

# Important features and utility of semiconductors in modern age

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The modern understanding of the properties of a semiconductor relies on quantum physics to explain the movement of charge carriers in a crystal lattice. Doping greatly increases the number of charge carriers within the crystals. When a doped semiconductor contains mostly free holes it is called p - type when it contains mostly free electrons it is known as n – type. The semiconductor doped under precise conditions to control the concentration and regions of p – type and n – type dopants.

Some of the properties of semiconductor materials were observed throughout the mid 19<sup>th</sup> and first decades of 20<sup>th</sup> century. The first practical application of semiconductors in electronics was the 1904 development of the cat's whisker detector a primitive semiconductor diode used in early radio receivers. Development in quantum Physics in turn led to the development of the transistor in 1947, the integrated circuit in 1958 and MOFET (Metal – oxide- semiconductor field effect transistor) in 1959. Semiconductor resistivity falls as its temperature rises, metals are opposite in nature. Its conducting properties may be altered in useful ways by introducing impurities in the crystal structure. After Silicon gallium arsenide is the second most common semiconductor and is used in laser diodes, solar cells, microwave frequency integrated circuits and others. Silicon is critical element for fabricating most electronic circuits.

Semiconductor devices can display a range of useful properties, such as passing current more easily in one direction than the others, showing variable resistance and sensitivity to light as heat. Because the electrical properties of a semiconductor material can be modified by doping or by the application of electrical fields or light, devices made from semiconductors can be used for amplification, switching and energy conversion.

The conductivity of silicon is increased by adding a small amount of pentavalent or trivalent ( boron, gallium, indium) atoms. Apart from doping, the conductivity of a semiconductor can equally be improved by increasing its temperature. This is contrary to the behavior of a metal in which conductivity decreases with increase in temperature. Semiconductor material has an electrical conductivity value falling between metal and insulator.

Semiconductors are materials which play an important role in the development in the field of Science and technology. The two most important semiconductors are Silicon (si) and Germanium (Ge). But some inherent limitations of si and Ge, like narrow and indirect band gaps leads to search for the new materials since last three decades, various groups of semiconductors have come up to play the role in various terrestrial as well as extra terrestrial applications. Some important semiconducting materials that compete with Ge and si in this reference belong to III – V, IV – IV etc groups of materials.

One of most important characters of semiconductors which distinguish it from metals and insulators, is its energy band gap. This property determines among other things, the wavelength of light which it can absorb or emit. As a result of this range of IFDS and lasers can be constructed with the wide range of visible and infrared portion of the spectrum. Concentration of

impurities or doping materials also play an important role to control the electronic and optical properties of semiconductors.

The semiconductor Germanium (Ge) is now used for the majority rectifiers, transistors and integrated circuits. Compound semiconductors are used in high speed devices and devices requiring the emission or absorption of light where the silicon and germanium are found to fail miserably. The binary III compounds like GaN and GaP and GaAs are commonly used for fabrication of light emitting diodes. The group II – VI compounds like ZnS, ZnSe and ZnTe also been successfully used detector, sensors, modulators and many more scientific applications.

Purpose and need of the study. One of the fundamental problems in the theory of solids is the calculation of binding energy of the crystal which plays an important role in understanding nature of interionic forces and of their effects on thermal elastic and anharmonic properties.

The little energies of crystals are highly useful in explaining a variety of phenomena of physical and chemical properties. The physical properties that seem to be related to be lattice energy are the stability, heats of fusion, vaporisation, sublimation, compressibility, thermal expansion critical temperatures molar entropy etc. the elastic constants are strong indicators of the short range contributions to the cohesive energy.

We are motivated to develop a new theoretical model for the lattice dynamics of zinc blende crystals due to the simplicity of their structure and use of some of the solids of this structure as binary semiconductors.

It is realised that physics of bonding in binary semi – conductors having zinc – blende structure is still not well understood,

motivated with this situation a rigid ion model utilizing valance force field approximate will be developed.

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