
ELECTRONICS DEVICES AND CIRCUITS

OBJECTIVE

REVIEW OF 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.

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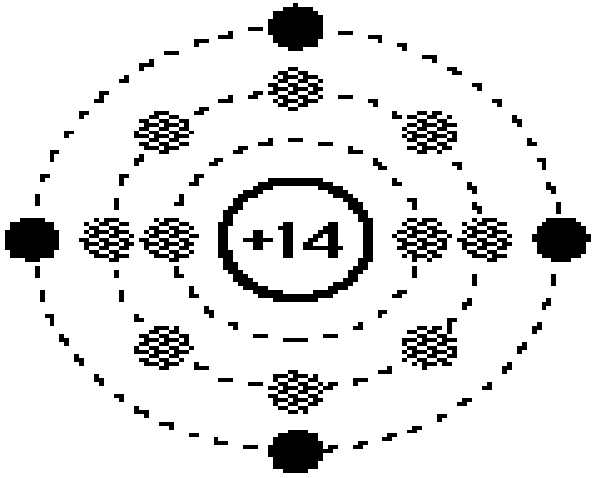
In solid state electronics, either pure silicon or germanium may be used as the intrinsic semiconductorwhich forms the starting point for fabrication. Each has four valence electrons, but germanium will at a given temperature have more free electrons and a higher conductivity. Silicon is by far the more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



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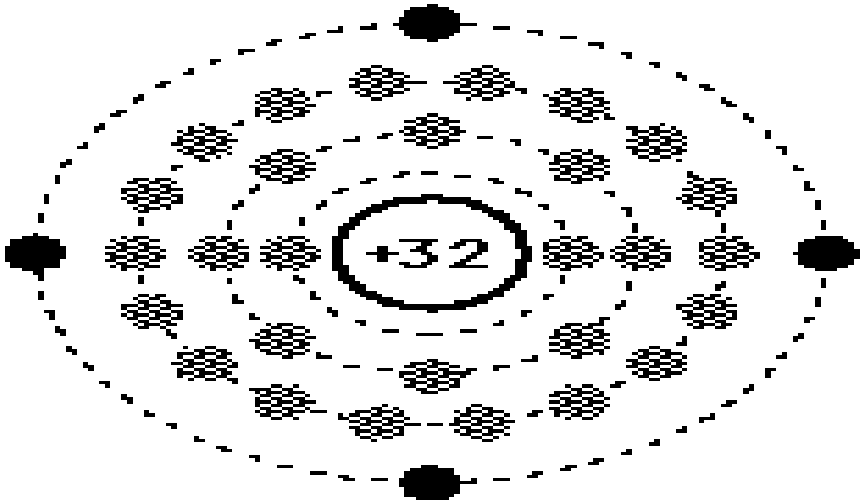

Germanium

Properties	Si	Ge
Atoms/cm^3	5.0×10^{22}	4.42×10^{22}
Atomic Weight	28.09	72.60
Breakdown Field	approx. 3×10^5	approx. 1×10^5
Crystal Structure	Diamond	Diamond
Density (g/cm^3)	2.328	5.3267
Dielectric Constant	11.9	16.0
Effective Density of States in the Conduction Band, Nc (cm^{-3})	2.8×10^{19}	1.04×10^{19}
Effective Density of States in the Valence Band, Nv (cm^{-3})	1.04×10^{19}	6.0×10^{18}
Electron Affinity (V)	4.05	4.0
Energy Gap at 300K (eV)	1.12	0.66
Intrinsic Carrier Concentration (cm^{-3})	1.45×10^{10}	2.4×10^{13}

Melting Point (deg C)	1415	937
Minority Carrier Lifetime (s)	2.5×10^{-3}	approx. 10^{-3}
Mobility (Drift) (cm^2/V-s) μ_n, electrons	1500	3900
Mobility (Drift) (cm^2/V-s) μ_p, holes	475	1900
Optical Phonon Energy (eV)	0.063	0.037
Phonon Mean Free Path (angstroms)	76 (electron) 55 (hole)	105
Specific Heat (J/g-deg C)	0.7	0.31
Thermal Conductivity at 300 K (W/cm-degC)	1.5	0.6
Thermal Diffusivity (cm^2/sec)	0.9	0.36
Vapor Pressure (Pa)	1 at 1650 deg C; 10^{-6} at 900 deg C	1 at 1330 deg C; 10^{-6} at 760 deg C