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International Journal for Modern Trends in Science and Technology, 7(10): 159-164, 2021

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0710026
Available online at: http://www.ijmtst.com/vol7issue10.html

Impact of Nanotechnology on Environment – A Review

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To Cite this Article
Subhadra Rajpoot. Impact of Nanotechnology on Environment – A Review. *International Journal for Modern Trends in Science and Technology* 2021, *7*, pp. 159-164. https://doi.org/10.46501/IJMTST0710026

Article Info
Received: 16 September 2021; Accepted: 15 October 2021; Published: 20 October 2021

ABSTRACT

The world is facing significant environmental challenges like improving the standard of air, soil, and water. Currently, industry is that specialize in detecting pollutants (from chemical spills, fertilizer and pesticide run-off), improving industrial and mining sites, treating contaminants and stopping further pollution. A potential solution to those problems is to use nanomaterials. Nanomaterials are often wont to assist with cleaning the environment and even provide efficient energy solutions, like nanomaterial based solar cells additionally to the present, nanomaterials help to enhance the standard and performance of the many consumer products. As results of this, the exposure to made nanomaterials is increasing day-by-day. However, there are both positive and negative impacts on the environment thanks to nanotechnology.Recent advances in nanotechnology have shown numerous societal benefits through the event or improvement of smart materials. Several engineered nanomaterials (ENMs) are produced during the last years which will be found in related sectors like health, food, home, automotive, electronics, and computers (Hansen et al., 2016). The estimated output of ENMs produced was up to 270,000 metric tons/year and during this case considering only SiO_2, TiO_2, FeO_x, AlO_x, ZnO, and CeO_2 nanoparticles.

KEYWORDS: Nanotechnology, Nanoparticles, Environmental impacts

INTRODUCTION

Nanotechnology has direct beneficial applications for medicine and the environment, but like all technologies that may have unintended effects that can adversely impact the environment, both within the human body and within the natural ecosystem.While taking advantage of this new technology for health environmental and sustainability benefits, science needs to examine the environmental and health implications.The impact of nanotechnology extends from its medical, ethical, mental,legal, and environmental applications to fields such as engineering, biology, chemistry, computing, material science, military applications, and communications.

Advances in nanotechnology could also be ready to provide more sensitive detection systems for air and water quality monitoring, allowing the simultaneous measurement of multiple parameters in real time response capability. Metal oxide nano catalysts are being developed for the prevention of pollution thanks to industrial emissions and therefore the photocatalytic properties of titanium oxide nanoparticles are often exploited to make self-cleaning surfaces that reduce existing pollution. However, while nanotechnology might provide solutions surely environmental problems, relatively little is understood at the present about the environmental impact of nanoparticles, though in some cases chemical composition, size and shape are shown to contribute to toxicological effects.Nanotechnology can assist resource saving through the utilization of lightweight, high strength materials supported carbon nanotubes and metal oxide frameworks as hydrogen storage materials.Other energy related applications include nanostructured electrode materials for improving the performance of lithium-ion batteries and non-porous silicon and titanium oxide in advanced photovoltaic cells.

It is important to develop an efficient strategy for the recycling and recovery of nano materials and methods are needed to assess whether the potential benefits of nanotechnology outweigh the risks.Lifecycle analyses are going to be a useful gizmo for assessing truth environmental impacts.The potential positive and negative effects of nanotechnology on the environment are discussed.Advances in nanotechnology could also be ready to provide more sensitive detection systems for air and water quality monitoring, allowing the simultaneous measurement of multiple parameters in real time response capability.Metal oxide nano catalysts are being developed for the prevention of pollution thanks to industrial emissions and therefore the photocatalytic properties of titanium oxide nanoparticles are often exploited to make self-cleaning surfaces that reduce existing pollution.

However, while nanotechnology might provide solutions surely environmental problems, relatively little is understood at the president about the environmental impact of nanoparticles, though in some cases chemical composition, size and shape are shown to contribute to toxicological effects.Nanotechnology can assist resource saving through the utilization of lightweight, high strength materials supported carbon nanotubes and metal oxide frameworks as hydrogen storage materials.Other energy related applications include nanostructured electrode materials for improving the performance of lithium-ion batteries and nano porous silicon and titanium oxide in advanced photovoltaic cells.It's important to develop an efficient strategy for the recycling and recovery of nanomaterials and methods are needed to assess whether the potential benefits of nanotechnology outweigh the risks.Lifecycle analyses are going to be a useful gizmo for assessing truth environmental impacts.The to be had facts at the modern makes use of and the manufacturing fee of nanoparticles is inadequate. According to estimates of the manufacturing fee of nanoparticles, approximately 2,000 heaps had been produced in 2004, and it's miles predicted that the manufacturing fee will boom to 58,000 heaps via way of means of 2020. Due to the exponential boom within side the manufacturing and use of nanoparticles, environmental and human exposures will also boom. As a result, their capability for inflicting risky outcomes has come to be a depend of issue for a few researchers (2). In this paper, we speak the conduct of nanoparticles withinside the surroundings and evaluate commercial nanoparticles, the unintended manufacturing of nanoparticles, herbal nanoparticles, and the environmental outcomes of nanoparticles.

DefinitionClassification and Applications of Nanoparticles

Nanotechnology is defined because the science of identification and control of materials with approximate dimensions of 1 to 100 nm that are utilized in new technologies thanks to their unique physical properties (3). Thus, nanoparticles are materials that are but 100 nm in size. These particles could also be spherical, tubular, or irregularly shaped. Nanoparticles are classified into two groups of natural and artificial nanoparticles, and these two groups are divided further into organic and inorganic (mineral) subgroups supported the chemical compositions of the nanoparticles. Fullerenes and carbon nanotubes (CNTs) with geogenic or pyrogenic origin are among the natural nanoparticles. Synthetic nanoparticles could also be produced either inadvertently (due to combustion or as a by-product) or deliberately. Nanoparticles that are produced deliberately using specific processes are called engineered or manufactured nanoparticles, e.g., fullerenes and CNTs. With reference to environmental issues, the present research associated with nanotechnology is concentrated mainly on engineered nanoparticles.

1) Organic Colloids

The colloidal materials in natural waters include particles and macromolecules that home in size from 1 nm to 1 µm. Thus, a number of these particles are nanoparticles. Although human knowledge concerning the structure and environmental impacts of natural colloids has increased significantly in recent years, their exact composition and functions are still unclear.

2) Soot

The processes of natural and artificial combustion that occur in mobile or fixed sources emit particles with a good range of sizes. Of such particles, only the very tiny particles, i.e., the so-called 'ultra-fine' particles are sufficiently small to be classified as nanoparticles. during this paper, all the lampblack particles within the range of nanoparticles are specified by the term "soot." Soot is released into the atmosphere thanks to the unfinished combustion of fossil fuels and renewable fuels, and it gets into water and soil via the precipitation that happens . lampblack , the economic sort of soot, has various uses, e.g., as a filler in rubber compounds, especially in tires. Particles of lampblack are within the nanometer size range, and their mean sizes in several materials vary from 20 to 300 nm.

3) Natural and unintentionally-produced fullerenes and carbon nanotubes

Although fullerenes and carbon nanotubes are considered to be engineered nanoparticles, natural fullerenes and carbon nanotubes also exist within the environment. a number of these fullerenes have an interstellar origin and were delivered to the world by comets and meteorites.

4) Natural and unintentionally-produced inorganic Nanoparticles (NP)

Natural mineral or inorganic nanoparticles can have atmospheric, geological, or biological origins. Mineral nanoparticles exist everywhere within the soil and in geological systems. Aerosols that are present within the atmosphere are also considered to be nanoparticles, and that they are the precursors of the larger particles that strongly influence the worldwide climate, atmospheric chemistry, the field of vision , and global emissions of pollutants. a number of the randomly and unintentionally produced nanoparticles are the platinum and radium particles that are produced within the catalytic converters of cars. Although most of those platinum and radium particles are attached to larger particles, about 17% of them are found among the fine aerosols (diameters but 0.43 µm.

5) Engineered fullerenes and CNTs

Among the fullerenes, buckminsterfullerene (C60) has been studied more extensively than the others, likely because it had been the earliest known member of the fullerene family. Most fullerenes are utilized in polymeric composites, like thin membranes, and in electro-optical devices and biological applications. thanks to the poor solubility of fullerenes in water, much research has been wiped out order to reinforce their usefulness, and various compounds are made up of C60, each of which has its own characteristics and attributes. Carbon nanotubes (CNTs) became an ongoing and controversial topic in physics (9). counting on the synthesis method and therefore the techniques wont to isolate and take away unconventional byproducts, various sorts of carbon nanotubes with different characteristics are obtained

Nanotechnology's environmental impact is often split into two aspects: the potential for nano technological innovations to assist improve the environment and therefore the possibly novel sort of pollution that nanotechnological materials might cause it released into the environment.

Used nanotechnology to

The quantity and heterogeneity of engineered nanomaterials (ENMs) released into the environment during manufacture, use, transport, and disposal are increasing steadily. Therefore, it becomes relevant to guage the potential impact of those ENMs on the environment and human health; particularly, since ENMs could interact with organisms and environmental complex matricesMany benefits of nanotechnology depend upon the very fact that it's possible to tailor the structures of materials had extremely small scales to realize specific properties, thus greatly extending the material science toolkit.Using nanotechnology, materials can effectively be made stronger, lighter, more durable,more reactive, more receive like, or better electrical conductors, among many other traits.Many everyday commercial products are currently on the market and in daily use that believe nanoscale materials and processes:

- Nanoscale additives two or surface treatments of materials can provide lightweight ballistic energy deflection and personal body armor, or can help them resist wrinkling, staining, and bacterial growth.
- Helped clean up past environmental damage
- Correct present environmental problems
- Prevent future environmental impacts surely help sustain the planet for future generations

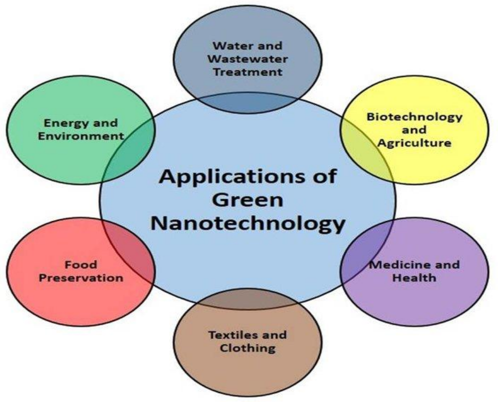

Fig. 17.7 Applications of green nanotechnology

Environmental applications of nanotechnology

A strong influence of nano chemistry on wastewater treatment air purification and energy storage devices is to be expected. Mechanical or chemical methods can be used for effective filtration techniques. One class of filtration techniques is based on the use of membranes with suitable hole sizes, whereby the liquid is pressed through the membrane. Nano porous membranes are suitable for a mechanical filtration with extremely small pores smaller than 10 nm ("nanofiltration") and may be composed of nanotubes. Nanofiltration is mainly used for the removal of ions or the separation of different fluids.

Magnetic nanoparticles offer an effective and reliable method to remove heavy metal contaminants from wastewater by making use of magnetic separation techniques. Using nanoscale particles increases the efficiency to absorb the contaminants and his comparatively inexpensive compared to traditional precipitation and filtration methods. Nanoscale iron particles have also shown potential as a detoxifying agent for cleaning environmental contaminants from brownfield sites.

Potential environmental effects

Nanoparticles have higher surface areas than the bulk materials which can cause more damage to the human body and environment compared to the bulk particles. Therefore, concern for the potential risk to the society due to nanoparticles has attracted national and international attentions. Nanoparticles are not only beneficial to tailor the properties of polymeric composite materials and environment in air pollution monitoring but also to help reduce material consumption and remediation. For example, carbon nanotubes and graphene-based coatings have been developed to reduce the weathering effects on composites used for wind turbines and aircraft. Graphene has been chosen to be a better nanoscale inclusion to reduce the degradation of uv exposure and salt. By using nanotechnology to apply a nanoscale coating on existing materials, the material will last longer and retain the initial strength longer in the presence of salt and uv exposure. Carbon nanotubes have been used to increase the performance of data information system. However, there are few considerations of potential risks need to be considered using nanoparticles:

The major problem of nanomaterials is the nanoparticle analysis method. As nanotechnology improves new and novel nanomaterials are gradually developed. However, the materials vary by shape and size which are important factors in determining the toxicity. Lack of information and methods of characterizing nanomaterials make existing technology extremely difficult to detect the nanoparticles in air for environmental protection.

Also, information of the chemical structure is a critical factor to determine how toxic and nanomaterial is, and minor changes of chemical function group could drastically change its properties. Full risk assessment of the safety on human health and environmental impact need to be evaluated at all stages of nanotechnology. The risk assessment should include the exposure risk and its probability of exposure, toxicological analysis, transport risk, persistence risk, transformation risk and ability to recycle .Life cycle risk assessment is another factor that can be used to predict the environmental impacts. Good experimental design in advance of manufacturing and nanotechnology-based product can reduce the material waste.

Nanoparticles may interact with environment in many ways: It may be attached to a carrier and transported in underground water by bio uptake, contaminants, or organic compounds. Possible aggregation will allow for conventional transportation to sensitive environments where the nanoparticles can break up into colloidal nanoparticles. There are four ways that nanoparticles or nanomaterials can become toxic and harm the surrounding environment

Hydrophobic and hydrophilic nanoparticles: Nano-coating researchers are currently working on TiO2 powder as a coating inclusion that will reduce the weathering effects, such as salt rain degradation on composite materials. Ivana fenogliol, et al expressed their concern that the effect of TiO2 nanoparticles to be assessed when leaked into the environment.

Mobility of contaminants: There are two general methods that nanoparticle can be emitted into atmosphere. Nano particles are emitted into air directly from the source called primary emission and are the main source of the total emissions. However, secondary particles are emitted naturally, such as homogeneous nucleation with ammonia and sulfuric acid presents.

Solubilities: Nanoparticles are invented and developed in advance of the toxic assessment by scientists. Many of the nanoparticles are soluble in water and are hard to separate from waste if inappropriately handled.

Disposals: Any waste product, including nanomaterials, can cause environmental concerns/ problems if disposed inappropriately.

Positive effects on environment

Nanotechnology offers potential economic, societal and environment benefits. Nanotechnology also has the potential to help reduce the human footprint on the environment by providing solutions for energy consumption, pollution, and green gas emissions. Nanotechnology offers the potential for significant environmental benefits, including:

- Cleaner, more efficient industrial processes.
- Improved abilities to detect and eliminate pollution by improving air, water, and soil quality.
- High precision manufacturing by reducing amount of waste.
- Clean abundant power viaduct more efficient solar cells.
- Removal of greenhouse gases and other pollutants from the atmosphere.
- Decreased needs for large industrial plants.
- Remediating environmental damages.

Negative effects on environment

Understanding of the environmental effects and risks associated with nanotechnology is very limited and inconsistent. The potential environmental harm through nanotechnology can be summarized as follows:

- High energy requirements for synthesizing nanoparticles causing high energy demand.
- Dissemination of toxic, persistent nano substances originating environmental harm.
- Lower recovery and recycling rates.
- Environmental implications of other lifecycle stages also not clear.
- Lacks trained engineers and workers causing further concerns.

Formations, emission, occurrence in faith of nanoparticles (np) in the environment

Assessing the risks imposed using nanomaterials in commercial products and environmental applications requires a better understanding of their mobility, bioavailability, and toxicity. For nanomaterials to comprise a risk, there must be both a potential for exposure and a hazard that results after exposure. Release of np may come from point sources such as production facilities, landfills, or wastewater treatment plants or from nonpoint sources such as where from materials containing np. Accidental release during production or transport is also possible in addition to the unintentional release there are also np released intentionally into the environment nzvi, for example is directly injected into groundwater polluted with chlorinated solvents. Whether the particles are released directly into water slash soil or the atmosphere they all end up in soil or water, either directly or indirectly for instance, via sewage treatment plants waste handling or aerial deposition. In the environment the formation of aggregates and therefore of larger particles that are trapped or eliminated through sedimentation effects the concentrations of free np. Humans can be either directly influenced by np through exposure to air, soil, or water or indirectly by consuming plants or animals which have accumulated np. Aggregated or adsorbed np will be less mobile, but uptake by sediment dwelling animals or filter feeders is still possible.

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