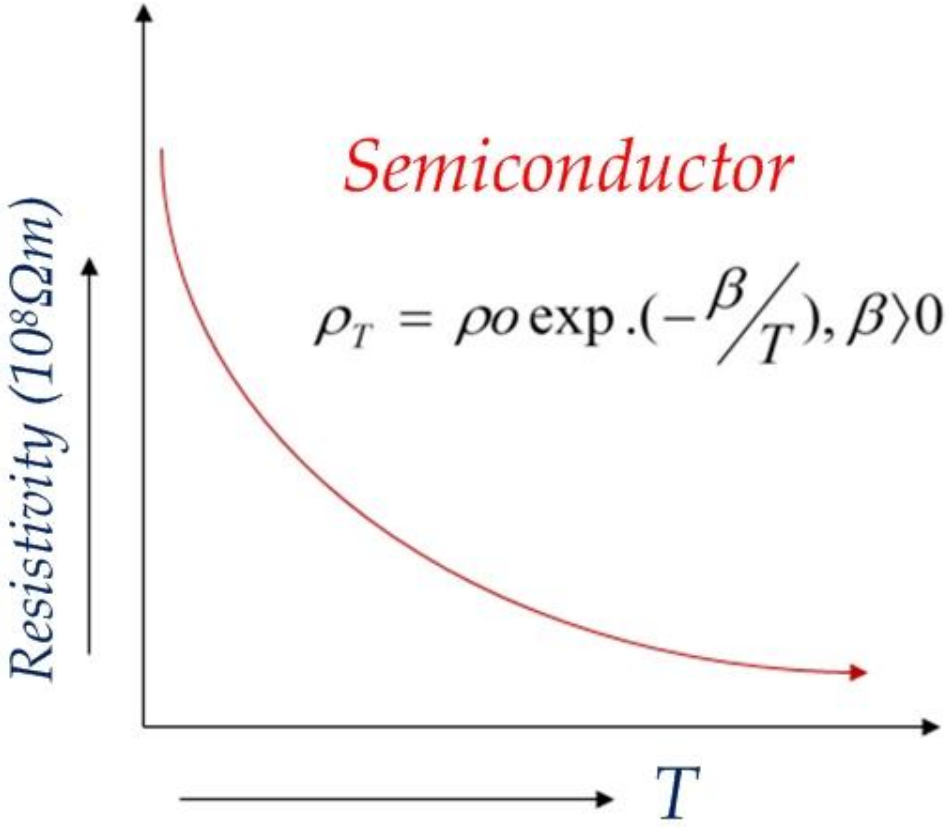


Intrinsic Material

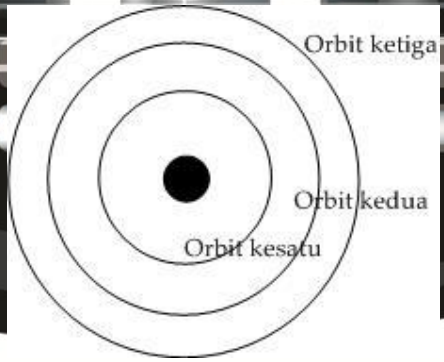


Conductivity Level of Conductor & Semiconductor Material





Intrinsic Material



1. Orbit / *Shells* ➔ disebut juga level energi
2. Elektron valensi ➔ Elektron yang berada di lapisan paling luar dari inti atom
3. Ionisasi ➔ proses hilangnya elektron valensi
4. Elektron bebas ➔ elektron yang keluar dari lintasan
5. Jumlah elektron dalam lintasan ➔ Jumlah maksimum elektron yang mungkin dalam satu lintasan, diberikan dengan rumus :

   $N_e = 2n^2$; dimana n adl jumlah lintasan

Tugas:

Jelaskan karakteristik dari *Intrinsic Material* bahan semikonduktor G_e dan S_i

*) tulis tangan ukuran A4 maksimal 4 halaman !!!

Tugas:

1. Jelaskan karakteristik dari Ekstrinsik material untuk *Negatif-Type material*
2. Jelaskan karakteristik dari Ekstrinsik material untuk *Positif-Type material*

*) tulis tangan ukuran A4 maksimal 4 halaman !!!

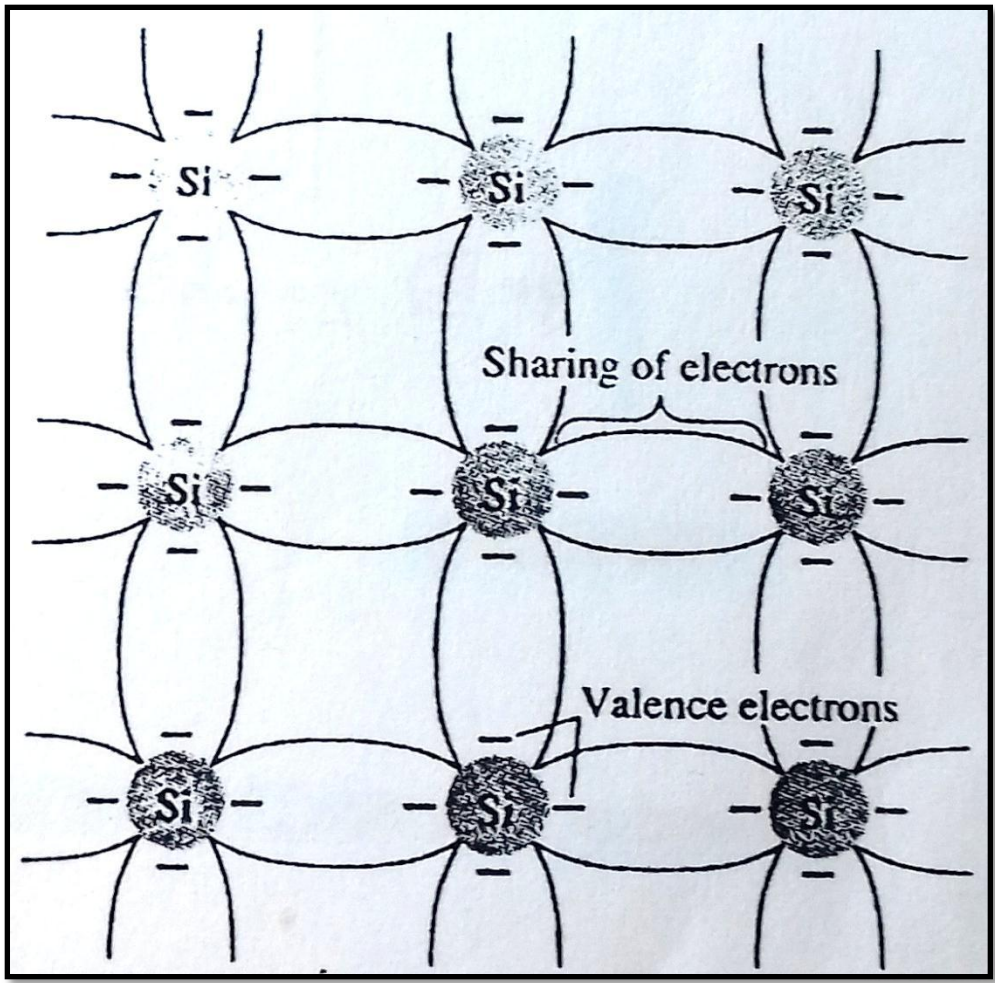
Tugas:

1. Jelaskan proses pembentukan IC dengan menggunakan **Czochralski (cz)** dan **Float Zone** methode !

   *) tulis tangan ukuran A4 maksimal 5 halaman !!!

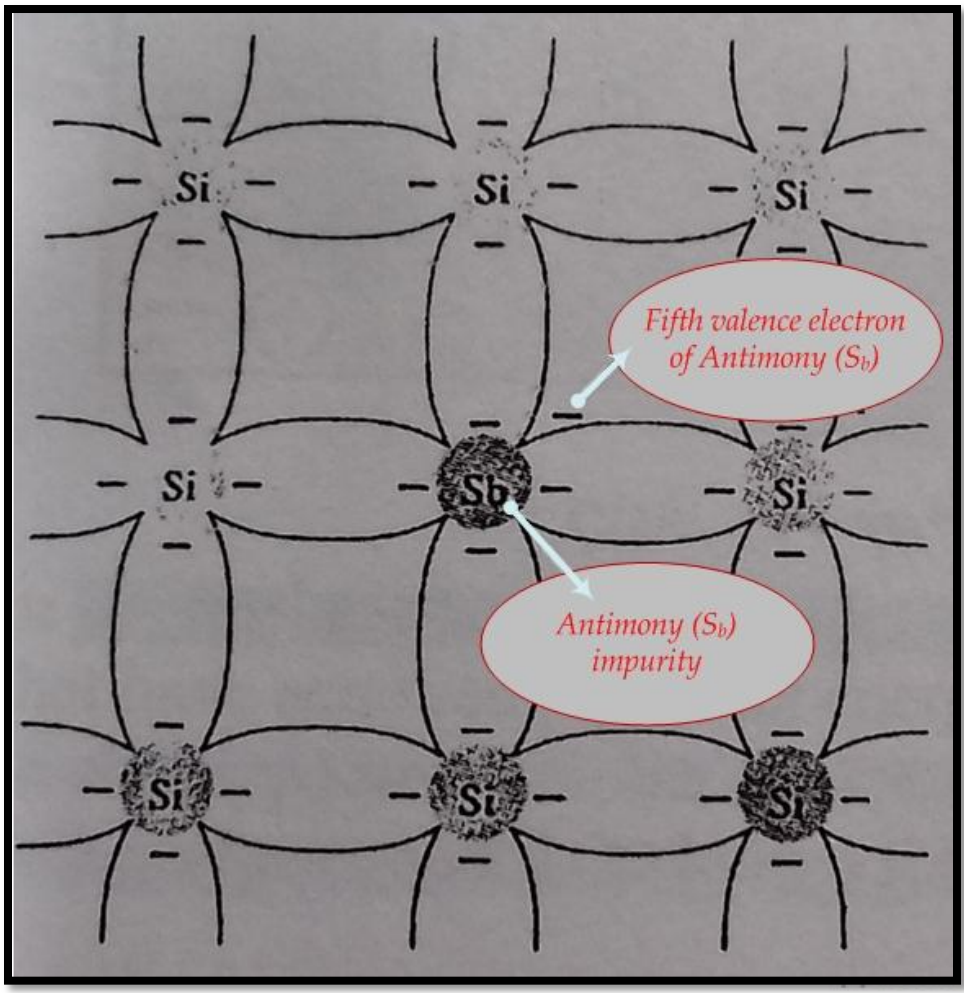
Extrinsic Material

- A semiconductor material that has been subjected to the **doping** process is called an **extrinsic material**
- Two type of extrinsic semiconductors:
  1. N-type
  2. P-type



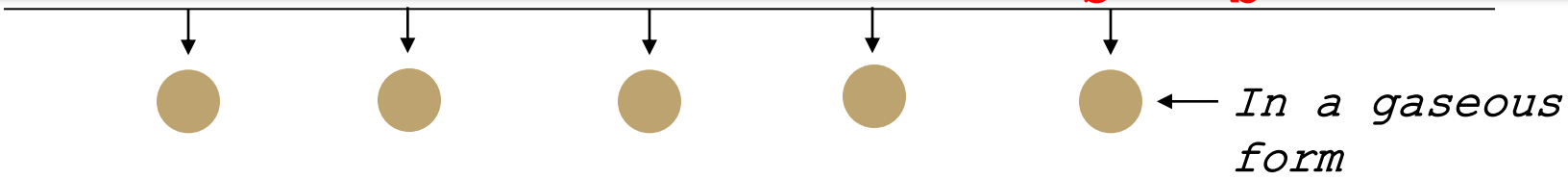
N-TYPE MATERIAL

- The n-type is created by introducing the impurity elements that have **five valence electrons** (pentavalent)
- Antimony (S_b), Arsenic (A_s), and Phosphorus (P)
- The diffused impurities are called donor atoms, since they have donated a relatively **"free" electron** to the structures
- The electron is called the **majority carrier** and the hole is the **minority carrier**



Making of Semiconductor N-Type

- *Valence Donor of Atom* 5 (P, A_S, S_b)



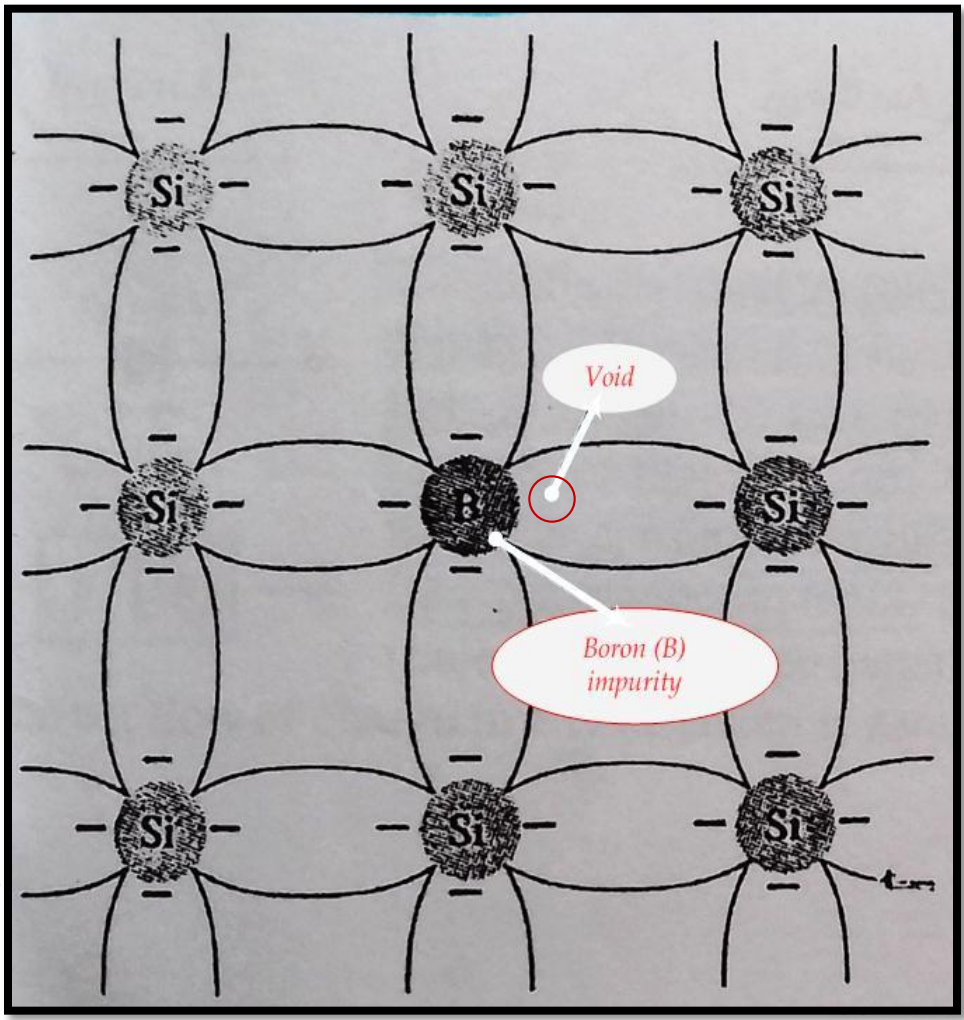
N-Type

Stove Temperature ≥ 1600°C

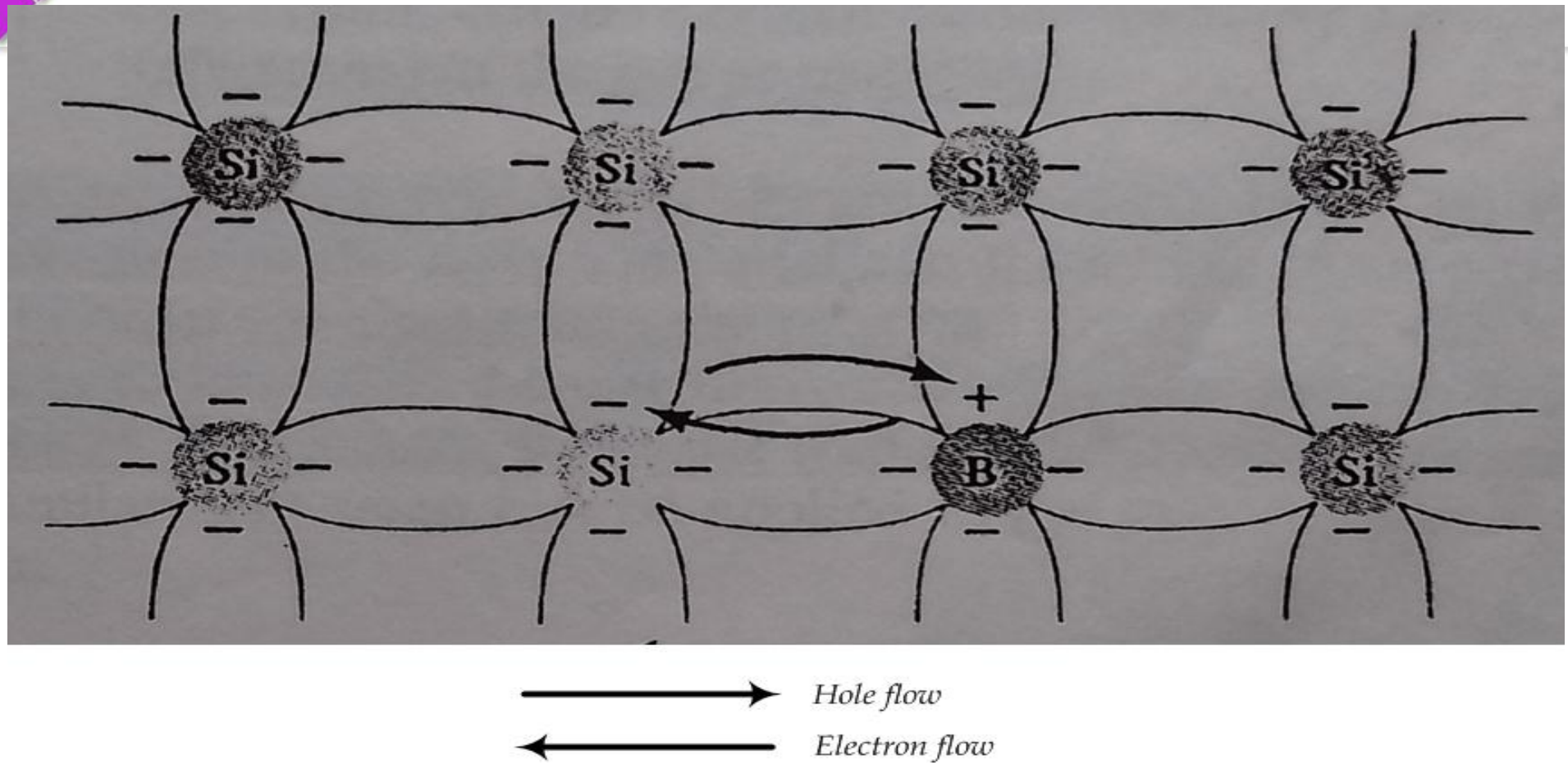
Diffusion Process of N-Type

P-type Material

- The p-type is created by introducing those impurity elements that have **three valence electrons**
- Boron (B), Gallium (G_a), Indium (I_n)
- There are insufficient number of electrons to complete the covalent bonds of newly formed lattice, the result vacancy is called a **hole**
- The diffused impurities are called acceptor atoms, since the hole will readily accept a "free" electron



P-type Material



- In a p-type material the hole is the majority carrier and the electron is the minority carrier

Making of Semiconductor P-Type

- *Valence Acceptor of Atom* 3 (B, Ga, In)

P-Type

Stove Temperature ≥ 1600°C

Diffusion Process of P-Type

TUGAS!!!

1. Mengapa bahan semikonduktor yang digunakan berbahan dasar dari Silicon (S_i) dan Germanium (G_e) ?
2. Apa tujuan proses impuritas (pencampuran bahan) pada proses difusi yang telah dijelaskan sebelumnya ?
3. Bahan apa saja yg dapat digunakan untuk proses difusi material semikonduktor tipe-P maupun tipe-N ?
4. Bagaimana **efek**nya jika di**masuk**kan Antimony (S_b), Arsenic (A_s), and Phosphorus (P) **ke dalam** campuran/impuritas **semikonduktor tipe-N** dalam jumlah yg berbeda setiap detiknya ? Jelaskan !
5. Begitu juga dengan campuran/impuritas semikonduktor tipe-P !