

CHAPTER 14.4 | SEMICONDUCTOR ELECTRONICS

Extrinsic Semiconductor

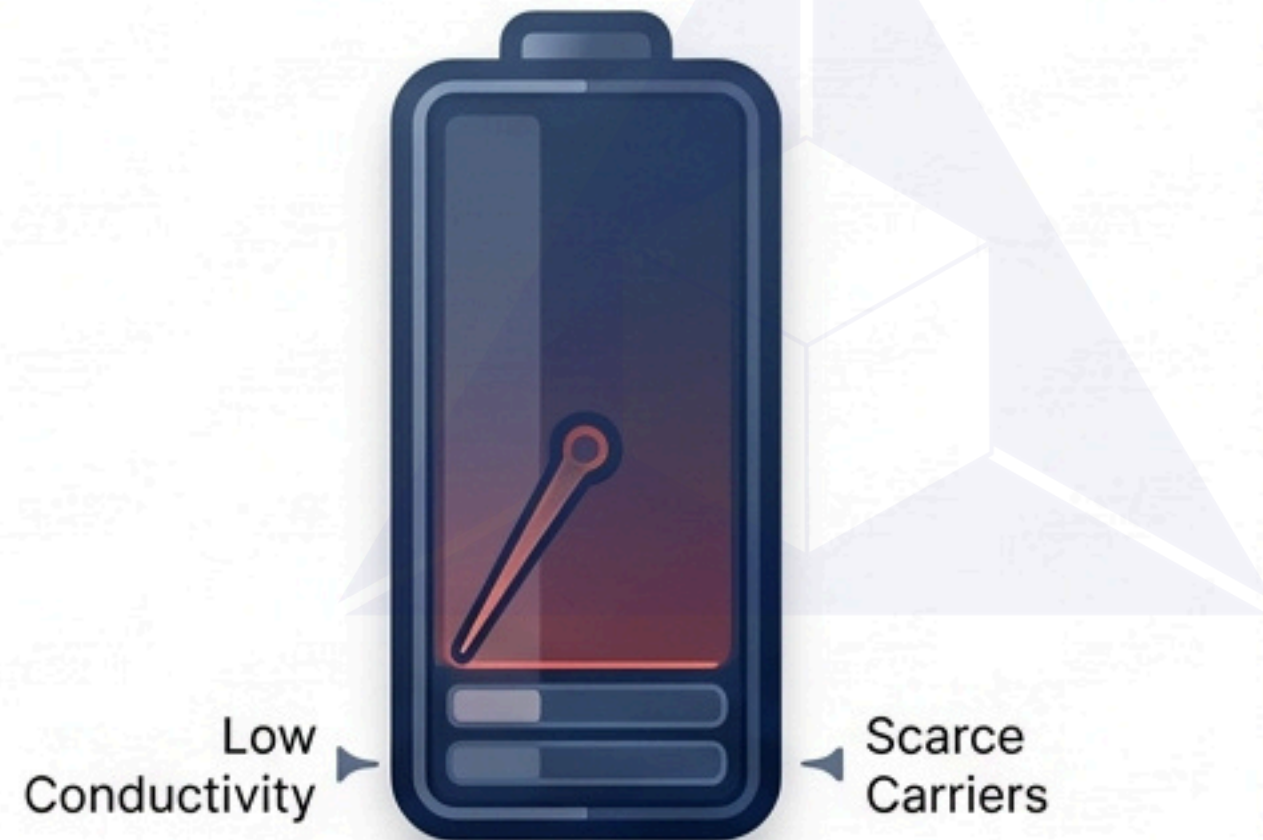
Enhancing intrinsic conductivity through precision doping.

NEET/JEE Essential Concept

The Conductivity Bottleneck

Intrinsic (Pure) State

At room temperature, intrinsic semiconductors possess extremely low conductivity. Charge carriers ($n_e = n_h = n_i$) are too scarce to build functional electronic devices.



**Addition of
Impurities
(Doping)**

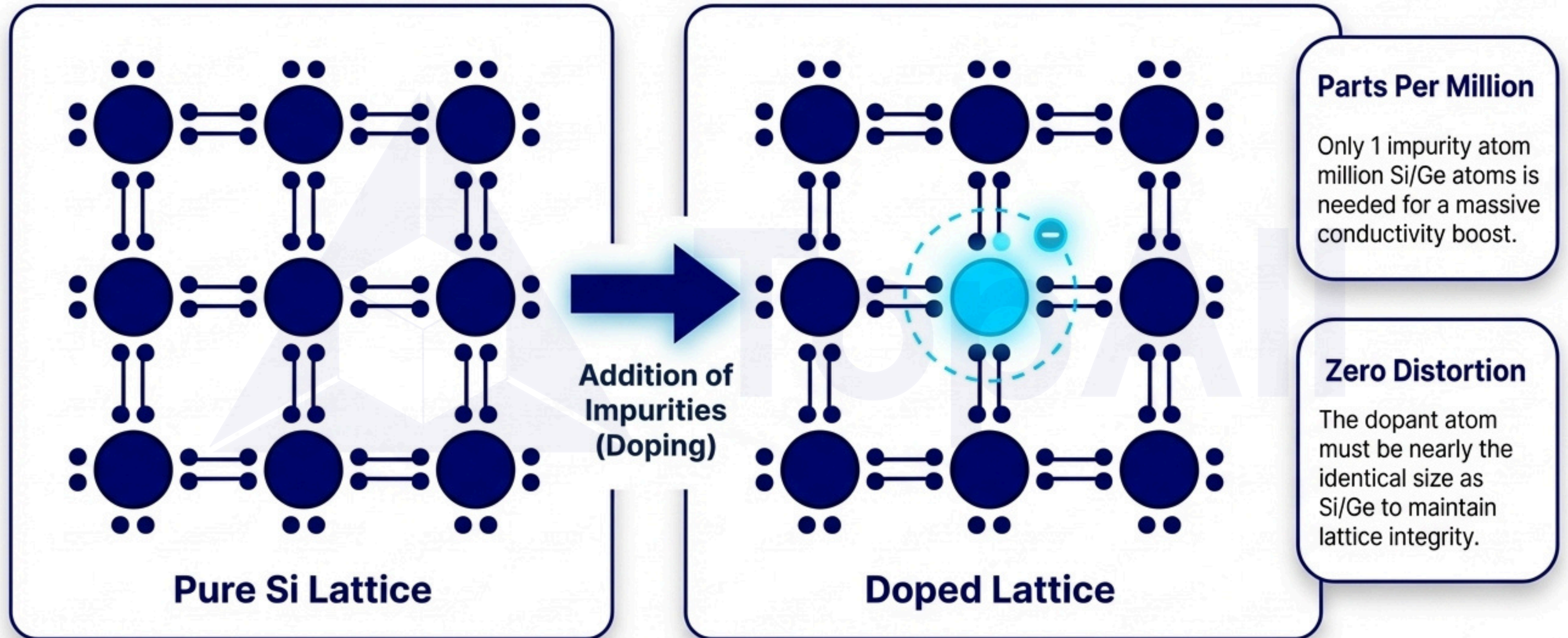
Extrinsic (Doped) State

Extrinsic semiconductors solve this. By adding a calculated trace amount of impurity, conductivity is multiplied manifold, transforming a weak conductor into a powerful electronic foundation.



The Art of Doping

Doping is the deliberate addition of desirable impurity atoms (dopants) to a pure semiconductor to manipulate its electrical properties.





**You've Learned the Theory.
Let's Test Them Now.**

$$E=mc^2$$



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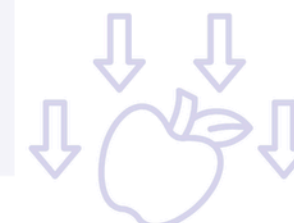
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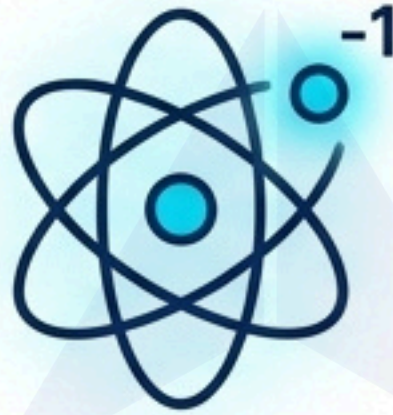
Key Highlights

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Two Types of Extrinsic Semiconductors

n-type (Negative)



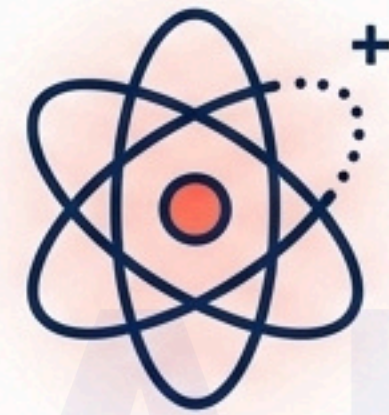
Valency: Pentavalent (Valency 5)

Dopants: As, Sb, P (Donor Impurity)

Mechanism: 4 electrons bond with Si; the 5th remains weakly bound and is donated for conduction.

Carrier Ratio: $n_e \gg n_h$ (Electrons are majority)

p-type (Positive)



Valency: Trivalent (Valency 3)

Dopants: In, B, Al (Acceptor Impurity)

Mechanism: 3 electrons bond with Si; the missing 4th creates a vacancy (hole) that accepts electrons.

Carrier Ratio: $n_h \gg n_e$ (Holes are majority)

Key Takeaways



- ✓ **Intrinsic is too weak:** Pure Si/Ge lacks sufficient room-temperature charge carriers for functional device applications.
- ✓ **Doping maintains structure:** Adding parts-per-million (ppm) of similar-sized impurities massively boosts conductivity without warping the crystal lattice.
- ✓ **n-type = Donors:** Pentavalent atoms (Phosphorus, Arsenic, Antimony) provide extra free electrons ($n_e \gg n_h$).
- ✓ **p-type = Acceptors:** Trivalent atoms (Boron, Aluminum, Indium) create electron-welcoming holes ($n_h \gg n_e$).



Exam Trap: Despite having majority carriers (electrons or holes), the crystal maintains overall electrical neutrality in both n-type and p-type semiconductors.



You've Learned the Theory.

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