# Electrical Conductivity in Semiconductors

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Perspective

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## ABOUT THE STUDY

The electrical conductivity of a semiconductor material is between that of a conductor, such as metallic copper, and that of an insulator, such as glass. Its resistivity decreases as the temperature rises, whereas metals have the reverse effect. By injecting impurities into the crystal structure, its conducting qualities can be changed in useful ways. A semiconductor junction is formed when two distinct doped regions occur in the same crystal. Diodes, transistors, and most modern electronics are built on the behaviour of charge carriers such as electrons, ions, and electron holes at these junctions. Silicon, germanium, gallium arsenide, and elements near the periodic table's "metalloid staircase" are examples of semiconductors. Gallium arsenide is the second most common semiconductor after silicon, and it is used in laser diodes, solar cells, microwave-frequency integrated circuits, and other applications. In the construction of most electrical circuits, silicon is a critical component.

Semiconductor devices can have a variety of beneficial qualities, including the ability to transmit current more easily in one way than the other, changeable resistance, and light or heat sensitivity. Devices composed of semiconductors can be utilized for amplification, switching, and energy conversion because the electrical characteristics of a semiconductor material can be adjusted by doping and the application of electrical fields or light. After a modest amount (on the order of 1 in 108) of pentavalent (antimony, phosphorus, or arsenic) or trivalent (boron, gallium, indium) atoms is added to boost the conductivity of silicon. Doping is the name given to this process, and the resulting semiconductors are referred to as doped or extrinsic semiconductors. Aside from doping, a semiconductor's conductivity can be enhanced by raising its temperature. This is in contrast to the behavior of metals, which sees conductivity decrease as temperature rises.

### Variable electrical conductivity

Because a current requires the flow of electrons, semiconductors in their normal state are poor conductors because their valence bands are full, restricting the entire flow of new electrons. Several approaches, like as doping and gating, have been devised to allow semiconducting materials to act like conducting materials. There are two types of modifications: n-type and p-type. These terms allude to an abundance or scarcity of electrons, respectively. A current would flow through the material if the number of electrons was balanced.

### Heterojunctions

When two differentially doped semiconducting materials are connected, heterojunctions form. P-doped and n-doped germanium, for example, could be combined in a configuration. As a result, electrons and holes are exchanged between the variably doped semiconducting materials. The n-doped germanium would have more electrons than the p-doped germanium, while the p-doped germanium would have more holes. Recombination, which causes migrating electrons from the n-type to come into touch with migrating holes from the p-type, causes the transfer to continue until equilibrium is achieved. A narrow strip of immobile ions forms as a result of this action, causing an electric field to traverse the junction.

### Excited electrons

A variation in electric potential causes a semiconducting material to lose thermal equilibrium and enter a non-equilibrium state. This allows electrons and holes to enter the system, where they interact through a process known as ambipolar diffusion. When a semiconducting material's thermal equilibrium is disrupted, the quantity of holes and electrons fluctuates. A temperature differential or photons, which can enter the system and form electrons and holes, can cause such disruptions. Generation and recombination are the processes that make and destroy electrons and holes, respectively.