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Semiconductor Materials And Devices

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Abstract:

the key physical properties of semiconductors, including their band structure, optical processes, and transport. It also discusses the applications of semiconductors, such as diodes, transistors, solar cells, and light-emitting diode. discusses the different properties of semiconductor materials that are required for different types of solid state sensors. It also discusses the materials that are used for these sensors, including silicon, germanium, and various compound semiconductors. discusses the fundamentals of semiconductors, including the classificationof electrical and electronic materials, and the different types of semiconducting materials. It also discusses the latest developments in the field of semiconducting materials, including spintronic materials, ferromagnetic semiconductors, and wide bandgap semiconductors. the subsequent rapid advances in materials, techniques, and understanding. It also discusses the future of semiconductor devices, including how they will be shaped bythe materials used and the constraints they impose on speed, power, and impedance. Semiconductors are defined to possess conductivity in between a nonconductor and a conductor. Because of this property, semiconductors are quite common on a daily basis in electronics since they probably won't short circuit like aconductor. They get their characteristic conductivity from their small band gap.

I. INTRODUCTION

A semiconductor can be considered a material having a conductivity ranging between that of an insulator and a metal. A crucial property of semiconductors is the band gap; a range of forbidden energies within the electronic structure of the material. Semiconductors typically have bandgaps ranging between 1 and 4 eV, whilst insulatorshave larger bandgaps, often greater than 5 eV.

[1]. The thermal energy available at room temperature, 300 K, is approximately 25 me V and is thus considerably smaller than the energy required to promote an electron across the bandgap. This means that there are a small number of carriers present at room temperature, due to the high energy tail of the Boltzmann-like thermal energy distribution. It is the ability to control the number of charge carriers that makes semiconductors of great technological importance.

Semiconducting materials are very sensitive to impurities in the crystal lattice as these can have a dramatic effecton the number of mobile charge carriers present.. This introduction of dopants results in the creation of new, intra-band, energy levels and the generation of either negative (electrons) or positive (holes) charge carriers. Moredetail on doping can be found on the electronic band structure webpage.

- **Crystal structure**

  Clicking on a title will reveal the relevant images for that crystal structure. More information on crystallographycan be found on this page.

- **Cubic Structures**

  Cubic structures have the simple property that their unit cells take the shape of a cube. There are three main variants of the cubic crystal system: the simple cubic, the body centered cubic (BCC) and the face-centred cubic(FCC) structures. Of greatest interest is the face-centred cubic, as several derivatives of this structure are found amongst semiconducting materials.

- **Diamond structure**

  The strong covalent bonds that carbon forms with itself result in the tetrahedrally-bonded diamond structure. Each diamond atom is bonded to four neighbours and has a co-ordination number of 8. Diamond is the prototype material, however, other Group IV elements (Si, Ge and Sn) also have this structure.

- **Zincblende structure**

  As with silicon and germanium, the III-V compound semiconductors form bonds with covalent characteristics. This results in a structure very similar to that of diamond, however, in diamond each carbon atom is bonded to another carbon atom. The zincblende structure consists of two interpenetrating FCC lattices, where one lattice is offset by 1/4 of the unit cell. One type of atom occupies one set of lattice positions and the other species the second lattce. A large number of III-V compound semiconductors adopt this structure, including AlAs, GaAs, GaP, InP and ZnSe.

- **Hexagonal Structures**

  Hexagonal structures have the property that they have hexagonal symmetry, with the unit cell assuming the shapeof a rhombus.

- **Wurtzite structure**

  Many III-V compound semiconductors can also be grown in a structural phase known as wurtzite and is thehexagonal analogue to the zincblende structure.

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