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Nanotechnology and Its Application – A Review

[1]Aditi Rajesh Nimodiya, [2]Shruti Sunil Ajankar

[1]Student, B.E, Department of Computer Science & Engineering, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, Maharashtra, India

[2]Student, B.E, Department of Computer Science & Engineering, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, Maharashtra, India

Abstract: Nanotechnology is currently the most demanding technology which is affecting almost every part of our daily life in a positive accept. We are using the products develop by nanotechnology on a daily basic without even knowing it. Nanotechnology is science, engineering and technology conducted at nanoscale. It deals with the understanding and control of matter at the nanoscale, dimensions between approximately 1 and 100 nanometers. Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors: information technology, homeland security, medicine, transportation, energy, food safety, and environmental science, among many others. In almost every field Nanotechnology's are used. This Paper mainly focused on the various applications and technology of Nanotechnology which is used world-wide by the people.

Index Terms - Technology, Nanotechnology, Nano, Nano-meter, Applications, Future Directions

I. INTRODUCTION

The term "Nanotechnology" was first defined by Norio Taniguchi of the Tokyo Science University in 1974. Nanotechnology, shortened to "Nanotech", is the study of manipulating matter on an atomic and molecular scale [8].

The prefix 'nano' comes from the Greek word 'nanos' meaning 'a dwarf'. Hence, 'nanotechnology' might well simply mean a technology to do with 'small' things [10]. Nanotechnology (Nano-small) is the study of small structure [3].

It is one of the most active research areas with both novel science and useful applications that has gradually established itself in the past two decades. Not surprisingly, it is observed that expenditure on nanotechnology research is significant. The U.S. National Nanotechnology Initiative (NNI) expenditures exceed $1 billion each year, with the President's 2008 budget for NNI at $1.5 billion. However, the research is mainly moving forward motivated by immediate profitable return generated by high value commercial products [6].

Generally, nanotechnology deals with structures sized between 1 to 100 nm and involve developing materials or devices within that size [8]. A Nano-meter is one billionth of meter-about one hundred thousand times smaller than the diameter of a human hair [3]. At Nano-meter level, individual molecules and interaction between them becomes important in comparison with the macroscopic properties of the material or device. Control at Nano-meter scale and manipulation of fundamental molecular structure permits to regulate the bulk macroscopic chemical and physical properties of the material and device [5].

The organization of this document is as follows. In Section 2 (**What is Nanotechnology**), It will give detail of What exactly Nanotechnology is and its definition. Section 3 (**Advancement in Nanotechnology**), present the development of Nanotechnology in today's world. In Section 4 (**Applications of Nanotechnology**) various applications of Nanotechnology are explained which are used in our life. Section 5 (**Future Directions**) explain the future directions in Nanotechnology. Discussed in Section 6 (**Conclusion**) a conclusion is the short summary of what we see in this review paper.

II. WHAT IS NANOTECHNOLOGY

Nanotechnology is science, engineering, and technology at the nanoscale, which is about 1 to 100 Nano-meters. Nanotechnology is the study and application of extremely small things and is used across all other science fields, such as chemistry, biology, physics, materials science, and engineering [1]. It is the use of very small particles of materials to create new large-scale materials [6].

More specifically, nanotechnology is the imaging, modeling, measuring, design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the Nano-meter scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/superior characteristic or property [2].

III. ADVANCEMENT IN NANOTECHNOLOGY

With the development in areas of materials science, chemistry and engineering over the previous few eras' nanotechnology has remained exploited in all fields where insignificant size plays crucial part in determining fundamental properties. They are being used from physics, engineering, and chemistry to biologicals and medicine.

Nanoparticles of cadmium telluride are employed in the labelling of biological molecules with precision. Nanoparticles of titanium dioxide effectively block UV radiation and they are the main component of sun screens. In 1985, carbon-60 molecule was exposed by Harry Kroto, Richard Smalley and Robert Curl and they won the Nobel Prize for their work in 1996. In 1991, carbon nanotubes were discovered by Iijima. A type of nanotechnology 'Bottom-up nanotechnology' involves the self-assembling traits of biological systems, such as DNA molecules which control the organization and structure of carbon nanotubes [5].

IV. APPLICATIONS OF NANOTECHNOLOGY

1) Medicine:

Nanomedicine, the application of nanotechnology in medicine, enables precise solutions for disease prevention, diagnosis, and treatment. This includes new imaging tools like improved MRIs; lab on-a-chip technologies for rapid testing in a doctor's office; novel gene sequencing technologies; nanoparticles that can help deliver medication directly to cancer cells, minimizing damage to healthy tissue; and graphene nanoribbons to help repair spinal cord injuries [1].

Manipulation of drugs, active compounds and devices at nanometer scale, allows to control and alter the essential properties and bioactivity of the ingredients. Thus, they allow to control the solubility of drugs, controlled release, and targeted drug delivery [5].

The scientific and scientific analysis areas have utilized the exclusive qualities of nanomaterials for various programs (e.g., comparison providers for mobile picture and therapeutics for the treatment cancer). Conditions such as biomedical nanotechnology, bio nanotechnology, and nanomedicine are used to explain this Multiple area. Features can be included to nanomaterials by interfacing them with scientific elements or components [7].

2) Diagnostics:

Nanotechnology-on-a-chip is one more sizing of lab-on-a-chip technological innovation. Attractive nanoparticles, limited to an appropriate antibody, are used to brand specific elements, components or harmful bacteria. Silver nanoparticles marked with short sections of DNA can be used for recognition of inherited series in an example. Multicolour visual programming for scientific assays has been obtained by embedding different-sized huge spots into polymeric microbeads. Nanopore technological innovation for research of nucleic chemicals transforms post of nucleotides straight into digital signatures [7].

3) Cancer Treatment:

In cancer therapy, tumour cells are destroyed by atomic oxygen which is generated by laser. Such molecular oxygen is highly cytotoxic, and it destroys tumour cells efficiently [5]. If scientists can load their cancer detecting gold nanoparticles with anticancer drugs, they could attack the cancer exactly where it lives. Such a treatment means fewer side effects and less medication used. Nanoparticles also carry the potential for targeted and time-release drugs. A potent dose of drugs could be delivered to a specific area but engineered to release over a planned period to ensure maximum effectiveness and the patient's safety.

These treatments aim to take advantage of the power of nanotechnology and the voracious tendencies of cancer cells, which feast on everything in sight, including drug-laden nanoparticles [6]. Dye used to produce atomic oxygen is occupied by cancer cells, and it only destroys the tumour cells which are exposed to the laser radiation without affecting the normal cells. To avoid adverse effects on normal cells, a porous nanoparticle is used to enclose the hydrophobic dye molecule which prevent it from spreading to other parts of the body [5].

4) Tissue Engineering:

Regenerative medicine and tissue engineering techniques are used to restore and improve lost functions of tissues [5]. Nanotechnology can help to reproduce or to fix broken tissues. "Tissue engineering" makes use of artificially activated mobile growth by susing appropriate nanomaterial-based scaffolds and growth aspects. Tissue technology might alternative today's traditional treatments like whole body transplants or artificial improvements [7].

These techniques showed the promising results in the past decades as compared to traditional therapy. Nanotechnology is widely used in tissue engineering. As natural bone surface is not smooth, and it comprises features that are about 100 nm across. In the hip or knee prosthesis, Nano-sized features on their surface minimize the probabilities of rejection. Moreover, they excite the making of osteoblasts [5].

5) Environmental Protection:

Nanotechnology can help in developing green technologies that can minimize environmental pollution [3]. Nanotechnology-enabled sensors and solutions are now able to detect and identify chemical or biological agents in the air, water, and soil with much higher sensitivity than ever before [1]. Substance catalysis and purification methods are two popular illustrations where nanotechnology already performs a part. The functions provide novel components with designed functions and chemical properties: for example, nanoparticles with a unique chemical around (ligands), or particular visual qualities. In this feeling, chemical makeup is indeed a primary nanoscience. In a short-term viewpoint, chemical makeup will provide novel "nanomaterials" and in the long run, excellent procedures such as "self-assembly" will allow time and energy protecting methods. Thus, chemical makeup types a platform for nanotechnology offering tailor-made elements, polymers etc, as well as groups and nanoparticles [7]. A smartphone extension has been developed to help firefighters monitor air quality around fires [1]. For environmental treatment, different implementations of nanotechnology have been successfully implemented at the laboratory scale. However, mostly these applications need confirmation of their effectiveness and safety in the field [4].

6) Space:

Nanotechnology may hold the key to making space flight more practical. Advancements in nanomaterials make lightweight solar sails and a cable for the space elevator possible. By significantly reducing the amount of rocket fuel required, these advances could lower the cost of reaching orbit and traveling in space. In addition, new materials combined with Nano-sensors and nanorobots could improve the performance of spaceships, spacesuits, and the equipment used to explore planets and moons, making nanotechnology an important part of the 'final frontier' [11].

Researchers are looking into the following applications of nanotechnology in space flight [11]:

- Employing materials made from carbon nanotubes to reduce the weight of spaceships like the one shown below while retaining or even increasing the structural strength.
- Using carbon nanotubes to make the cable needed for the space elevator, a system which could significantly reduce the cost of sending material into orbit.
- Deploying a network of Nano-sensors to search large areas of planets such as Mars for traces of water or other chemicals.
- Working with Nano-sensors to monitor the levels of trace chemicals in spacecraft to monitor the performance of life support systems.

7) Food:

Complex set of designing and experimental difficulties in the nourishment and bioprocessing industry for assembling top notch and safe sustenance through productive and supportable means can be tackled through nanotechnology. Microorganisms recognizable proof and nourishment quality observing utilizing biosensors; insightful, dynamic, and brilliant sustenance bundling frameworks; nanoencapsulation of bioactive nourishment mixes are few cases of developing uses of nanotechnology for the nourishment business. Nanotechnology can be connected in the creation, handling, security and bundling of nourishment. A nanocomposite covering procedure could enhance sustenance bundling by putting against microbial specialists straightforwardly on the surface of the covered film. Nanocomposites could expand or decline gas penetrability of distinctive fillers as is required for diverse items. They can likewise enhance the mechanical and hotness safety properties and bring down the oxygen transmission rate [7].

8) Agriculture:

Uses of nanotechnology can possibly change the whole agriculture part and nourishment industry anchor from generation to preservation, handling, bundling, transportation, and even waste treatment. Nano Science ideas and Nanotechnology applications can possibly update the generation cycle, rebuild the preparing and protection forms and rethink the nourishment propensities for the individuals. Real Challenges identified with agriculture like Low profit in cultivable regions, Large uncultivable ranges, Shrinkage of cultivable terrains, Wastage of inputs like water, composts, pesticides, Wastage of items and obviously Food security for developing numbers can be tended to through different utilizations of nanotechnology [7].

9) Infrastructure:

Embedded nanoscale sensors and devices may provide cost effective continuous monitoring of the structural integrity and performance of bridges, tunnels, railways, parking structures, and pavement over time. Corrosion-resistant, self-healing Nano-enabled paints can help bridges and concrete last longer. Nano coatings could be used to increase the life span of water and sewer pipes [1].

10) Cosmetics:

One field of use is in sunscreens. The customary substance UV security methodology experiences its poor long-haul steadiness. A sunscreen in view of mineral nanoparticles, for example, titanium dioxide offers a few focal points. Titanium oxide nanoparticles have a tantamount UV security property as the mass material, however lose the cosmetically undesirable whitening as the molecule size is decline [7].

11) Consumer Electronics:

Transistors, the basic switches that enable computing, have gotten smaller and smaller with nanotechnology. Smaller, faster, and better transistors brought about smartphones, wearables, and many other devices we use every day. Novel nanoscale electronic devices may soon help achieve quantum computers, or an entirely new type of supercomputer that can learn and solve problems like a human brain [1].

V. FUTURE DIRECTIONS

The multidisciplinary arena of nanotechnology and its applicability in discovering novel analogues and manipulation of available techniques may have probability to enhance health care. Nanotechnology has emerged as a powerful tool in modern day medicine in a relatively short time period. Therefore, Nano-materials have entered in industrial production. Most of the applications of nanoparticle in medicine are focused on targeted drug discovery & delivery and gene therapy. In biological sciences, nanoparticles are substituting organic dyes which necessitate high photo-stability and innumerable abilities. There are few developments to the remote-control functionality of Nano-probes, like magnetic nanoparticles being used in removal of tumours from the body with the release of drug or destroying the surrounding area to get rid of tumour. The main tendency in future development of Nano-materials is to make them flexible for countless uses by control of signals emitted and hereby revolving them into Nano-devices. In near future, nanotechnology will embellish a critical tool against severe and infectious diseases. Moreover, another future perspective involves the catalysis of biologically inspired Nano - biomaterials and their development. In this way, the functional catalysis will stimulate the capabilities of natural tissues and organs. Current trends in nanotechnology have developed to enhance the quality of human life. Integrating the interactions of tissue and cell-biomaterial and the Cell-Nano-Topography at nanoscale is the major clinical goal of Nano-medicine [5].

VI. CONCLUSION

1) Nanoscience refers to the science & discipline and Nano technology refers the applied part of it including the engineering to control, manipulate and structure the matter at an unimaginably small scale: Nano scale [8].

2) Nanotechnology has changed the living of people and develop the society in various way. The benefits of nanotechnology use are numerousand this technology offer lot of possibilities in different fields [9].

3) Nanotechnology may offer us a wide variety of proficiencies and these may be utilized in reasonable and thoughtful way [5]. Furthermore, nanotechnology and nanomaterials is a swiftly growing area of research where new properties of materials on the Nano-scale can be utilized for the benefit of industrial and a number of capable developments exist that can potentially modify the service life and life-cycle cost of construction infrastructure to make a new world in future [4].

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