

The vital role and applications of nanoelectronics in the Nanotechnology Domain

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ABSTRACT

Nanotechnology is the study of extremely small structures, having size of 0.1 to 100 nm. It is also defined as the technology at the Nanoscale. It revolutionizes almost in all the fields *viz.*, Physics, Electronics, Mathematics, Computer Science, Information Technology, Chemistry, Biology, Biophysics, Bioinformatics, etc. But out of with these all, it plays a vital role in the field of Electronics. Hence, such technology is called as a Nanoelectronic technology. This technology is one of the very important technology to make the electronics into Nanoscale, so that the devices will make into more smart system. Since, the Nanotechnology is continually playing a vital role in improving the capability of electronic products. This technology also made the devices very light making the product easy to carry or move and at the same time it has reduced the power requirement. In the present paper work, the development of nanotechnology in electronics and its applications in various fields of electronics is discussed. The broad Nanoelectronic applications include Nanotransistors, Nanorobotics, Nanosensors, Nanowire and Nanocomputing etc. Hence, from the overall contributions of literatures of all above mentioned applications and its new development, it is concluded that the Nanoelectronics are the most important field in the Nanotechnology domain.

Keywords: Nanotechnology, Nanoelectronics, Applications of Nanoelectronics.

INTRODUCTION

The word "Nanotechnology" was introduced for the first time by Nario Taniguchi at the international conference on industrial production in Tokyo in 1974. The ideas and concepts behind nanotechnology started with a talk entitled "There's Plenty of Room at the Bottom" by physicist Richard Feynman at an American Physical Society meeting at the California Institute of Technology on 29 December 1959 [1]. The term nano originated from the Greek which means "Dwarf". It is one billionth of a meter. One nanometer, $1 \text{ nm} = 10^{-9} \text{ m}$. Nanotechnology is the technology or the study of extremely small structures, having size of 0.1 to 100 nm. It is also defined as the technology at the Nanoscale. Nanotechnology is also defined as the Art and Science of manipulating matter on an atomic scale, generally 100 nanometers or smaller, and the fabrication of devices or materials that lie within that size range. Nanotechnology is one of the leading scientific fields today, since it combines knowledge from the fields of Physics, Chemistry, Biology, Medicine, Informatics, and Engineering. It is an emerging technological field with great potential to lead in great breakthroughs that can be applied in real life.

ROLE OF NANOTECHNOLOGY IN ELECTRONICS

Nanotechnology plays vital and crucial role in the field of electronics. The resulting field developed from the combination of nanotechnology and electronics is called as "NANO-ELECTRONICS". Nanoelectronics refer to the use of nanotechnology on electronic components. It is also defined as the science which deals with the electronic components manufactured and engineered at a molecular scale. The electronics has been the main driving force for all the technological advancement taking place in the sciences [2]. There are two approaches in nanotechnology: bottom-up and top-down. The first approach, the bottom-up, involves manipulating small numbers individual atoms or more complex molecules, into structures typically using minute probes. The second, top-down, approach implies controlling processes to force atoms and molecules to

build-up themselves to desired locations and/or Structures. The main target of this technology is to reduce the size, risk factor and surface areas of the materials and molecules. Nanoelectronics develop its products and circuits at super miniature level. It also provides faster, smaller and more portable systems. Nanoelectronics have a very broad application like Nanotransistors, Nanosensor, Nanorobotics, Nanowires and Nanocomputing. This application is very important and it has many advantages not only in the field of electronics but others too.

Nanotransistors

The most widely used products in the Electronics industries is a transistor. It is the major component and basic building block of any electronics equipment. A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. In Nanotransistor technology, transistor dimensions are measured in nanometers. When combined in the millions and billions, they can be used to create sophisticated programmable information processors. As transistor technology advanced, their dimensions were reduced from the micrometres (μm) to the nanometres (nm) scale, so that more and more of them could be included in electronic systems. Today, billions of transistors are used in our smartphones, tablet and personal computers, supercomputers, and the other electronic systems that have shaped the world we live in. In addition to their economic importance, transistors are scientifically interesting Nanodevices.

Nanorobotics

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots. Nanorobotics is the technology of creating machines or robots at or close to the scale of a nanometer (10⁻⁹metres) or it can also be defined as a computer-controlled robotic device constructed of nanoscale components to molecular precision and is microscopic in size [3]. The terms nanobot, nanoid, nanite, nanomachine, or nanomite have also been used to describe such devices currently under research and development [4]. Nanorobotics has a wide application in Medical field. These robots play a key role in the field of biomedicine. Nanorobotics is particularly used for the removal of kidney stone,

treatment of cancer & elimination of defected part in the DNA structure, Treatment & Diagnosis of Diabetes, dental treatment, deliver the drug, genetic therapy, cancer treatment etc[5-6]. The Nanorobotic future is very bright. The development and research on Nanorobotics is nonending. More and more advancement yet to come in future in the field of Nanorobotics. The advantage of this technology is that it reduces the risk, minimizes the cost of surgery, easy to operate etc.

Nanosensor

Nanosensors are sensing devices with at least one of their sensing dimensions being not greater than 100 nm. It is an extremely small device capable of detecting and responding to physical stimuli with dimensions on the order of one billionth of a meter. Nanosensors are any biological, chemical, or surgical sensory points used to convey information about nanoparticles to the macroscopic world [7]. Basically there are three types of sensors namely Biosensor, Chemical sensor, physical sensor. Nanosensors have applications in defense, the medical and healthcare world and consumer products. It is use to detect airborne chemicals, viruses and bacteria, measuring the temperature of living cells and measuring temperature of nanofluids etc [8]. The healthcare and biomedical sector is the largest initial market for nanosensors owing to increasing requirement for rapid, compact, accurate and portable diagnostic sensing systems. Nanosensors have the capabilities to address this requirement. Blood sensors capable of detecting multiple pathogens or chemical compounds are one such example. Point-of-care diagnostics are possible with nanosensors. Some of the advantages of this sensor is that faster response, better signal-to-noise, more accurate data, increased data density, less impact on the phenomenon being measured.

Nanowire

A nanowire is a nanostructure, with the diameter of the order of a nanometer (10⁻⁹ meters). It can also be defined as the ratio of the length to width being greater than 1000. Alternatively, nanowires can be defined as structures that have a thickness or diameter constrained to tens of nanometers or less and an unconstrained length. At these scales, quantum mechanical effects are important – which coined the

term "quantum wires" [9]. Nanowires are considered as building blocks for the next generation of electronics, photonics, energy, sensors, and biomedical applications. One-dimensional nanowire structures offer unique opportunities to control properties of semiconductors such as density of states, transport of electrons and photons. Nanowires may lead to the integration of microelectronic devices on silicon with optoelectronic and photonic devices based on compound semiconductors.

Nanocomputing

Nanocomputing describes computing that uses extremely small, or nanoscale, devices. Nanotechnology has done a great development and advancement in computer. It is divided into categories- Electronic Nano computing, Mechanical Nano computing, Chemical Nano computing, Quantum Nano computing etc [10]. Nanotechnology is already in use in many computing, communications, and other electronics applications to provide faster, smaller, and more portable systems that can manage and store larger and larger amounts of information. Because of nanotechnology, the speed of computers has increased while the price of computing has decreased.

CONCLUSION

This paper discussed the history of nanotechnology, role of nanotechnology in electronics and its wide field of application and its advantages. The new world of nanodevices would be comparatively faster, uses less material, minimizes the risk and consume less power. Nanotechnology based devices will enable the new creation of world of innovative electronic based products. In the world of electronics, flexibility is a major breakthrough in the world of electronics.

Conflicts of interest: The authors stated that no conflicts of interest.

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