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Nanotechnology applications in electronics

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I. Introduction

Nanotechnology deals with the design of structures, systems, and devices that are small in size. The small size increases their novel purpose and functionality, this devices tend to have a small surface area to volume ratio. In essence, nanoparticles are as tiny as much as one-millionth the size of threads. Thus, the manipulation of nanoparticle requires high power microscopes, to view and manipulate the particle which in turn has opened a world of immense possibilities. Diverse industrial fields and scientific endeavors have explored the techniques of manipulation of properties at a microscopic scale (Nasrollahzadeh, Sajadi, Sajjadi, & Issaabadi, 2019).

Nanotechnology offers a revolutionary path for technological developments. Much of the concerns concerning material management are addressed by nanotechnology. Thus, because nanotechnology encompasses the fabrication and chemical application of systems from individual submicron dimensions to nonmaterial into larger systems, it can be argued that this kind of technological revolution offers a new perspective of solving problems. In this regard, resultant nanostructure has the capability of providing solutions to technical and environmental challenges. Arguably, nanotechnology has more significant potential in terms of resultant devices in the field of medicine, electronics, and environmental science. This essay's point of focus is the application of nanotechnology in the field of electronics.

Nanoelectronics configurations

Arguably, the electronic setting of nonmaterial is different from the materials used in the traditional manufacturing process. These changes are caused by systematic differences in the density of electronic energy levels. As a function of size, these changes result in substantial optical and electrical variations. Resultant variation causes the formation of unique materials that owing to their size, has a significant fraction of surface atoms, high surface energy, and surface confinement. These properties make nonmaterial to be exceptional, increasing their ease for fabrication, ideal utilization in composite materials, and their functionality as bulk materials.

Nanoelectronics

Nanoelectronics is a field of nanotechnology that entails the application of nanotechnology in electronic components. In most instances, these components are often fewer nanometers in size. But, the smaller the electronic components become, the harder they are to manufacture (Gramling, Kiziroglou, & Yeatman, 2017). Nanoelectronics cover a diverse set of materials and devices with common characteristics that they are soo tiny that the physical effect alters the material properties at the nanoscale. The functionality of these devices is enhanced by inter atomic interactions and the resultant quantum mechanical properties. Nanoelectronics plays a vital role in the field of electronics since it develops nano machines through the application of scientific methods.

In this way, the main risk factors, size, and surface areas of material are drastically reduced. Nanoelectronics devices are tiny and have improved capability, easy to carry, and minimal power requirements. These types of electronic components are made up of the current high technology production process, resulting in the production of Nanoelectronics transistors. Nanoelectronics transistors have the capability of making computer processors more potent than convectional semiconductors (Meneghesso, Moens, Östling, Sonsky, & Stoffels, 2017). Some of the Nanoelectronics applications utilizing nanotechnology include; optoelectronics displays and wearable, flexible devices.

Optoelectronics

Optoelectronics devices are components that source, detect, and control light and usually come in many shapes and forms. Such appliances are highly energy-efficient and are increasingly becoming famous due to their potential to solve

environmental problems and energy consumptions. The primary type of material used in these components is made of nanofibres and carbon nanotubes. The resultant electronic devices such as incandescent light lamps and halogen lamps are highly effective in energy consumption and longevity (Davis, 2017).

Displays

Display technologies are mainly groups into three areas; organic LEDs, electronic papers, and other devices intended to form still images. Organic light-emitting diodes are based on the phenomena that particular organic material emits light when fed by electric currents. The application of nanotechnology in OLEDs and nanofabrication techniques is in the manufacture of transparent electrodes and nanoparticle-based coating for pacing the OLEDs to protect them from environmental damages.

Besides, new technological intervention in the development of OLEDs is the use of a nanometer of graphene as transparent conductors (Ahn & Hong, 2014). This has paved the way for the manufacture of a large mass of inexpensive OLEDs on a vast area and a cost-effective, flexible plastic substrate. On the other hand, nanotechnology has been widely used in the manufacture of electronic paper, which uses power consuming backlight to illuminate its pixels. The use of nanotechnology in the development of electronic paper has made it easy to hold text and images indefinitely without drawing electricity, but allowing for the images to be changed.

Wearable, flexible devices

Currently, wearable electronics is a new trend characterized by a fast-growing array of smart watches, fitness bands, and next-generation health monitoring devices. Owing to the fast-paced nature of adopting wearable technology, such devices will take over the small electronic devices that will extend into the textile industry. In this regard, e-textile will revolutionize the design and production of a new generation of garments with distributed sensors and electronic functions.

II. Nanoelectronics applications under development

Development of Cadmium selenide nanocrystals

It is common knowledge that typical electronic circuits are integrated with rigid silicon wafers. The greatest challenge posed by the use of silicon wafers is the absence of flexibility, which prevents the development of a wide range of applications. In the current modern world, electronics have become more pervasive hence the need for flexibility. However, the greatest challenge is finding the right mix for desirable performance and cost-effective manufacturing costs. Nanotechnology solves these problems through the development of nanoscale particles of the semiconductor cadmium selenide, which has the potential of being coated on flexible plastics. The most encouraging aspect of the use of cadmium selenide is the ability to form flexible high performing electronics because nanocrystals can move electronics faster compared to the commonly amorphous silicon (Stinner et al., 2015). Besides, apart from the speed, cadmium selenide is deposited at room temperature, which opens the possibility of using a flexible plastic foundation, unlike the use of amorphous silicon operates at higher temperature ranges.

Also, nanocrystals can easily be dispersed by an ink liquid medium using multiples technique to make electronics circuits. The possibility of creating high performing and flexible electronic is possible since the operation of nanocrystals employs the use of low volts. Low voltage is a necessity for the practical functionality of portable electronic devices that will work with batteries hence increasing their usefulness. It is worth noting that the use of nanocrystals ensures that there is a combination of flexibility, simplicity, and low power requirements paving the way for the design of new and pervasive electronic devices, such as sensors.

Development of silicon nanophotonics

The breakthrough in research on the applicability of silicon nanophotonics is encouraging.IBM, for instance, is planning on the use of light instead of the electrical signal to transmit information for future computing. This is a necessity basing on the huge chunks of data in need of processing, retrial and storage. In essence, silicon nanophotonics allows the integration of optical components with electrical circuits on a single silicon chip. Nanophotonics technology offers a new perspective regarding ways in which huge chunks of data can be transmitted between computer chips and large data centers (Physicsworld, 2019). The use of photonic in the electrical component will revolutionize the ease of data transfer using much lesser energy compared to traditional means. Because the accumulation of data is at an alarming rate, massive monoliths of servers and switches consume a lot of energy while the data rates are exceeding the capability of convectional devices to interconnect.

For instance, the use of electronics such as the HD televisions requires extraordinary high

pixel density and frame rates rendering convectional HDMI cables useless. Capacitance of wires causes dissipation of energy, an issue that can be solved through the adoption of photons. The use of photonic as a means of communication in electrical devices will increase the ability of these devices to increases their processing power, capacity, and resultant speed.

How nanotechnology improves the quality of electronic devices

Improvements to the fabrication process

According to Nasrollahzadeh, Sajadi, Sajjadi, & Issaabadi (2019), fabrication is the process of developing a method to make electrical products and related components. In most instances, conventional means of manufacturing electrical devices are used costly and complicated, and at the time, the quality of the final product is diminished. The application of nanotechnology helps in solving this problem and also cuts down on the fabrication cost. Nanotechnology offers the option of utilizing phosphide materials to complement traditional silicon materials used in the fabrication of electronic devices. Through the use of nanotechnology, a new set of techniques are used to manufacture semiconductors such as the inverse metal-assisted chemical etching process. The result is the production of quality electronic devices that have improved performance, low cost of manufacturing, and increased lifespan with regards to functionality.

Improvement of device functionality

The quality of electronic devices is gauged based on how it functions and performs respective tasks. The use of nanotechnology in computing devices will result in the production of quality devices with better memory, faster and larger capacity to store data. For instance, the creation of 14-nanometer transistors means that the entire computer memory could be stored on single chips, while the utilization of magnetic random access memory means those computers will be able to boot instantly. RAM is only enabled by nanometer-scale magnetic tunnel injection and can result in quick and effective means of data storage during a system shutdown or enabling resumes.

Improved displays and flexibility

High-quality electronic devices such as Television and computer monitors are now available due to the integration of nanotechnology in their production phase. The most common types of Television under production are purely high quality due to the ultra high definition displays that utilize the quantum dots to produce vibrant colors at the same time saving on electrical energy consumption. Thus, it is crystal clear that nanotechnology does not only increase the quality of displays in some electronic devices but also helps in cutting down the energy requirement of operating such devices. Besides, the use of nontechnology in computing products is remarkable, resulting in quality devices. For instance, the production of flash memory chips for Smartphone and thumb drives and antibacterial coating on keyboards and cell phone casing has also improved the quality and functionality of these electronic gadgets (Verma, 2018).

Flexible, bendable, foldable, and rollable electronics are in full application in different sectors.

Additionally, wearable devices and the internet of thing devices are the common dominant trend in the current modern era. These flexible devices have been developed by the use of nanotechnology, through the utilization of nonmaterial's like graphene and cellulosic nonmaterial. Thus, it is essential to highlight that technological innovation, such as electronic papers, is a product of nanotechnology and has opened up the door to countless possibilities and the invention of quality, flexible, and efficient smart devices.

Improvement on the safety of electronic devices

Its lifespan also determines the quality of an electronic device. Traditional methods of fabrication during the manufacturing phase resulted in the production of some faulty devices. Commonly, electrical discharges from internal components and shortages are common phenomena due to the nature of the material in use that has a shorter life span and in need of frequent maintenance and replacement. Besides, the chemical composition of the material used in fabricating electronic devices poses a detrimental health effect on users. Meanwhile, the technological revolution as a result of using nanotechnology has resulted in the production and utilization of nanoparticle suspensors. Nanoparticle suspensors tend to be cheap, safer, and reliable compared to conventional lead-based solders that also pose health hazards.

Improved device communication

Communication links, in particular, wireless connection is an essential requirement to a broad range of consumer devices. Ranging from computer devices to the Internet of Things devices, both require a variety of high data rate wireless communication protocols, while other devices contain wireless controllers. It is common knowledge that all these devices are powered by

batteries; hence, during the fabrication process; low power consumption is a critical requirement while at the same time keeping in mind that the communication aspect consumes a lot of power. Nanotechnology offers a solution to these challenges through the ubiquitous use of low cost, highly functioning silica integrated chips and nanoscale devices, which are promising in facilitating the communication capabilities of electronic devices (Meneghesso, Moens, Östling, Sonsky, & Stoffels, 2017).

III. Conclusion

This paper gives an in-depth analysis of nanotechnology, its application in electronics, and the resultant advantaged concerning the quality of the devices. Froe the discussions, it is evident that nanotechnology has immense benefits and possible gains if the scope of its applicability is increased. The variety of electronic devices is highly improved due to the nature of materials used during fabrication, which are cost-effective, safer, and reliable and low energy consuming material. However, the industrial players in the electronic filed should not be blinded by that fact nanotechnology also pose a risk and requires strict regulation of its applications and development. For instance, through the use of nanotechnology, minute recording electronic devices can be used for surveillance purposes, thus breaching individual privacy. Hence, such issues require urgent attention to tackle emerging issues such as the possible weaponizing of nanotechnology and the production of smart bullets for military use.

References

[1]. Ahn, J., & Hong, B. H. (2014). Graphene for displays that bend. *Nature Nanotechnology*, *9*(10), 737-738. doi:10.1038/nnano.2014.226

[2]. Davis, N. (2017, July 10). An Introduction to Optoelectronics. Retrieved from https://www.allaboutcircuits.com/technical-articles/an-introduction-to-optoelectronics/

[3]. Gramling, H. M., Kiziroglou, M. E., & Yeatman, E. M. (2017). Nanotechnology for Consumer Electronics. *Nanoelectronics*, 501-526. doi:10.1002/9783527800728.ch22

[4]. Meneghesso, G., Moens, P., Östling, M., Sonsky, J., & Stoffels, S. (2017). Smart Power Devices Nanotechnology. *Nanoelectronics*, 163-204. doi:10.1002/9783527800728.ch7

[5]. Nasrollahzadeh, M., Sajadi, M. S., Sajjadi, M., & Issaabadi, Z. (2019). An Introduction to Nanotechnology. *Interface Science and Technology*, *28*, 1-27. Retrieved from https://doi.org/10.1016/B978-0-12-813586-0.00001-8

[6]. Physicsworld. (2019, May 28). The promise of silicon photonics – Physics World. Retrieved from https://physicsworld.com/a/the-promise-of-silicon-photonics/

[7]. Stinner, F. S., Lai, Y., Straus, D. B., Diroll, B. T., Kim, D. K., Murray, C. B., & Kagan, C. R. (2015). Flexible, High-Speed CdSe Nanocrystal Integrated Circuits. *Nano Letters*, *15*(10), 7155-7160. doi:10.1021/acs.nanolett.5b03363

[8]. Verma, S. S. (2018, May 28). Nanotechnology: advantages & disadvantages|Scientific India Magazine. Retrieved from http://www.scind.org/1175/Technology/nanotechnology:--advantages-&-disadvantages.html