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A Comprehensive Review on Nanotechnology: Categories, Applications and Initiatives

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ABSTRACT

Nanotechnology, as a frontier technology, can play a crucial role in India's development, given its diverse applications across sectors. The paper focuses on the revolutionising industries by unfastened fresh potential at the molecular level, driving advance in fields like medicine but it also raises significant enquiry about safety, ethics, and rule. Nanotechnology has the prospective of create new resources and products that may revolutionize all areas of life. Nanoparticles permit doctors to focus medicines on the sickness cause, pleasing to the eye effectiveness and lessening unpleasant effects. The paper highlights the strategy of matter at proportions ranging from 1 to 100 nanometers, where distinctive phenomena permit for fresh applications.

Keywords: Technology, Industries, Nano-Scale, Nanoparticles, Nanometer Electrical, Devices, And Chemistry

INTRODUCTION

Nanoscience is studying nanomaterials and their properties. Where the 21th Century was the era of macro-science ,characterized By gigantic Boeings ,roaring shuttles ,draculian Dams ,monstrous Refineries and Power plants ,the 21th century will be dominated by nano –science ,featured by microscopic weapons ,molecular surgical devices ,ultra –thin packaging, minute light emitting diodes and molecular switches and circuits .As science processed in last few decades , the importance of the emerging area of nanotechnology is becoming quite apparent to the Indian scientific community too. Nanotechnology is a part of science and technology about the control of matter on the atomic and molecular scale - this means things that are about 100 nanometres across. Nanotechnology includes making products that use parts this small, such as electronic devices, catalysts, sensors, etc.

Nanotechnology is the design ,characterization ,production and application of structures, devices and systems by controlling shape and size at the nano-scale .Eight to then atoms span one nanometer .The human hair is approximately 10,000 to 80,000 nm thick ,Nano-science is the world of the nano-scale is that the smaller it gets ,the larger its relative surface area becomes . Its electronic structure dramatically too. Both effect lead greatly improved catalytic activity but can lead to aggressive chemical reactivity. “Nanotechnology, also shortened to nanotech, is the use of matter on an atomic, molecular, and supramolecular scale for industrial purposes. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also now referred to as molecular nanotechnology” (Drexler, K. Eric 284)

With the help of nanotechnology, one of the materials with distinct properties can be fabric. Nanomatecles take advantage of their increased surface area to ratio. Their optical properties ,e.g. fuel become a function of the particle diameter. When brought into a bulk material ,nano particles can strongly influence the mechanical properties ,such as the stiffness or elasticity. Scientists currently debate the future implications of nanotechnology. “Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in nanomedicine, nanoelectronics, biomaterials energy production, and consumer products. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials” (Buzea, C.; Pacheco, I. I.; Robbie, K. 36)

The biological and medical research scientists have exploited the unique properties of nanomaterial for various applications, e.g., contrast agents foe cell imaging and therapeutic for treating cancer. Functionalities can be added to nano materials by interfacing them with biological molecules or structures. Thus far, the integration of nanomaterials with biology has led to the development of diagnostic devices, contrast agents, analytical tools, therapy, and drug delivery vehicles.

Diagnostics: Nanotechnology on a chip is one dimension of lab; chip technology. Biological tests measuring the presence or activity of selected substances become quicker, more sensitive and more flexible when certain nanoscale

particles are put to work as tags or label specific molecules, structures or microorganisms. For example, gold nanoparticles tagged with short segments of DNA can be used for detection of genetic sequence in a sample. Researchers have successfully used DNA origami-based nanobots capable of carrying out logic functions to achieve targeted drug delivery in cockroaches. “It is said that the computational power of these nanobots can be scaled up to that of a Commodore.(Amir, Y.; Ben-Ishay, 373)

Multi-colour optical coding for biological assays has been achieved by embedding different sized quantum dots into polymeric micro beads. “Nanofibers are used in several areas and in different products, in everything from aircraft wings to tennis rackets. Inhaling airborne nanoparticles and nano-fibers may lead to a number of pulmonary diseases, e.g. fibrosis” (Byrne, J. D.; Baugh, J. A. 50)

Nanotechnology can help to reproduce or to repair damage tissue. This so- called "tissue engineering" make use of artificially stimulated cell proliferation by using suitable Nano material based scaffolds and growth factors. Tissue engineering might replace today's conventional treatments, e.g. transplantation of organs or artificial implants. The nano-materials field includes subfields which develop or study materials having unique properties arising from their nano-scale dimensions. “Interface and colloid science has given rise to many materials which may be useful in nanotechnology, such as carbon nanotubes and other fullerenes, and various nanoparticles and nanorods. Nanomaterials with fast ion transport are related also to nanoionics and nanoelectronics” (Narayan, R. J.; Kumta, 38)

Chemical catalysis and filtration techniques are two prominent examples where nanotechnology already plays a role. The synthesis provides novel materials with tailored features and chemical properties with tailored features and e.g. Nano particles with a distinct chemical surrounding for specific optical properties. Chemical catalysis benefits especially from Nano practical, due to the extremely large surface to volume ratio. The application potential of Nano-practical in catalysis ranges from fuel cell to catalytic converts and photo-catalytic devices. Catalysis is also important for the production of chemicals.

A strong influence of nano-chemistry on waste- water treatment, air purification and energy strong devices is to be expected. Mechanical or chemical methods can be used for effective filtration techniques. Nanoporous membranes are suitable for a mechanical filtration with extremely small pores smaller than 10 nm. Nano-filtration is mainly used for the removal of ions or the separation of different fluids. On a larger scale, the membrane filtration technique is named ultra filtration which works down to between 10 and 100 nm.

The most advanced nanotechnology projects related to energy are storage conversion, manufacturing improvements by reducing materials and process rats, energy saving e.g. by better thermal insulation, and enhanced renewable energy source. Today's best solar cells have layers gather to aboard light at different energies but they still only manage to use 30 percent of the sun’s energy. Commercially available solar cells have much lower efficiencies. Nanotechnology can help increase the efficiency of light conversion by specifically designed nanostructures. The degree of efficiency of combustion engines is not higher than 15-20% at the moment. Nanotechnology can improve combustion by designing specific catalyst with maximize surface area.

An example for an environmentally friendly from energy is the use of fuel cells powered by hydrogen, which is ideally produced by renewable energies. The most prominent nanostructure material in fuel cells is the catalyst consisting of carbon supported noble metal practical with diameters of 1-5nm. Suitable materials for hydrogen strong contain a large number of small nano-scale nanosized pores. Many nano-structured materials like nano-tubes, Zeolites or alanates are under investigation. Current high-technology production process are based on traditional top down strategies, nanotechnology has already been introduced silently. The critical length scale of integrated circuits is already at the nano-scale regarding the gate length of transistor in CPUs or DRAM devices.

Novel Semiconductor Device: An example of such novel device is based on spintronics. The dependents of the resistance of a material on an external field is called magnetoristance . This effect can be significantly amplified for Nano size objects, for example when two ferromagnetic layers are separated by a nanomagnetic layer which is several Nano materials thick .The GMR effect has led to a strong increase in the data storage density of her disks I need made the gigabyte range possible. The so called tunnelling Magneto resistance is very e similar to GMR and based on the pin development tunnelling of electrons through adjacent ferromagnetic layers. Both the GMS and the TMR effect can be used to create a non-volatile main memory of computers, such as the so called magnetic random access memory or MRAM.

In the modern communication technology, traditional analogue electrical devices are increasing replaced by optical or optoelectronic device due to their enormous bandwidth and capacity, respectively two promising examples for or photonic crystals and quantum dots. These are non scaled objects which can be used, among many other things, for the construction of lasers. The advantage of a Quantum dot laser over the traditional semiconductor laser is that their emitted wavelength depends on the diameter of the dot. Quantum dot lasers are cheaper and offer higher beam quality then conventional laser diodes. Nanotechnology is already impacting the field of consumer goods, providing products

with novel functions ranging from easy to clean to scratch resistant. Already in use are different Nano practical improved products.

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Food: Nanotechnology can be applied in the production, processing, safety and packaging of food. A nanocomposite coating process could improve food packaging by placing anti-microbial agents directly on the surface of the coated film. Nanocomposites could increase or decrease gas permeability products. They can also improve the mechanical and heat resistance properties and lower the oxygen transmission rate. The first sunglasses using protective and antireflective ultrathin polymer coatings are on the market. For optics, nanotechnology also offers scratch resistant coatings based on nanocomposites. The use of nanofibres makes clothes water and stain repellent or wrinkle free.

Textiles with a nano-technological finish can be washed less frequently and at lower temperatures. Nanotechnology has been used to integrate tiny carbon particles membrane and guarantee full surface protection from electrostatic charges for the wearer. The traditional chemical UV protection approach suffers from 15 poor long term stability. A sunscreen based on mineral nanoparticies such as titanium dioxide offer several advantages. Timanium dioxide nanoparticles have a comparable UV protection property as the bulk material, but lose the cosmetically undesirable whitening as the particle size is decreased.

CONCLUSION

Nanotechnology enhances functions like electro-magnetic field shielding, electrical conducting, anti-static, camouflaging, stealth, water repellency, and so on. Nanotechnology brings together scientists and engineers from many different subjects, such as applied physics, materials science, interface and colloid science, device physics, chemistry, supramolecular chemistry (which refers to the area of chemistry that focuses on the non-covalent bonding interactions of molecules), self-replicating machines and robotics, chemical engineering, mechanical engineering, biology, biological engineering, and electrical engineering.

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