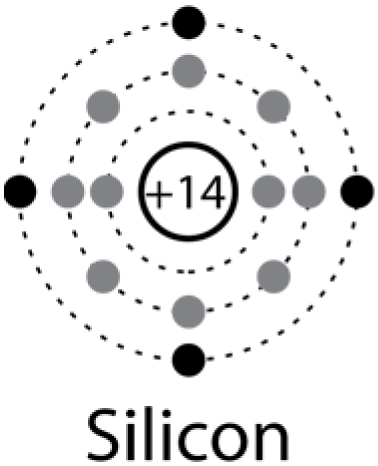
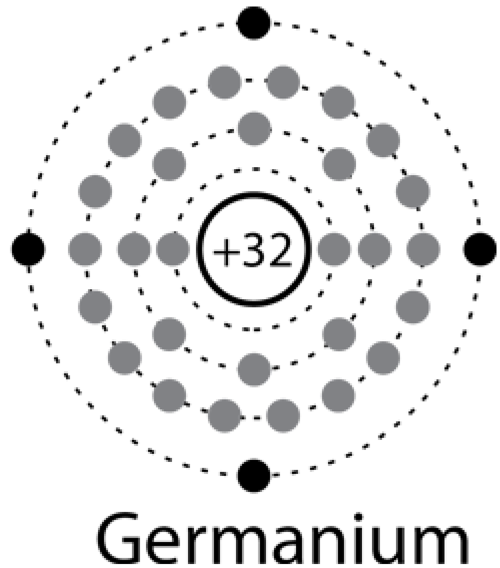
Silicon and Germanium

Solid state electronics arises from the unique properties of silicon and germanium, each of which has four valence electrons and which form crystal lattices in which substituted atoms (dopants) can dramatically change the electrical properties.





Click on either for more detail.

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Silicon

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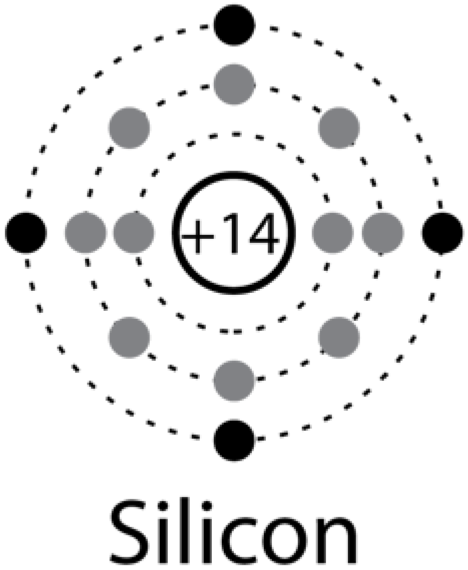
Semiconductor concepts

In solid state electronics, either pure silicon or germanium may be used as the intrinsic semiconductor which forms the starting point for fabrication. Each has four valence electrons, but germanium will at a given temperature have more free electrons and a higher conductivity. Silicon is by far the more widely used semiconductor for electronics, partly because it can be used at much higher temperatures than germanium.

Silicon crystal structure	Discussion of lattice
Intrinsic	Effect of doping

semiconductor



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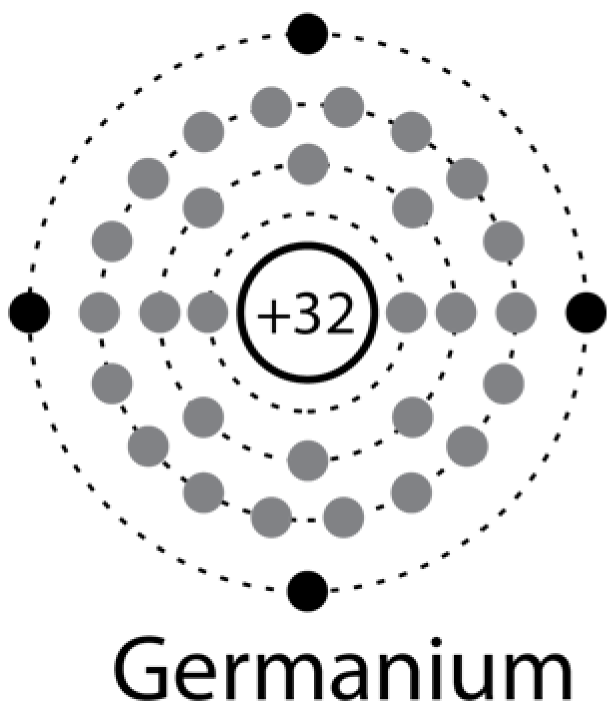
Germanium

In solid state electronics, either pure silicon or germanium may be used as the intrinsic semiconductor which forms the starting point for fabrication. Each has four valence electrons, but germanium will at a given temperature have more free electrons and a higher conductivity. Silicon is by far the more widely used semiconductor for electronics, partly because it can be used at much higher temperatures than germanium.



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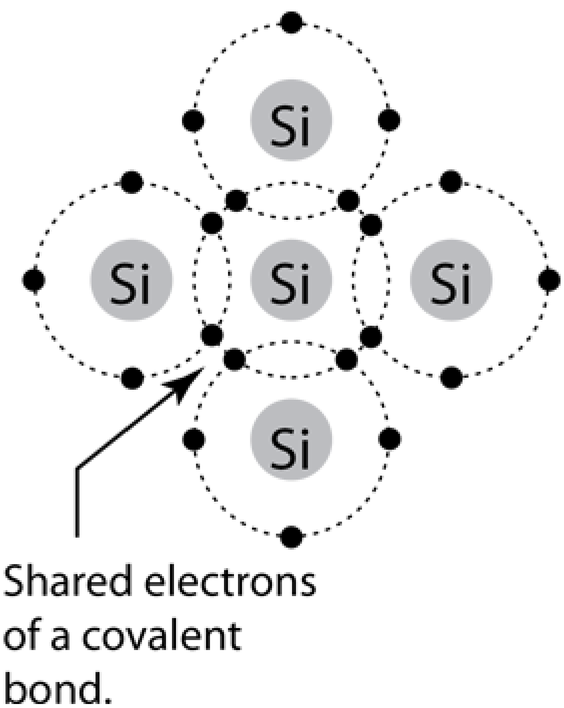
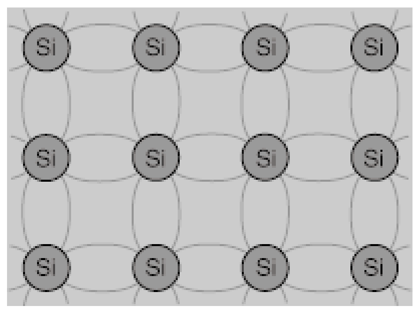
Silicon Lattice



Silicon atoms form covalent bonds and can crystallize into a regular lattice. The illustration below is a simplified sketch; the actual crystal structure of silicon is a diamond lattice. This crystal is called an intrinsic semiconductor and can conduct a small amount of current.



The main point here is that a silicon atom has four electrons which it can share in covalent bonds with its neighbors. These simplified diagrams do not do justice to the nature of that sharing since any one silicon atom will be influenced by more than four other silicon atoms, as may be appreciated by looking at the silicon unit cell.

Show crystal structure

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Valence Electrons

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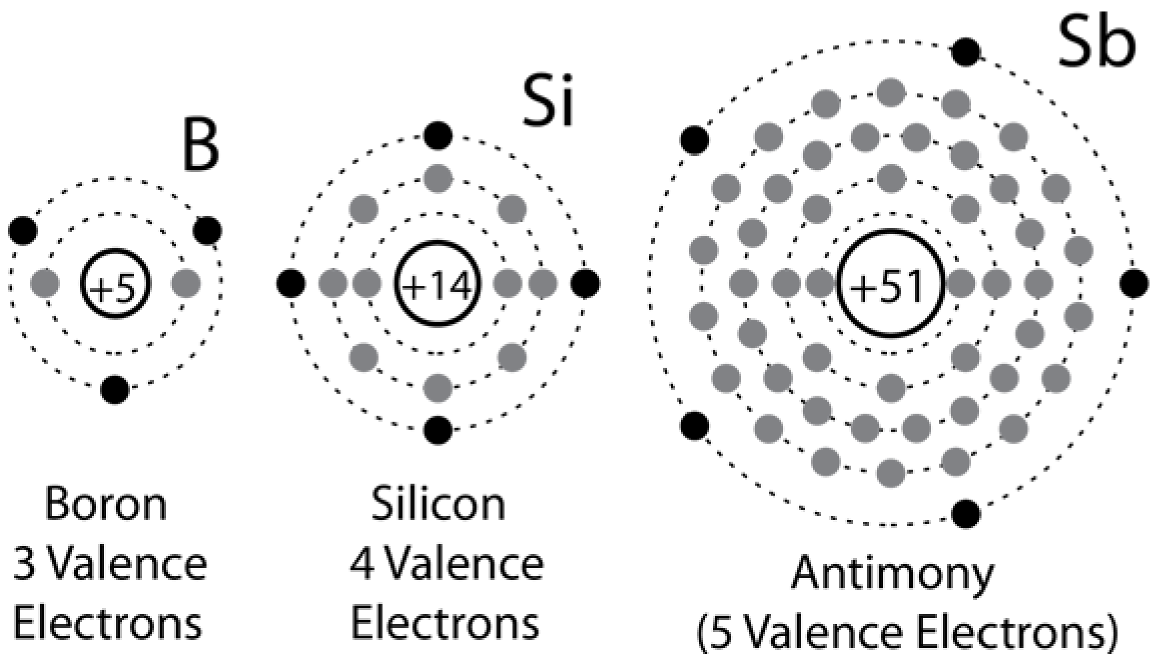
The electrons in the outermost shell of an atom are called valence electrons; they dictate the nature of the chemical reactions of the atom and largely determine the electrical nature of solid matter. The electrical properties of matter are pictured in the band theory of solids in terms of how much energy it takes to free a valence electron.



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