Original Research Paper

Volume - 12 | Issue - 11 | November - 2022 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Physics

DEVELOPMENT OF NANOTECHNOLOGY: PROS AND CONS

Dr. K.S.S. Raja Sekhar JL in Physics, Government Junior College, Gollaprolu, Kakinada District, Andhra Pradesh, India.

ABSTRACT Nanotechnology is developing rapidly in various industrial applications, medical imaging, disease diagnosis, drug delivery, cancer treatment, gene therapy and many more. However, some concerns have been expressed about risks posed by engineered nanomaterials (ENMs), their potential to cause undesirable effects, contaminate the environment and adversely affect susceptible parts of the population. Thus, substantial attention has to be paid to the potential risks of Nanoparticles. Some studies showed that numerous types of Nanoparticles are able to pass certain biological barriers and exert toxic effects on crucial organs like brain, liver, kidney and skin. Recently some of the studies showed that there may be reproductive toxicity of the nanomaterials. Nanotechnology is at the cutting edge of rapid technological development as it has many potential human health benefits, but it is perceived with some apprehension for its potential human health risks.

KEYWORDS : *Nanotechnology, Engineered nanomaterials, nanomedicine, nanoelectronics, nanotoxicology*

INTRODUCTION

Nanotechnology is a branch of science that involves manipulating structures and properties at the Nano scale range, from 1 to 100 nanometers. A particle which is 1 nanometer in size is 10-9 meters small – a billionth of a meter. With the concept introduced initially in 1959 by physicist Richard P Feynman during his **"There's Plenty of Room at the Bottom"** talk in which he expressed the ability to control and manipulate the individual atoms and molecules, the study has today developed exponentially to revolutionize the perspectives in industry, agriculture and mostly in medicine. Nanomaterials are of three types viz natural, incidental and engineered.Natural sources of nanoparticles include combustion products forest fires, volcanic ash, ocean spray, and the radioactive decay. Natural nanomaterials can also be formed through weathering processes of metals, rocks etc. Sources of incidental nanoparticles include vehicle engine exhausts, smelting, and welding fumes, combustion processes from domestic solid fuel heating and cooking. It can also be a byproduct of wear and corrosion products. Intentionally-manufactured Nano scale materials will be referred to as engineered nanomaterials (ENMs)**.** They are usually produced by bottom-up processes, such as physical and chemical vapor deposition, liquid phase synthesis, and self-assembly.

Positive Impacts Of Nanotechnology

Nanotechnology has numerous applications in various fields. They are widely used in medicine (drug delivery, diagnostic techniques etc.), electronics, food science, space, fabrics, environment and many more.

Nanomedicine

Among the medical applications of nanotechnology in medicine, the technique that is currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer cells). Particles are engineered so that they are attracted to diseased cells, which allow direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease.

Nanobots could be sent into a patient's arteries to clear the blockages. Surgeries could become much faster and accurate. Nano robots could actually be programmed to repair specific diseased cells (such as cancer cells), functioning in a similar way to antibodies in natural healing processes.

Researchers are developing a technique to kill bacteria using gold nanoparticles and infrared light. This method may improve the cleaning of instruments in hospitals. They are also investigating the use of quantum dots to treat antibiotic resistant infections. They also demonstrated a bandage that applies electrical pulses to a wound using electricity produced by nanogenerators worn by the patient.

Nanoelectronics

Using Nanotechnology in the field of electronics we may increasethe capabilities of the electronic devices by reducing their weight and power consumption. We can improve the display screens by reducing power consumption while decreasing the weight and thickness of the screens. Using carbon nanotubes to guide electrons to illuminate pixels, resulting in a lightweight, millimeter thick "nanoemmissive" display panel.Some Researchers have demonstrated an LED build with zinc oxide nanostructures called fins which generates much higher light output than existing designs of similar size. Researchers have demonstrated a low power method to use nanomagnets as switches, like transistors, in electrical circuits. Their method might lead to electrical circuits with much lower power consumption than transistor based circuits.They have also demonstrated a laser that uses a nanopatterned silicon surface that helps produce the light with much better frequency control than previously achieved. This may allow much higher data rates for information transmission over fiber optics.

Food Science

Nanofood refers to the food generated by using nanotechnology in processing, production, security, and packaging of food. Nanotechnology has immense potential in the post-harvest food processing. It enhances food bioavailability, taste, texture, and consistency, or conceals the unpleasant taste or odor, and modifies the particle size, size distribution, possible cluster formation, and surface charge. Edible nano-coatings (~ 5 nm thin coatings) can be used in meat, fruits, vegetables, cheese, fast food, bakery goods, and confectionery products, in which they serve as gas and moisture barriers. In addition, they provide flavor, color, enzymes, antioxidants, anti-browning compounds, and a prolonged shelf life to the manufactured products. Zinc oxide nanoparticles can be mixed in plastic packaging to block UV rays and provide anti-bacterial protection; while improving the strength and stability of the plastic film.Nanosensors are being developed that can detect bacteria and other contaminatesat packaging plants. This will allow for frequent testing at a much lower cost than sending samples to a lab for analysis.

Space

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 Nanosensors and Nano robots could improve the performance of spaceships, spacesuits, and the equipment used to explore planets and moons, making nanotechnology an important part space exploration.Employing materials made from carbon nanotubes to reduce the weight of spaceships. Including layers of bio-nano robots in spacesuits, the outer layer of bio-nano robots would respond to damages to the spacesuit, for example to seal up punctures.

Nanotechnology In Fabrics

Making composite fabric with nano-sized particles or fibers allows improvement of fabric properties without a significant increase in weight, thickness, or stiffness as might have been the case with previously-used techniques. For example incorporating nano-whiskers into fabric used to make pants produces a lightweight water and stain repellent material.

Air Pollution

There are two important ways in which nanotechnology is being used to reduce air pollution: catalysts, which are currently in use; and nano-

structured membranes, which are under research and development.

Catalysts can be used to enable a chemical reaction at lower temperatures or make the reaction more effective. Nanotechnology can improve the performance of catalysts used to transform vapors escaping from cars or industries into harmless gases as these catalysts made from nanoparticles have greater surface area to interact with the reacting chemicals than catalysts made from larger particles. The larger surface area allows more chemicals to interact with the catalyst. Nanostructured membranes, on the other hand, are being developed to separate carbon dioxide from industrial plant exhausts.

Researchers demonstrated a method to improve the conversion of carbon dioxide to useful chemicals with nanostructured catalysts by adjusting the flow to concentrate the carbon dioxide close to the surface of the catalyst.

Adverse Effects Of Nanotechnology

Though there are so many advantages with the nanomaterials, there may be some potential risks with them. The large-scale and unrestricted use of NPs has led researchers to consider the problems, challenges and consequences of their environmental impact. To know the adverse effects of them, we have to study the various causes of their production and their behavioral aspects on humans and animals.The potential health and environmental effects of nanoparticles need to be thoroughly evaluated before they are widely commercialized.

Some products containing nanoparticles like cosmetics, coatings, paints etc. can release nanoparticles into the environment in various ways. There are three main ways that nanoparticles enter the environment. The first one is emission during the production of materials like mining operations. The second one is emission during usage like. The third one is emission after disposal of nanoparticle products like nanoparticles in sewage and wastewater streams.

The first emission process results from the production of materials. Studies of metals refinery found that the mining and refining of metals releases a significant amount of nanoparticles into the air. Wind speed can also cause nanoparticles generated in mining to spread further and have increased penetration power. A high wind speed can cause aerosolized particles to penetrate enclosures at a much higher rate than normal particles.

Construction also generates nanoparticles during the manufacture and use of materials. The release of nanomaterials can occur during the evacuation of waste and dust from cleanout operations and filter residuals.

Normal abrasion and deterioration of buildings can also release nanoparticles into the environment on a long-term basis.

Nanotoxicology:

It is the study of the toxicity of nanomaterials.Because of size effects and large surface area to volume ratio, nanomaterials has unique properties that affect their toxicity. Of the possible hazards, inhalation exposure appears to present the most concern, with animal studies showing pulmonary effects such as inflammation, fibrosis, and carcinogenicity for some nanomaterials. Skin contact and ingestion exposure are also a concern.

The extremely small size of the nanomaterials makes them to enter the human body than larger sized particles. The behavior of nanoparticles is a function of their size, shape and surface reactivity with the surrounding tissues. A large number of particles could overload the body's phagocytes, the cells that ingest and destroy foreign matter, thereby triggering stress reactions that lead to inflammation and weaken the body's immune system against other pathogens.

Another concern is their potential interaction or interference with the biological processes inside the body. Because of their large surface area, nanoparticles will, on exposure to tissues and fluids, immediately adsorb onto their surface. This may affect the regulatory mechanisms of enzymes and other proteins.

Nano materials are also able to pass through the biological membranes, cells, tissues and organs that larger-sized particles cannot. Nanomaterials can gain access to the blood stream via inhalation or ingestion. Broken skin may improve skin uptake of nanomaterials. Then, once in the blood stream, nanomaterials can be transported around the body and be taken up by organs and tissues, including the brain, heart, liver, kidneys, spleen and bone marrow.

When nanoparticles enter the soil through agricultural process, atmospheric deposition, rain erosion, surface runoff or other ways, the nanoparticles will accumulate in the soil as time goes because of their weak mobility in the soil. It is also indicated that the concentrations of nanoparticles in the soil are higher than those in water or air, implying that soils might be the main source of nanoparticles released into the environment.

Plants serve as a potential pathway for the transportation of nanoparticles. Through the food chain, nanoparticles can be accumulated in consumers.The Phytotoxic effect of nanoparticles causes reduction in the root length, shoots length and biomass production. It may also cause genetic material damage.In recent years, research in this area has been focused on the interaction between plants and nanoparticles, and the effects of nanoparticles on ecology, the food chain and human health; evaluating the pros and cons of nanoparticles requires interdisciplinary knowledge.

CONCLUSION

In recent times, the rapid advancement in nanotechnology has brought major developments in the areas of the medicine, agriculture, industry, environment, and other sectors. New issues and ideas about nanoparticles require the development of appropriate laboratory methods. Currently, there are several uses of nanoparticles in the environment, including the removal of contaminants from water, sewage, and air. However, apart from the applications of nanoparticles, they can cause some hazards to the environment from their production to their disposal.As a result, environmental risk assessments of nanoparticles during their lifecycles are essential. It is worth noting that the study of the effects of nanoparticles on industrial and non-industrial workplaces also is very important. Also, the measurement of exposures of workers in outdoor workplaces to nanoparticles released from various sources is essential. It is important to gatherinformation on the characteristics of various nanoparticles, especially their toxicological properties. In plants that deal with engineered nanoparticles, safety measures should be considered to minimize the occupational exposure. Also, some guidelines should be established concerning the safe handling and use of nanoparticles in research laboratories. We should ensure that no adverse effects result from the use of nanoparticles while getting benefits from them.

REFERENCES

1) Ranganathan R, Madanmohan S, Kesavan A, Baskar G, Krishnamoorthy YR, Santosham R, Ponraju D, Rayala SK, Venkatraman G (2012). "Nanomedicine: towards development of patient-friendly drug-delivery systems for oncological applications". International Journal of Nanomedicine. 7: 1043–60. doi:10.2147/IJN.S25182. PMC 3292417. PMID 22403487.
2) Patra JK, Das G (September 2018). "Nano based drug delivery systems: recent developments and future prospects". Journal of Nanobiotechnology. 16 (71): 71. doi:10.1186/s12951-018-0392-8. PMC 6145203. PMID 30231877.
3) Waldner, Jean-Baptiste (2007). Nanocomputers and Swarm Intelligence. London: ISTE. p. 26. ISBN 978-1-84704-002-2.
4) Beaumont, Steven P. (September 1996). "III–V Nanoelectronics". Microelectronic Engineering. 32 (1): 283–295. Doi:10.1016/0167-9317(95)00367-3. ISSN 0167-9317.
5) K.W. Powers, S.C. Brown, V.B. Krishna, S.C. Wasdo, B.M. Moudgil, S.M. Roberts, Research strategies for safety evaluation of nanomaterials. Part VI. Characterization of nanoscale particles for toxicological evaluation. Toxicol. Sci. 90, 296–303 (2006)
6) M.V. Dias, N.F.F. de Soares, S.V. Borges, M.M. de Sousa, C.A. Nunes, I.R.N. de Oliveira, E.A.A. Medeiros, Use of allyl isothiocyanate and carbon nanotubes in an antimicrobial film to package shredded, cooked chicken meat. Food Chem. 141, 3160–3166 (2013).
7) Bereznenko, S., Bereznenko, N., Skyba, M., et al. (2020) A novel equipment for making nanocomposites for investigating the antimicrobial properties of nanotextiles. International Journal of Clothing Science and Technology. Vol. Ahead of Print. Available at: https://doi.org/10.1108/IJCST-07-2019-0107
8) Buzea, Cristina; Pacheco, Ivan I.; Robbie, Kevin (December 2007). "Nanomaterials and nanoparticles: sources and toxicity". Biointerphases. 2 (4): MR17–71. arXiv:0801.3280. doi:10.1116/1.2815690. PMID 20419892. S2CID 35457219
9) Oberdörster, Günter; Maynard, Andrew; Donaldson, Ken; Castranova, Vincent; Fitzpatrick, Julie; Ausman, Kevin; Carter, Janet; Karn, Barbara; Kreyling, Wolfgang (October 2005). "Principles for characterizing the potential human health effects from exposure to nanomaterials: elements of a screening strategy". Particle and Fibre Toxicology. 2: 8. doi:10.1186/1743-8977-2-8. PMC 1260029. PMID 16209704
10) Hasanuzzaman M, Mohsin SM, Bhuyan MB, Bhuiyan TF, Anee TI, Masud AA, Nahar K (2020), "Phytotoxicity, environmental and health hazards of herbicides: challenges and ways forward", Agrochemicals Detection, Treatment and Remediation, Elsevier, pp. 55–99, doi:10.1016/b978-0-08-103017-2.00003-9, ISBN 978-0-08-103017-2, S2CID 213066898