Central

SOT-23 CASE

DESCRIPTION

[illegible]

NOTE: [illegible]

MAXIMUM RATINGS	SYMBOL		UNIT
Power Dissipation [illegible]	P_D	[illegible]	[illegible]
Operating and Storage Temperature	T_J, T_{stg}	[illegible]	°C

ELECTRICAL CHARACTERISTICS [illegible]

[illegible]

What is a Semiconductor?

A **semiconductor** material has an electrical conductivity value falling between that of a conductor, such as metallic copper, and an insulator, such as glass. Its resistivity falls as its temperature rises; metals behave in the opposite way. Its **conducting** properties may be altered in useful ways by introducing impurities ("doping") into the crystal structure. When two differently doped regions exist in the same crystal, a semiconductor junction is created. The behavior of charge carriers, which include electrons, ions, and electron holes, at these junctions is the basis of diodes, transistors, and most modern electronics. Some examples of semiconductors are silicon, germanium, gallium arsenide, and elements near the so-called "metalloid staircase" on the periodic table. 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 a 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 other, showing variable resistance, and having sensitivity to light or heat. Because the electrical properties of a semiconductor material can be modified by doping and 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 the order of 1 in 10^8) of pentavalent (antimony, phosphorus, or arsenic) or trivalent (boron, gallium, indium) atoms. This process is known as doping, and the resulting semiconductors are known as doped or extrinsic semiconductors. Apart from doping, the conductivity of a semiconductor can be improved by increasing its temperature. This is contrary to the behavior of a metal, in which conductivity decreases with an increase in temperature.

The modern understanding of the properties of a semiconductor relies on quantum physics to explain the movement of charge carriers in a crystal lattice.[1] Doping greatly increases the number of charge carriers within the crystal. When a doped semiconductor contains free holes, it is called "p-type", and when it contains free electrons, it is known as "n-type". The semiconductor materials used in electronic devices are doped under precise conditions to control the concentration and regions of p- and n-type dopants. A single semiconductor device crystal can have many p- and n-type regions; the p–n junctions between these regions are responsible for the useful electronic behavior. Using a hot-point probe, one can determine quickly whether a semiconductor sample is p- or n-type.[2]

Some of the properties of semiconductor materials were observed throughout the mid-19th and first decades of the 20th 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. Developments in quantum physics led in turn to the invention of the transistor in 1947,[3] the integrated circuit in 1958, and the MOSFET (metal–oxide–semiconductor field-effect transistor) in 1959.

Properties Of a Semi Conductor

Variable electrical conductivity

Semiconductors in their natural state are poor conductors because a current requires the flow of electrons, and semiconductors have their valence bands filled, preventing the entire flow of new electrons. Several developed techniques allow semiconducting materials to behave like conducting materials, such as doping or gating. These modifications have two outcomes: **n-type** and **p-type**. These refer to the excess or shortage of electrons, respectively. A balanced number of electrons would cause a current to flow throughout the material.[4]

Heterojunctions

Heterojunctions occur when two differently doped semiconducting materials are joined. For example, a configuration could consist of p-doped and n-doped germanium. This results in an exchange of electrons and holes between the differently doped semiconducting materials. The n-doped germanium would have an excess of electrons, and the p-doped germanium would have an excess of holes. The transfer occurs until an equilibrium is reached by a process called recombination, which causes the migrating electrons from the n-type to come in contact with the migrating holes from the p-type. The result of this process is a narrow strip of immobile ions, which causes an electric field across the junction.[13][4]

Excited electrons

A difference in electric potential on a semiconducting material would cause it to leave thermal equilibrium and create a non-equilibrium situation. This introduces electrons and holes to the system, which interact via a process called ambipolar diffusion. Whenever thermal equilibrium is disturbed in a semiconducting material, the number of holes and electrons changes. Such disruptions can occur as a result of a temperature difference or photons, which can enter the system and create electrons and holes. The process that creates and annihilates electrons and holes are called generation and recombination, respectively.[4]

Light emission

In certain semiconductors, excited electrons can relax by emitting light instead of producing heat.[5] These semiconductors are used in the construction of light-emitting diodes and fluorescent quantum dots.

High thermal conductivity

Semiconductors with high thermal conductivity can be used for heat dissipation and improving thermal management of electronics.

Thermal energy conversion

Semiconductors have large thermoelectric power factors making them useful in thermoelectric generators, as well as high thermoelectric figures of merit making them useful in thermoelectric coolers.[6]

Materials

Main article: List of semiconductor materials

Silicon crystals are the most common semiconducting materials used in microelectronics and photovoltaics.

A large number of elements and compounds have semiconducting properties, including:[5]

- Certain pure elements are found in group 14 of the periodic table; the most commercially important of these elements are silicon and germanium. Silicon and germanium are used here effectively because they have 4 valence electrons in their outermost shell, which gives them the ability to gain or lose electrons equally at the same time.
- Binary compounds, particularly between elements in groups 13 and 15, such as gallium arsenide, groups 12 and 16, groups 14 and 16, and between different group-14 elements, e.g. silicon carbide.
- Certain ternary compounds, oxides, and alloys.
- Organic semiconductors, made of organic compounds.
- Semiconducting metal–organic frameworks (MOF).

The most common semiconducting materials are crystalline solids, but amorphous and liquid semiconductors are also known. These include hydrogenated amorphous silicon and mixtures of arsenic, selenium, and tellurium in a variety of proportions. These compounds share with better-known semiconductors the properties of intermediate conductivity and a rapid variation of conductivity with temperature, as well as occasional negative resistance. Such disordered materials lack the rigid crystalline structure of conventional semiconductors such as silicon. They are generally used in thin film structures, which do not require material of higher electronic quality, being relatively insensitive to impurities and radiation damage.

Preparation of semiconductor materials

Almost all of today's electronic technology involves the use of semiconductors, with the most important aspect being the integrated circuit (IC), which are found in desktops, laptops, scanners, cell-phones, and other electronic devices. Semiconductors for ICs are mass-produced. To create an ideal semiconducting material, chemical purity is paramount. Any small imperfection can have a drastic effect on how the semiconducting material behaves due to the scale at which the materials are used.[4]

A high degree of crystalline perfection is also required, since faults in the crystal structure (such as dislocations, twins, and stacking faults) interfere with the semiconducting properties of the material. Crystalline faults are a major cause of defective semiconductor devices. The larger the crystal, the more difficult it is to achieve the necessary perfection. Current mass production processes use crystal ingots between 100 and 300 mm (3.9 and 11.8 in) in diameter, grown as cylinders and sliced into wafers.

There is a combination of processes that are used to prepare semiconducting materials for ICs. One process is called thermal oxidation, which forms silicon dioxide on the surface of the silicon. This is used as a gate insulator and field oxide. Other processes are called photomasks and photolithography. This process is what creates the patterns on the circuit in the integrated circuit.

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