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ENVIRONMENTAL NANOTECHNOLOGY AND ITS FUTURE

[1]Neleeshiya doray

[1]Undergraduate

[1]Department of environmental technology ,

[1]University of colombo, Colombo, Sri lanka

Abstract : This study has been undertaken to investigate the Environmental nanotechnology is a rapidly growing field that uses the unique properties of nanomaterials to address environmental challenges. Nanomaterials are materials that have at least one dimension in the nanoscale (1-100 nanometers). This size range gives them a number of properties that make them well-suited for environmental applications, such as their large surface area, their ability to interact with biological systems, and their unique optical and electrical properties.

There are a number of potential applications of environmental nanotechnology, including:

Water purification: Nanoparticles can be used to filter out pollutants, remove bacteria, and even break down viruses from water.

Air purification: Nanoparticles can be used to capture and remove pollutants from the air, such as particulate matter, volatile organic compounds, and even greenhouse gases.

Energy conservation: Nanoparticles can be used to create more efficient energy-saving devices.

Waste management: Nanoparticles can be used to break down organic waste, remove toxins from hazardous waste, and even recycle materials that were previously considered to be waste.

Environmental monitoring: Nanoparticles can be used to create sensors that can detect pollutants at very low levels.

The future of environmental nanotechnology is very promising. With continued research and development, we can expect to see this technology make a major positive impact on the environment in the years to come.

IndexTerms **-nanotechnology, pollution prevention, source reduction,field emission display, polymer supported ultra filtration.**

I. INTRODUCTION

INTRODUCTION

Using materials and structures with nanoscale dimensions, which typically range from 1 to 100 nanometers, is referred to as nanotechnology. Without releasing it, it's possible that we currently use nanotechnology on a regular basis. For instance, proteinaceous molecules work as "molecular motors" to propel everything from flagellar motion to muscular flexion in living animals like bacteria, beetles, and humans. To enhance the mechanical qualities of tires, start the formation of photographic films, and act as critical catalysts in the petrochemical industry, nanometer-sized particles have been produced.

Environmental engineers and scientists are already utilizing nanoscale structures to some extent. Nanoscale colloids, which include the dispersion of nanosized particles in media with special properties, are produced naturally by the weathering of materials such as iron oxides and silicates and by microorganisms such as bacteria and algae. These colloids may play a role in the fate, transport, transformation, and bioavailability of environmentally harmful substances.

The environment frequently contains anthropogenic and natural colloids of solids, liquids, and gases in liquids as well as solids and liquids in gases. Nanotechnology does not, however, only concern itself with tiny objects. Structure and the capacity to work-observe, control, and construct at the atomic or molecular level are more crucial considerations. Due to their size and structure, these materials and systems frequently display novel and drastically altered physical, chemical, and biological properties.

Nanoparticles or nanocrystals, nanolayers, and nanotubes make up the fundamental building blocks of nanotechnology. These nanostructures differ in their construction and the arrangement of their atoms and molecules. The most fundamental structure in nanotechnology is a nanoparticle, which is a cluster of tens to thousands of atoms with an aggregate diameter of roughly 1-100 nm. These nanoparticles are made atom by atom, so experimental conditions govern their size and shape.

These particles are also known as nanocrystals because the atoms they contain are highly organized or crystalline.

Hydrogen bonding, dipolar forces, hydrophilic or hydrophobic contacts, gravity, and other forces frequently cause nanostructures to be structured or self-assemble into highly ordered layers. Because of this self-assembly, many naturally occurring biological structures, including membranes, vesicles, and DNA, are created. Many applications of nanotechnology, including photonics, catalysts, and membranes require repeating structures with specific periodicities. The core of the development of nanotechnology is understanding and self-assembling nanostructures. unique mechanical, electrical, and chemical properties of nanostructures known as carbon nanotubes. Carbon atoms are typically organized in spiral lattices in the shape of hexagons to make nanotubes. The tubes are virtually flawless crystals and are considerably thinner than graphite whiskers.

NEED OF THE STUDY.

The establishment to develop new ways to cleanup pollution . nanomaterials can be used to absorb , filter , or break down pollutants in water, air and soil. this could help to clean up existing pollution and prevent new pollution from being released into the environment . in short, environmental nanotechnology has the potential to make a significant positive impact on the environment. by studying this field , we can develop new technologies that can help us to clean up pollution , create more sustainable manufacturing process , generate clean energy , and improve our understanding on environmental process . we can create more sustainable manufacturing processes . nanomaterials can be used to create new materials and products that are more energy - efficient and less polluting to produce . this could help to reduce our overall environmental impact , nanomaterial can be used to create more efficient solar cells ,fuel cells , and other renewable energy technologies . this could help us to reduce our reliance on fossil fuels and combat climate change , and also create new sensors and tools that can help us to better understand how pollutants interact with the environment . this could help us to develop more effective ways to manage pollution and protect our natural resources .

3.1 Preventing pollution

Pollution prevention refers to "source reduction" and other techniques that effectively employ resources like raw materials, energy, and water to minimize or stop the production of trash. Additionally, this strategy calls for the creation of more ecologically friendly manufactured goods as well as the use of less harmful and renewable reagents and processing materials, whenever possible. Technologies for preventing pollution may benefit greatly from nanotechnology. For instance, home lighting powered by nanotechnology might save energy use by as much as 10%. For instance, nanostructured catalysts can increase the selectivity for desired reaction products, increasing the e ciency of chemical synthesis. Zeolites, which are porous crystalline solids with clearly defined structures and are frequently employed for separation and catalysis, are one example.

Zeolites with nanostructures are more environmentally friendly for two reasons. First, visible light triggers the oxidation reaction, which lowers energy usage. Second, accessing low-energy reaction pathways through the use of visible light helps reduce wasteful secondary photoreactions and increases the yield of the targeted product.

An environmentally friendly method of producing microelectronics is the assembly of nanostructures using biopolymers or materials with a biological theme. Recent estimates show that to create a single 2 gram, 32 megabyte microprocessor, 1.7 kg of fossil fuel and chemicals, together with 32 kg of water, are needed. Biomolecular nanolithography is a bottom-up strategy that seeks to replace the current processes for making semiconductor chips. At room temperature, lines and grids are formed by stretching out nanoscale metal particles on a biopolymer template or scaffold into well-defined chip structures. The fabrication of these structures uses biodegradable materials like poly lysine.

The use of nanotechnology could also aid in producing safe materials to replace the harmful ones currently in use. For instance, computer monitors built of nontoxic, energy-e cient cathode ray tubes are replacing those made of those, which contain numerous harmful elements. Compared to cathode ray tube computer monitors, newer liquid crystalline displays are smaller, don't contain lead, and use less power.

By getting rid of dangerous heavy metals and substantially reducing the amount of material and energy needed, using carbon nanotubes in computer screens may further reduce environmental effects while yet meeting customer demand for improved performance.

3.2 Treatment and remediation

The early effect of nanotechnology research was mostly on cleanup and end-of-pipe treatment systems. Several publications have arisen on the usage of various micro particles for the treatment and remediation of contaminants in the environment. Nanoparticles containing various oxidants, reductants, and nutrients, for example, have been proposed as effective for encouraging pollutant transformation and boosting microbial growth because their tiny size and larger surface area make them more reactive and adaptable in terms of deployment.

Because of their peculiar crystal structures and lattice organization, nanoparticles can also exhibit chemical reactivity not seen in bigger particles. Conventional approaches for in situ remediation of chlorinated organic solvents, such as trichlorethylene, yield unwanted byproducts such as dichloro-ethylene and vinyl chloride. Using nanoscale bimetallic particles effectively eliminates any unwanted byproducts. Light-activated nanoparticles, such as the large band gap semiconductors titanium dioxide and zinc oxide, are still being researched for their potential to remove organic pollutants from diverse media. These particles are widely available, affordable, and have a low toxicity. Recently, zinc oxide nanoparticles were demonstrated to work as both a sensor and a photocatalyst in the remediation of chlorinated phenols.

Because UV light represents only 5% of the solar spectrum, I am very interested in manipulating the surface of nanoparticles with organic or inorganic dyes to extend their photoresponse from UV to visible light, making them even more effcient as photocatalyst for the transformation of environmental contaminants.

Nanoparticles could also provide a lot of flexibility for in-situ cleanup. Nanoparticles, for example, are easily deployed in ex situ slurry reactors for treating contaminated soils, sediments, and solid wastes. They can also be anchored to a solid matrix such as carbon, zeolites, or membrane to improve the treatment of water, wastewater, or gaseous process streams.Direct subsurface injection of nanoscale iron particles has already been proven to effectively convert chlorinated organics, trichloroethylene, to environmentally benign chemicals, whether under gravity feed or pressurized conditions. The method also has a lot of potential for immobilizing heavy metals and radionuclides. Nanoscale bimetallic particles, such as iron/palladium or zinc/palladium, have been shown in studies to be effective reductants and catalysts for a wide range of typical environmental pollutants, including PCBs, organochlorine insecticides, and halogenated organic solvents.

Almost all chlorinated hydrocarbons were reduced by nanoscale metallic particles. Furthermore, there is considerable evidence that iron-based nanoparticles can be utilized to remove many other stubborn pollutants, such as anions, heavy metals, and radionuclides. Nanotubes have been proposed. As a superior dioxin sorbent. Dioxin sorption energy on carbon nanotubes is nearly three times that of activated carbon. The promise of employing carbon nanotubes to manage air and water pollution appears to be very promising, however large-scale nanotube uses in the near future are limited by cost and availability.

Another example of a nanomaterials-related use in environmental treatment and remediation is the use of dendritic nanoscale chelating agents for polymer-supported ultrafiltration. Dendrimers are highly branched polymers with a specified composition and a nanoscale architecture. Metal ions and zero valent metals can be encapsulated in these nanostructures, allowing them to dissolve in appropriate fluids or bind to appropriate surfaces. This method may offer a way to create a functional, cost-effective, and environmentally sound material for polymer-supported ultrafiltration, depending on the compound.

3.3 Nanotechnology pitfalls

Nanotechnology is a revolutionary scientific and engineering endeavor that will undoubtedly have an impact on the present infrastructure of consumer goods, production procedures, and material utilization. Not unexpectedly, the prospective benefits of nanotechnology have dominated scientific and mainstream media coverage. However, every technology can be a double-edged sword. Concerns concerning nanotechnology's environmental and safety implications have just lately been raised in the mainstream media.

Some precursors of nanotechnology-related contamination are already visible: As millions of computers and cell phones are discarded each year, poisonous gallium arsenide used in microchips reaches landfills in increasing proportions. The nature of nanomaterials themselves, the features of the goods made from them, or aspects of the manufacturing process involved may all have potentially harmfull impacts.

Some nanoparticles' large surface area, crystalline structure, and reactivity, for example, may facilitate the transport of toxic materials in the environment, whereas the size and chemical composition of nanostructures may cause biological harm due to the way they interact with cellular materials. Can nanostructures, for example, proliferate in the environment if they can self-assemble in the laboratory? If so, what will become of those nanostructures, as well as their environmental and health consequences?

II. Acknowledgment

I acknowledge the significant potential of environment nanotechnology to address some of the most pressing environmental challenges of our time . nanotechnology has the potential to revolutionize environmental remediation , pollution control and resource recovery . in the future , I believe that environmental nanotechnology will play an increasingly important role in protecting out planet . nanosensors will be used to detect pollutants at the molecular level , and nanoremediators will be used to develop new energy sources and to improve the efficiency of our water and waste treatment systems . I am excited to see how environmental nanotechnology will shape the future of our planet . I believe that it has the potential to make a real difference in the fight against environmental degradation .

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