Nanotechnology in Wearable Electronics

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***Abstract*--With the development of technology in the 21st century, wearable electronics are no far behind any other technology. Apart from becoming an integral part of human's life, these electronics occupy a center stage because of their big size reduction and fast functional capabilities. Inclusion of nanotechnology to these wearable electronics is a "cherry on the cake". The research aims at giving an overview of the forms and usage of nanotechnology in wearable electronics with properties like flexibility, comfort, size etc compatible with**

wearable electronics intact. The research also throws light on how materials like carbon nano-tubes, graphene, polymers, sensors and actuators are used by researchers to establish the maximum benefit and compatibility between wearable electronics and nanotechnology.

Keywords- Wearable Technology, nano-materials, nanofabrication, Actuators,

I. OVERVIEW OF TECHNOLOGY

December 29, 1959 marks a glorious event in the history of Science when Richard Feyman in a talk titled "There's Plenty of Room in the Bottom" put forward his research and concepts in nanotechnology at an American Physical Society meeting at University of California. [1] After that the evolution of nanotechnology went through various leaps and bounds to evolve in its present bifurcated forms like nano-robotics, nano-tubes, nano composite structures etc. The four genres of evolution of nano technology can be summed as follows

Nanotechnology was launched in the year 2000 with its first and foremost usage in First generation products (popular as passive nanostructures) which performed the task of aerosols and collides.

2005 marks the second generation with the launch of "active nanostructures" that have multi-tasking ability such as actuators and sensors.

In 2010 (third generation) nanotechnology flourished as 3D networking, guided assembling, robotics and hierarchical architectures.

2015, marks the fourth generation wherein integrated nano-systems started to take shape.

With the development of e-textiles and smart fabrics, the researchers started focusing on the idea of using nanotechnology in wearable electronics. The researchers have led to the launch of nano wearable sensors from the traditions actuators that are much more comfortably fitted for the wearable's and human body.

II. INTRODUCTION

Simply put, Nanotechnology refers to the branch of engineering dealing in miniature (means an element of one billionth i.e. 10^{-9} or 0.000000001 within systems such as weights and measures, time, value, weight and length) individual atoms.[1][2] With the growing civilization and needs of people it is essential to launch technologies small sized technologies/gadgets along with maximum benefit. Nanotechnology aims at achieving this objective. This technology, although ancient, is developing at a fast rate to meet the needs of current generation. In 1980's, an IBM group attempted inventing tunneling microscope using this technology and which turned out to be one of the most progressive inventions of those days.

Nanotechnology uses processing of separation, consolidation and deformation of materials using single units of atoms or

molecules. Nano-scale plays an essential role in determining the nano proportions of nano-materials.[1] For instance

- In cases of zero-dimensional nano-materials, entire material is measured within nano-scale.[1]
- In cases of two-dimensional nano-materials, the entire material would lie outside the scope of nano-scale.[1]
- In cases of three-dimensional nano-materials consisting of nanotubes, nano wires, bulk powders etc., the dimensions would not be limited to the nano-scale.[1]

III. TECHNIQUES USED

Nanofabrication is the technique which is used and focuses on integrations of memory chips and high density microprocessors at atomic level. The bifurcation is as follows-

A. Top-down Approach- This approach uses micro-fabrication method to settle the required order and shape of small devices derived from larger ones. This approach is backed by nano-lithography wherein the exposed material is automatically discarded thus saving the essential material via a mask. Engraving of base material in final product can be carried on chemically using x-rays, ultra-violet rays or electron beams. General application of this technique is on the manufacturing of computer chips.[1][2]

B. Bottom-up Approach- This approach recognizes self-assembly chemical synthesis and molecular fabrication as one of its important aspects. Self-assembly can be defined as a technique in which because of little manipulation components assemble in an orderly manner.[1][2] This phenomenon occurs of chemical engineering and material science playing there parts in the procedure.

IV. HOW NANOTECHNOLOGY ENABLES WEARABLE ELECTRONICS

Wearable electronics have been in existence since the birth of technology but it has gained rapid momentum with the growth of civilization. Simply put, the term “wearable electronics” stands for electronic devices compatible to be put in use when worn on human body. [2] This has been made possible because of changing genres of nano-technology with respect to censors, computers, internet, GPS Systems, WiFi Systems etc. The scope of wearable electronics has now expanded its ambit to sectors like fitness, healthcare, commercial and industrial applications. The main objective in developing a product in the category of wearable electronics is flexibility and small size which can be achieved using components like composites, dielectric elastomers, polymers etc.[2]

Nano materials in wearable electronics enable generation of stimuli via magnetic, mechanical, thermal or chemical process by using actuators and sensors. Actuators are meant to react to signals as transferred from sensor. Stimulus can also be generated due to structural deformations, heating, noise, force etc. The main aim of utilizing nano technology in wearable electronics is to feed real time data into monitoring central system by using various sensors which examine and react to temperature, strains, body movements, voice and facial expression detection etc. [2] The distinguishable feature of modern nano technology based wearable electronics and traditional wearable electronics is that while the former uses minute sensors and actuators, the latter uses rigid materials and semi-conductors making them unsuitable for or incompatible with human body.[2]

V. TYPES OF WEARABLE TECHNOLOGIES

A. WEARABLE HEALTH TECHNOLOGY

This includes technologies that enable diagnosis of patient’s health with accurate results and low/no pain. Apart from assembling data, this technology also enables monitoring and reaching to conclusions about a patient’s health.[3]

B. NANOTECHNOLOGY ELECTRONICS FOR WEARABLE HEALTH MONITORING

As scientifically proven, skin (being the largest organ of human body) is capable to act as a signal source that both generate and transmits biological signals to give conclusions regarding important health metrics of an individual. The most significant of skin is that it enables vital transmitting of various biological signals from inner organs, blood vessels and dermis and epidermis. Gadgets pertaining to nanotechnology will utilize the stimulus generating characteristic of skin to act as sensors in order enable wearable gadgets to enable health monitoring.[3]

C. WEARABLE TEXTILE TECHNOLOGIES

Nano fibers and Nano coating permits breakthrough changes in textile industry. Nanotechnology has contributed much in this field, for instance, communication facilities, data transfer, control on environment etc. The peculiar properties imbibed in Nano silver, UV blocking, self-cleansing, flame retardant and nano metal oxide coatings enable to transform the entire physical structure of textiles.[3]
Some of the examples can be as follows-

- Bacteria proof finishing in medical textiles and inner wears.[3]
- UV protection in sunscreens.[3]

D. WEARABLE CONSUMER ELECTRONICS

Consumer electronics can be termed as electronic devices used in the day to day activities of an individual which helps to catalyze the activities . Consumer electronics occupies various sectors like entertainment, communication, office productivity etc. For Example- Google Smart glasses which is computerized overall with an existing CPU, microphone, high definition camera etc.[3]

VI. CONCLUSION

Wearable technology is the need of the hour and usage of nanotechnology in wearable electronics fulfils the need of the present generation ensuring compatibility and flexibility. The positive impact of usage of nanotechnology has been seen in various industries in health industry, consumer industry etc as discussed widely in the research. In the coming years, wearable technologies especially smart glasses and smart watches will surely occupy the entire electronic market and nanotechnology will give a boost to it. Thus, the research concludes that the time is not far when wearable electronics backed by nanotechnology will become a part of life of individuals and corporations. This would also ease their ability to do work because of much better flexibility and no interruption. With respect to corporations, these technologies are going to enhance the communication between corporations with widened market research. Apart from that, these technologies will also uphold the values of good society as it will enable police, fireman military members to public and personal safety.

VII. REFERENCES

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[3] Michael Berger, "The Skills and Tools Making Technology Invisible"