Semiconductors and Its Application

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ABSTRACT: No wonder, semiconductors have influenced the universe beyond anything before they might have thought. While the communications and processing data were still necessary by the people, thanks to the semiconductors all essential tasks were conveniently accomplished and infinitely less time were needed than, for example, during vacuum tubes. The building blocks of the whole electronics and computing sectors are semi-conductive materials. Without integrated circuits (chips) which consist of semiconductor materials, compact, lightweight, high speed and low-energy equipment would not be possible. This essay explores the general history, description and impact of semi-conductors on semi-conductors. Information on the effects of temperature on MOSFET band difference, carrier density, mobility, carrier diffusion and velocity saturation, current density, threshold voltage, leakage current and interconnection resistance are given below. In the various industries of digital electronics and networking we also give application of semiconductor materials.

KEYWORDS: Applications of Semiconductors, History of Semiconductor, Radiation, Semiconductor.

INTRODUCTION

A semiconductor is a material that can, under some conditions, conduct electricity, but not others, and typically a solid chemical part or a compound, making it a strong electric current control medium. Its conductivity depends on a control electrode's current or voltage, or its infrared (IR), visible light, ultraviolet (UV), or x-ray intensity radiation. The unique characteristics of a semiconductor depend on the added impurities or dopants. Similar to the conduction of the current in a wire, an N-type semiconductor mostly holds the current in the form of negative charge electrons. A semi-conductor of form P is primarily assisted by electron shortcomings known as holes. A hole has a positive electrical charge, equal to and opposed to the electron charge. A hollow flow occurs in a semiconducting material in a direction opposite to electron flow. Antimony, arsenic, boron, mercury, germanium, selenium, silicone, Sulphur and terrurium are elementary semiconductors. Silicon is the most known, providing the base for the most integrated circuits (ICs). Gallium arsenide, indium antimonite and the oxides of most metals are popular compounds for semiconductors. Gallium arsenide (GaAs) is typically used in low-noise, high-gain, low signal amplification. The most commonly used semiconductors include gallium arsenide, germanium and silicone. Silicon is used in electronic circuit manufacturing, and in solar cells, laser diodes, etc, gallium arsenide is used[1].

Some compounds are not suitable conductors (metals) or insulators (glass). Semiconductors are considered a material that has a crystalline form that has very few free electrons at room temperature. Its resistivity lies between the driver and the isolator. Regulated conductance may be produced when sufficient impurities are applied to the semiconductors. A few cases Silicon, germanium, carbon etc. Semiconductors. The basic block of modern electronics includes transistors, solar cells, LEDs and digital and analogue integrated circuitry are semiconductors.

Quantum mechanics is used to describe the motion of electrodes and troubles in a crystal structure and even a lattice for a contemporary interpretation of the properties of a semiconductor. A better comprehension of the complications and speeds of the microprocessors in semiconductor materials and manufacturing processes have continuously increased[2]. With the improved electrical conductivity of a semiconductor material temperature that is the opposite of a metal's conduct. A variety of useful properties such as the flow of current in one way can be shown more effectively by semi conductive devices with variable resistance, and light or heat sensitivity. Since the electrical properties of the semi-conductor material can be adjusted by controlled impurity addition or by application of electrical fields or illumination, semi-conductor equipment for amplification, switching and transfer of energy can be used. The actual transfer of free electrons and "holes" collectively known as charging carriers is in a semi-conductor. Growing the number of charging carriers of a semi-conducting drug called "doping" dramatically increases. If the doped semiconductor includes mostly free pants, so the word "p-type" is used, and the term "n-type" is generally used with free electrons.

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1.1 Semiconductor applications in electrical equipment: Semiconductors are materials conducting electric current that can be controlled easily and act as insulators as well as conductors. Ses features have enabled semiconductors in electronics[4]. All about us are semiconductor chips. They can be found from the family car into the pocket calculator in almost every commercial product that we touch. Halfway systems are present today in a wide variety of sectors, including computers, transmission systems, aerospace, construction, agriculture and health care. Semiconductor has decreased the size, cost efficiency and durability of electronic devices, such as MP3 players, HDTVs, CD players, computers and mobile phones.

1.2 Solar cell semiconductor applications Technology: Much of the solar cells absorb the photons in semitrate materials nowadays as the result of charger generation and the subsequent separation of the photo produced charging carriers. The semiconductor layers are the primary components of the solar cell and the core component of the solar cell. There are various semiconductor materials for conversion of the energy of photons into electric energy.

1.3 Telecommunications uses of semiconductors: As a result of the need for quicker knowledge delivery, the telecommunications sector is rising bigger than ever. The fibre optic transmission soon becomes the foundation for the transfer of audio, video and internet data. The broadband networking components experience relentless research and development as this industry matures[5]. These include lasers that generate VCSEL, Edge, Film DWDM filters and waveguides, EDFA and Raman amplifiers, photodiode detectors, etc.. Their functions are also included.

1.4 Semiconductor used in computers: One of the most important technology supporting modern computers is semiconductors. They form the basis of all modern electronic devices using circuits. In order to solve vacuum tubing problems used on analogue computer, these materials first were presented. The tubes would often leak and electrons would often flame out metals used to transfer electrons inside them. These problems were not faced by semiconductors. The materials of the semiconductor conduct electrons totally differently from the materials, thereby stopping them from burning out. Contrary to vacuum tubes, semiconductors had little time to warm up until usage for prolonged periods.

DISCUSSION

A semiconductor is a material that can, under some conditions, conduct electricity, but not others, and typically a solid chemical part or a compound, making it a strong electric current control medium. Its conductivity depends on a control electrode's current or voltage, or its infrared (IR), visible light, ultraviolet (UV), or x-ray intensity radiation. Gallium arsenide, indium antimonite and the oxides of most metals are popular compounds for semiconductors. Gallium arsenide (GaAs) is typically used in low-noise, high-gain, low signal amplification. The most commonly used semiconductors include gallium arsenide, germanium and silicone. Silicon is used in electronic circuit manufacturing, and in solar cells, laser diodes, etc, gallium arsenide is used[6], [7]. Quantum mechanics is used to describe the motion of electrodes and troubles in a crystal structure and even a lattice for a contemporary interpretation of the properties of a semiconductor. A better comprehension of the complications and speeds of the microprocessors in semiconductor materials and manufacturing processes have continuously increased[4]. Figure 1 examples of semiconductors.

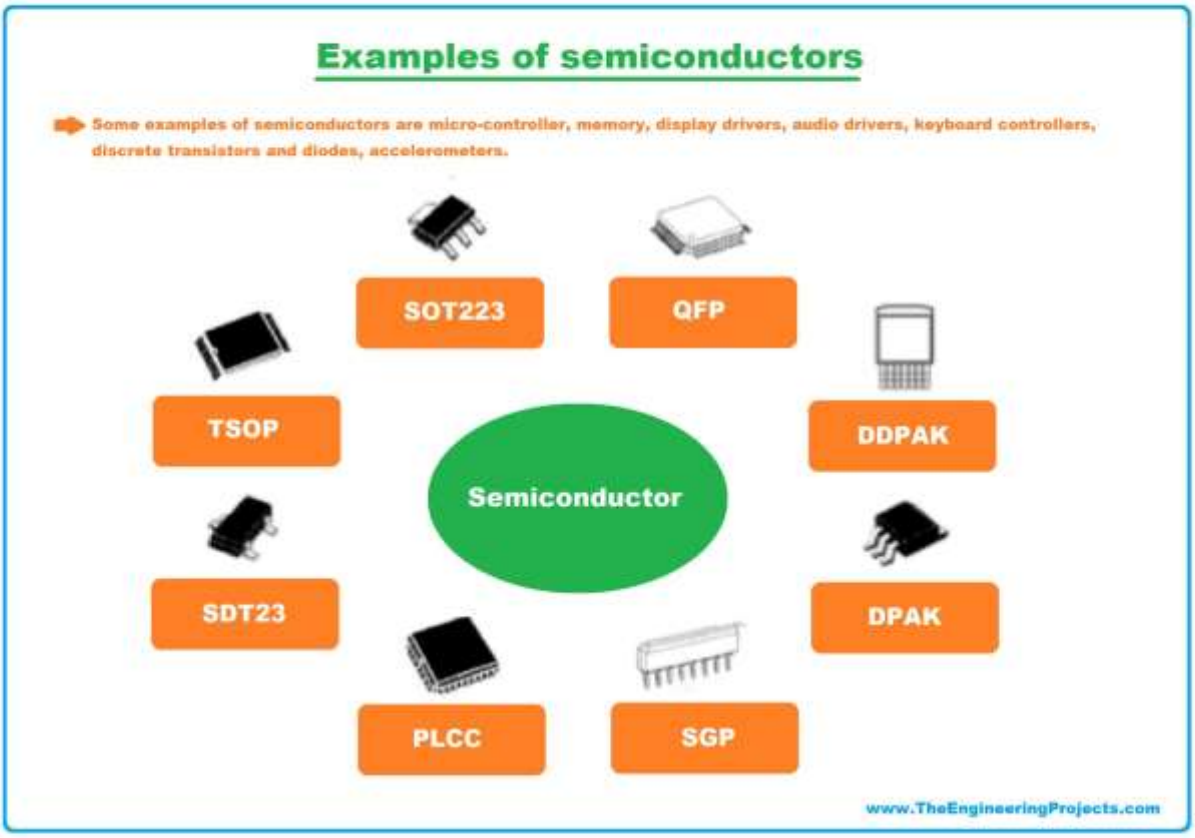

Figure 1: Examples of Semiconductors.

At temperatures near absolute zero, pure Ge and Si behave like perfect insulators. But their conductivities increase with increase in the temperature. For Ge, the binding energy of an electron in the covalent bond is 0.7 eV. If this energy is supplied in the form of heat, some of the bonds are broken, and the electrons are set free.

At ordinary temperatures, some of the electrons are set free from the atoms of Ge or Si crystal, and they wander in the crystal. The absence of an electron at a previously occupied place implies a positive charge at that place. A “hole” is said to be created at the place where the electron is set free. A (vacant) hole is equivalent to positive charge and it has a tendency to accept an electron.

When an electron jumps to a hole, a new hole is produced at the place where the electron was previously. The motion of electrons in one direction is equivalent to the motion of holes in the opposite direction. Thus, in intrinsic semiconductors, holes and electrons are produced simultaneously, and both of them act as charge carriers.

There are two types of extrinsic semiconductors: n-type and p-type.

n-type semiconductor: Elements such as arsenic (As), antimony (Sb) and phosphorus (P) are pentavalent, while Ge and Si are tetravalent. If a small amount of antimony is added to the Ge or Si crystal, as an impurity, then out of its five valent electrons, four will form covalent bonds with neighboring Ge atoms. But the fifth electron of antimony becomes almost free to move in the crystal.

If a potential voltage is applied to the doped Ge-crystal, the free electrons in doped Ge will move towards the positive terminal, and the conductivity increases. Since the negatively charged free electrons increase the conductivity of doped Ge crystal, it is called an n-type semiconductor.

p-type semiconductor: If a trivalent impurity like indium, aluminium or boron (having three valence electrons) is added in a very small proportion to tetravalent Ge or Si, then three covalent bonds are formed with three Ge atoms. But the fourth valence electron of Ge cannot form a covalent bond with indium because no electron is left for pairing.

The absence or deficiency of an electron is called a hole. Each hole is regarded as a region of positive charge at that point. As the conductivity of Ge doped with indium is due to holes, it is called a p-type semiconductor.

Thus, n-type and p-type are the two types of semiconductors, and their uses are explained as follows: A p-type semiconductor and an n-type semiconductor are joined together, and the common interface is called a p-n junction diode.

A p-n junction diode is used as a rectifier in electronic circuits. A transistor is a three-terminal semiconductor device, which is made by sandwiching a thin slice of n-type material between two bigger pieces of p-type material, or a thin slice of p-type semiconductor between two bigger pieces of n-type semiconductor. Thus, there are two types of transistors: p-n-p and n-p-n. A transistor is used as an amplifier in electronic circuits.

A comparison between a semiconductor diode and a vacuum would give a more vivid glimpse about the advantages of semiconductors.

- Unlike vacuum diodes, there are no filaments in semiconductor devices. Hence, no heating is required to emit electrons in a semiconductor.
- Semiconductor devices can be operated immediately after switching on the circuit device.
- Unlike vacuum diodes, no humming sound is produced by semiconductors at the time of operation.
- Compared to vacuum tubes, semiconductor devices always need a low operating voltage.
- Because semiconductors are small in size, the circuits involving them are also very compact.
- Unlike vacuum tubes, semiconductors are shock-proof. Moreover, they are smaller in size and occupy less space and consume less power.
- Compared to vacuum tubes, semiconductors are extremely sensitive to temperature and radiation.
- Semiconductors are cheaper than vacuum diodes and have an unlimited shelf life.
- Semiconductor devices do not need a vacuum for operation.

In summary, the advantages of semiconductor devices far outweigh those of vacuum tubes. With the advent of semiconductor material, it became possible to develop small electronic devices that were more sophisticated, durable and compatible. The most common semiconductor device is the transistor, which is used to manufacture logic gates and digital circuits. The applications of semiconductor devices also extend to analog circuits, which are used in oscillators and amplifiers. Semiconductor devices are also used in integrated circuits, which operate at a very high voltage and current. The applications of semiconductor devices are also seen in daily life. For example, high-speed computer chips are made from semiconductors. Telephones, medical equipment and robotics also make use of semiconductor materials [2], [8]–[10].

The Semiconductor device is made up of a material that is neither a good conductor nor a good insulator, it is called a semiconductor. Such devices have established wide applications because of their reliability, compactness, and low cost. These are discrete components which are used in power devices, compactness optical sensors, and light emitters, including solid-state lasers. They have a wide range of current and voltage handling capabilities, with current ratings more than 5,000 amperes and voltage ratings more than 100,000 volts. More importantly, semiconductor devices lend themselves to integration into complex but readily build-up microelectronic circuits. They are having probable future, the key elements of the majority of electronic systems including communications with data-processing, consumer, and industrial-control equipment.

CONCLUSION

Silicon can be regarded as the carrier of our knowledge. There have been two revolutions in the development of information (approximately 500 years apart). First of all, the details given by Johan Gutenberg in the other invention of the transistor is open to many. The global knowledge volume is currently doubling per year. We take for granted many things (for example, laptops, Internet and cell phones) without silicon microelectronics. In vehicles, home appliances, equipment and more, computer circuits are also present. Equally important are optoelectronic devices in daily life, such as data transmission fibre optic communication, data storage. The number of transistors in an integrated circuit grew exponentially over time after the beginning of semiconductor electronics. In brief we have summarized the early development of semiconductors and rating. The temperature effects of semiconductors were also explored. With rising temperature, the energy band difference, mobility, threshold voltage and saturation velocity are decreasing. Conductance, carrier density, leaks current and resistance to interconnection rise at higher temperature. On the other side. We have also researched semiconductor applications in basic electrical equipment, telecommunications and wireless networks and finally in the solar industry

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