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"Nanotechnology in Electronics"

Manjula K[1], Thanushree R[2]

[1] Assistant Professer Dept of Electronics and Communication SJC Institute of Technology Chickballapur,Karnataka,India manjulak@sjcit.in

[2] Dept of Electronics and communication. S J C Institute of technology Chickballapur, Karnataka.

ABSTRACT:

Nanotechnology has become a powerful tool in electronics, enabling the creation of smaller, faster, and more energy-efficient devices. This abstract briefly discusses how nanotechnology is being incorporated into electronic devices and its significant influence on multiple sectors. The next industrial revolution will be based on nanotechnology. How can they be utilized in electronic gadgets? Since 2000, many people and organizations have asked this question, which is about how to measure the impact of nanotechnology, a field of science that deals with very small things, on different countries and regions. This article gives an overview of the main views of the key organizations that have addressed this topic from 2000 to 2016. orWe differentiate between two primary viewpoints. The focus is on the technical benefits that nanotechnology can provide to tackle significant development challenges. This sentence means that we look at how nanotechnologies fit into nanoelectronics in different situations, such as society, economy and politics. Electronics rely on materials that are very small, such as carbon nanotubes, graphene, and quantum dots, because they have special features that no other materials have. Smaller and faster transistors, interconnects and displays can be achieved by using carbon nanotubes and graphene, which have very good electrical and mechanical properties. Quantum dots, which can change how they interact with light and electricity, allow for improvements in devices that show images, convert sunlight into energy and detect signals.

Keywords— Nanotechnology,Nanoelectronics

Introduction

Nanotechnology in electronics is nothing but nanoelectronics.Nanoelectronic is concerned with understanding and exploiting the properties of devices, which have dimensions at the nanometre scale.

Microelectronics will gradually evolve into nano-electronic. In fact, this has already happened as can be seen from the smallest feature size of present integrated circuits, which is below of one micrometer. It is currently believed that optical lithography can be used for ground rules down to 150 nm and might even be used for the 100 nm generation and below. This would imply an increasing process and mask complexity, and consequently, increasing the cost.

Molecular-scale electronic has been widely touted as "the next step" in electronic miniaturization, with theory and research suggesting that single molecules may have the capability to take the place of today's much larger electronic components.

what are the advantages of scaling down of devices?

Speed of operation - Reduction of the parasitic capacitances associated with non-conductive paths in an electronic device leads to a higher cut-off frequency. This enables a device to operate at much higher speeds. Density - An obvious advantage. This reduces size and cuts materials cost. Power dissipation - This is reduced due to lesser resistance in interconnects and currents flowing in smaller circuits. In lasers, the use of lower dimensional systems reduces the threshold current due to improved density of states distribution. New applications - This enables certain uses, currently speculative, but very much in the offing.

Integrated circuits are also known as microelectronic. The term micro derives from micro-fabrication technology, which embraces all highly sophisticated techniques like optical- and electron-beam lithography, metallization, implantation and etching that allow generating structures on the scale of one micrometer.

In the early 1970's, two scientists, Ari Aviram and Mark Ratner, began to envision electronic circuit elements made from single molecules and described in detail how they might function. This was the origin of the field of molecular electronics, now sometimes called molecular-scale electronics.

The emergence of molecular electronics and spintronics is providing a challenge to traditional electronic manufacturing techniques. Significant reduction in size and the sheer enormity of numbers in manufacturing are the benefits of molecular electronics. Scientists predict that computers will be assembled using molecules in the future, pushing technology far beyond the limits of silicon.

Approaches in nanoelectronics

A. Bottom up approach

Electronics produced by controlling material composition and structure at the molecular level through a bottom-up approach may result in devices and fabrication techniques that are not achievable through top-down approaches. A concise overview of bottom-up and hybrid bottom-up/top-down approaches for nanoelectronics is provided in this paper, with a focus on memories using the crossbar motif. First, we will talk about resistance-change memory devices and typical electromechanical devices based on core-shell nanowire structures and carbon nanotube structures, respectively. These device architectures exhibit terabit-scale density potential, robust switching, and promising performance metrics.

Second, we will go over the designs that are being created for array-based systems, hybrid crossbar/CMOS circuits, and circuit-level integration. These architectures include experimental demonstrations of important ideas such chemically programmed stochastic demultipluxers that are independent of lithography. Last but not least, bottom-up fabrication techniques offer the chance to assemble three-dimensional, vertically integrated multifunctional circuits, will be critically discussed.

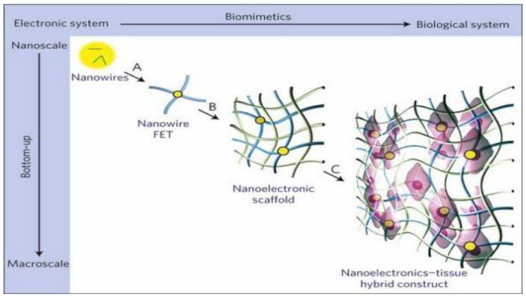

Fig 1. Nanoelectronics bottom up

B. Top down approach

Using short-wavelength light sources for lithographic patterning is the most popular top-down manufacturing method. One major benefit of the top-down method, which was designed for integrated circuit fabrication, is that there is no need for an assembly stage because the components are patterned and produced in situ.Because of the high level of refinement in the production of microelectronic chips, the field of optical lithography is rather mature. Current short-wavelength optical lithography techniques achieve dimensions slightly below 100 nanometers, which is the conventional threshold definition of the nanoscale.Extreme ultraviolet and X-ray radiation are examples of shorter wavelength sources that are being developed to enable lithographic printing processes to attain diameters between 10 and 100 nanometers. Electron beam lithography, one type of scanning beam method, produces patterns as small as 20 nanometers. Beyond only being able to employ a larger range of materials with curved surfaces, these nanoscale printing processes have various other benefits. Specifically, these methods may be implemented in standard labs using significantly less expensive apparatus than traditional submicron lithography. All top-down methods face the difficulty of applying their effective results at nanoscale dimensions, notwithstanding their success at the microscale (millionths of a meter).A second drawback is that they use planar processes, which make it challenging to manufacture arbitrary three-dimensional things since structures are formed by adding and removing patterned layers (deposition and etching).

CORE DEVICES IN NANOELECTRONICS

A. Carbon Nanotubes

Carbon Nanotubes (Cnts) are a type of carbon that have a cylindrical shape at the nanoscale. Nanotubes have been built with a length-to-diameter ratio of 132,000,000:1, which is much bigger than any other material. These round carbon structures have special characteristics, which are useful for making tiny devices, processing information, manipulating light and other areas of materials science and technology. , Carbon nanotubes are very good at conducting heat, bending, and carrying electricity. They can be mixed with other materials to make them stronger and better.

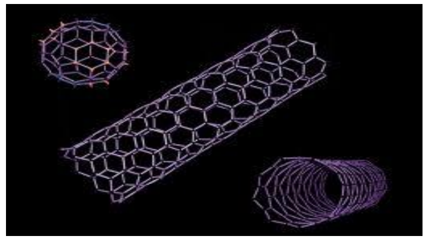

Fig 2.Carbon Nanotubes

B . SI Nanodots

Quantum dots, also called nanodots, are tiny particles of inorganic semiconductor that have hundreds or thousands of atoms and measure one billionth of a meter. In the mid-1980s, these materials were created for use in optoelectronics. They possess unique characteristics in terms of structure, electronic behavior, and light absorption and emission. They absorb light in the near UV region and emit visible light with its color influenced by both the size of the nanodot and the surface chemistry. By controlling the size of nanodots during their creation with nanoscale accuracy, we can also adjust their optical properties. Furthermore, nanodots have a longer lifespan than organic fluorophores and can absorb light from a wide range of wavelengths. Quantum dots can emit light when stimulated by electricity, and they have many advantages over other materials. These advantages, such as their small size, their ability to emit different colors, and their stability, make them a good choice for using nanotechnology in many ways in the future.

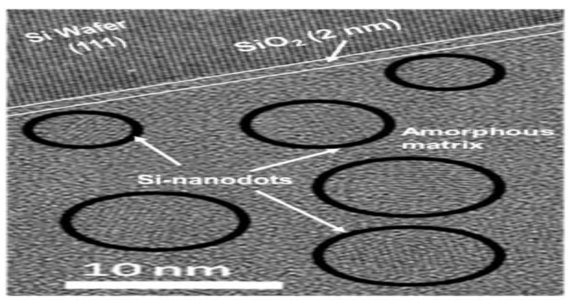

Fig 3. Si nanodots

C . Nanowires

The definition of a nanowire is that it is a tiny structure that has a very small diameter, less than a billionth of a meter, and can be any length. When dealing with such small sizes, quantum mechanical phenomena become significant, leading to the creation of "quantum wires". Nanowires are tiny structures that can be made of various materials, such as metals, semiconductors, or insulators. Some nanowires are made of molecules that are either organic (like DNA) or inorganic (like Mo6S9-xIx).

In the near future, it is possible to use nanowires to connect small components into compact circuits. Nanotechnology can be used to fabricate components from chemical substances.

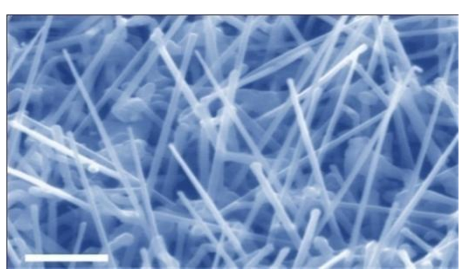

Fig 4 . Nanowires

ADVANTAGES

- Reduce the size of transistors used in IC
- Increase the density of memory chips
- Nanolithography
- Improve display screens on electronic devices.
- Reduce power consumption

APPLICATIONS

- Defence and Security
- Nanobiotechnology
- Nano Devices
- Optical Engineering
- Medicine and Drugs

Future Scope

With the aid of nanoelectronics, which is rapidly expanding in manufacturing, scientists are using it to investigate hitherto undiscovered properties of natural resources. Nanoelectronics has created the smallest feature-rich integrated circuit chip, which is then incorporated into robots. The field of nano electronics, which will be extremely useful to the technological world in the near future, is likewise progressively developing in micro electronics. The great accomplishment of nanoelectronics, according to researchers, will be the assembly of intelligent devices such as computers utilizing molecules in the future.

We may see hybrid gadgets in the future, fusing the advantages of both strategies. In this case, we would employ exotic materials to provide additional functionalities on a very large-scale circuit produced by a traditional semiconductor process that are only required at specific locations. In applications where function, chemical flexibility, and low processing costs are more important than perfection, newly produced nanostructures can also compete. One of those exciting fields is electronic biosensors, which employ carbon nanotubes or nanowires to identify certain compounds. However, there may be other, less known applications as well.

CONCLUSION

By manipulating materials at the molecular level, we can create new electronics that are not achievable with traditional methods. strategies for nanoelectronics, specifically focusing on memory devices using the crossbar structure, are discussed in this review. Initially, we talked about two types of memory devices: those that use carbon nanotubes and those that use core-shell nanowires. These structures demonstrate strong switching capabilities, which could lead to high-performance metrics and the possibility of achieving terabit-scale density. Second, we will review architectures being developed for circuit-level integration, hybrid crossbar/CMOS circuits, and array-based systems. This includes experimental demonstrations of key concepts such as lithography-independent, chemically coded stochastic demultipliers. Finally, there are methods that allow for the creation of three-dimensional, multi-functional circuits that can be assembled from the bottom up.

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