Recent Advances in Nanotechnology

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***Abstract*-**Nanotechnology is the area where the movement of single atom can be monitored. Researcher are working on small scale with a restriction that one dimension of material should be in 1-100 nm range. Significant modifications in various properties of different materials were found at nanoscale. The doping of various nanoparticles like metals, semiconductors into the material like polymers, graphene enhanced the properties which can be used for different uses in many areas. These enhanced properties of materials are used in computer industry, solar cell, crops losses, food industry etc. Nanotechnology has opened the gates for many industry and sectors to produce smart devices. In coming days, nanotechnology will be used at commercial level and will play a vital role to rise the economy of a country. This paper focuses on studying and exploring these different applications of nanotechnology in various domains and discusses the future prospective of nanotechnology.

***Index Terms*-** Nanotechnology, nanoparticles, graphene, nanocomposites

I. Introduction

Nanotechnology is the study of matter at nanoscale i.e., at least one dimension should be in the 1-100 nm range. Nanotechnology has the ability to create a new industrial revolution that will have a major impact on society and everybody's' life. The optical, structural, chemical properties of a material change at nanoscale. Nanotechnology opens the way for amazing and smart materials. This technology has been proved to be a unique and noble technology due to its ability to modify the things at small scale. Nanotechnology can control and manipulate the materials at nanoscale as per need of its uses. Researcher and scientist are working to make materials at nanoscale by using the enhancement in the properties of these materials. Nanotechnology have its general impact on the growth of any industry in today's time. Nanotechnology is already used in many areas like sunscreen, cosmetics, textiles, drug delivery, bio-medical, and has applications in clean environment [1-8]. There are two approach in nanotechnology one is bottom-up approach and the other is top-down approach.

All over the world lots of researcher are working on nanotechnology and trying to implement it so that it can be blended into the day to day life of humans. Each nation wants its scientist and engineers to do best for the development of smart materials and nano devices. The methods and components of this small-scale technology are under continuous development and all generation are improving the foundation for the next generation. Nanotechnology is not a single discipline, but it comprises physics, chemistry, biology, and engineering. Nanotechnology reduced the gap between pure sciences and engineering. Nanoparticles of metals, semiconductors, polymers are synthesizing by different method for different uses and having their applications from material science to electronics, energy storages to clean environment. Researcher are using CNTs graphene and polymers for making nanocomposites. Nanocomposites are used in various smart devices like sensors, packaging materials, textiles and in various industry [2,3,4,5]. Nanotechnology has been proved to be the best and sustainable technology because of its potential in the development of a nation. Now a days, the product based on nanotechnology helps in the growth of economy of countries. In nanotechnology, the optical, chemical, structural, mechanical, electrical properties of material can be tuned for desired applications. Nanoparticles in different concentration play crucial role in the modification of properties of nanomaterials. 2 D material like graphene is used in the manufacturing of solar cell for increasing its efficiency and reducing the cost per watt [9,10,11].
A material of bulk size has constant properties irrespective of its size but at the nanoscale size dependent properties such as quantum confinement, surface to volume ratio etc. are observed. Several physical phenomena become noticeable pronounced at the nanoscale like opaque sheet on reducing the size up to nanoscale become transparent, inert materials become catalysts, insulators become conductors. Gold become very powerful catalyst at nanoscale.

II. Experimental approach

Researchers found many ways to produce the nanoparticles like physical methods and chemical methods. There are various methods available for the synthesis of nanoparticles like Physical Vapor Deposition, Chemical Vapor Deposition, Vacuum Sputtering Method, Ball milling method, sol-gel methods, micro-emulsion methods and many more.

But micro-emulsion method is the best suitable method for synthesizing nanoparticles because in this method the size of the nanoparticle can be controlled up to few nanometer. Formation of the nanoparticles can be confirmed by the Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM). There are other characterization techniques also available to characterize the nanomaterials like UV-visible spectroscopy, Photoluminescence, Fourier Transform Infrared Spectroscopy (FTIR), Tunneling Electron Microscopy (TEM) etc.

III. Applications and scope

It was noticed that at nanoscale the properties of materials modified due to high surface to volume ratio of nanoparticles compared to bulk particles. It has been reported that the material like nanoparticles of ZnO are used for the purification and self-cleaning. Nano sensors are playing a vital role in many sectors because of high sensitivity and small size. Now a days lots of researchers are working on the purifications of water pollutant free water to give the better life to its public and it has become possible today because of nanotechnology. Carbon Nano Tubes (CNT) has been used in computer technology by many researchers worldwide for better efficiency and low cost [12,13].

In today's time computer industry is evolving everyday so efficiency of computers plays a crucial role. The efficiency of computer can be increased by using two dimensional materials. Nanotechnology also contributing to environment by enable smart plant sensors. These smart plant sensors can improve the productivity and can reduce the crop losses. Smart materials based on nanotechnology are being used in food industry for food storages and packaging materials [14,15,16,17].

A variety of applications of Nanotechnology can be found in the literature as making smart materials for packaging, smart clothes, medical nanobots, sensors, solar cells etc. to name a few. These fancy applications are forcing researchers worldwide to explore new prospective of using nanotechnology in future application areas as developing smart devices, smart home to making smart cities, smart vehicles etc. [18,19]. Now researchers should mentions the applications and uses of their work in a clear and presentable way so that the new researcher and industries wants to work in that field must have clean approach to work and implement the ideas for the development of society. The commercialization of product developed by nanotechnology started and people are waiting eagerly to adopt this technology for the ease of doing business and living.
Nanoparticles and nanomaterials have a range of applications including nano computers, energy storage devices, electronic and optical displays, magnetic refrigeration, color imaging technique and drug delivery etc. Many products used in day to day life like cosmetics, sunscreens, fibers, textiles, and paints already have nanoparticles. Nanoparticles also persist in the environment and keep it safe and clean [20,21].

Table 1: Proposed applications and industry in nanotechnology.

S. No.	Applications of Nanotechnology	Industry
1	Sunscreen	Cosmetics Industry
2	Smart material for packaging	Food Industry
3	Smart clothes	Textile industry
4	To clean the environment	Environment
5	Drug delivery, medical nanobots	Medicine
6	Sensors	Optical Industry
7	Crops	Agricultural
8	To purify the water	Water Industry
9	Energy storage, biofuel, solar cells, batteries	Power Industry
10	Flexible devices and wires	Electronics Industry
11	Self-cleaning glasses	Glass Industry
12	Light weighted tennis	Tennis industry
13	Nanocomposites	Manufacturing Industry
14.	Toys	Toys Industry

Nanotechnology is not limited to the applications mentioned above but have the vast applications in almost all filed of science and engineering. In table 1, we have mentioned some of the applications used in day to day life.

IV. Conclusion

In day to day life of individuals the use of nanotechnology is continuously increasing. Now the life of humans will change globally due to the future possibilities and products that can be developed by nanotechnology. Researchers and scientists are exploring the field and are coming up with new and innovative ideas on how to develop the smart devices .

or smart products based on their work in nanotechnology. We should now move into the direction of commercialization of products based on nanotechnology. Once the commercialization of smart devices and products will be initiated at large scale then only we can realize the world of this beautiful and smart technology. This paper gives an idea about the recent development in the field of nanotechnology and future scope of nanotechnology.

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