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Nanotechnology in Environment: Water purification

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Abstract:

Nanotechnology is a diverse technology, with a potential to change the world as we know it today. It is the study of controlling and manipulating matter on an atomic or molecular scale. It deals with structures the size of 100 nanometers or smaller in at least one dimension. Now a day's nanotechnology and its various applications in environment become revolutionary approaches to pollution control, water purification and environmental monitoring .This article explores the innovative applications of nanotechnology in purification of water for a sustainable environment.

I. INTRODUCTION

Nanotechnology refers to the branch of science and engineering devoted to designing, producing and using structures, devices and systems by manipulating atoms and molecules at nanoscale.Nanotechnology offers promising solutions for sustainability in various environmental sectors.It can enhance water purification, air filtration and soil remediation process.Nano materials can also improve energy efficiency and storage as well as enable the development of more light weight and durable materials for construction and transportation, reducing environmental impacts. However careful consideration of potential risk and ethical implications is crucial in its applications .

II. NANOTECHNOLOGY IN ENVIRONMENT

The manipulation of matter at the nanoscale, holds immense promise for addressing pressing environmental challenges. By leveraging nonmaterial and nanodevices, scientist are revolutionizing approaches to pollution control, water purification and environmental monitoring in safe guarding our environment and fostering sustainability.

A. Nanotechnology in Water Purification

Access to clean water is a fundamental human right, yet many communities worldwide face water scarcity and contamination. Nanotechnology offers novel solutions through advanced filtration membranes and nanocomposite materials. Nanoparticles like carbon nanotubes and grapheme oxide exhibit exceptional filtration properties, effectively removing contaminants such as heavy metals, pathogens and pollutants from water sources.

B. Nanotechnology in Pollution Remediation

Industrial activities often result in soil and air pollution, threatening ecosystems and public health.Nanoparticle based adsorbents and nanostructured materials can selectively capture and immobilize pollutants, facilitating their removal from soil and ground water.

C. Nanotechnology in Environmental Monitoring and Sensing

Timely and accurate detection of environmental contaminants is essential for effective management and mitigation strategies. Nanotechnology enabled sensors offer high sensitivity and selectivity for monitoring pollutants in air, water and soil. Moreover, nanoscale sensors integrated into remote monitoring systems provide comprehensive environmental data, supporting informed decision-making and proactive intervention measures.

D. Nanotechnology in Energy production and storage

Nanotechnology plays a crucial role in developing efficient and sustainable energy technologies. Nanomaterials are used in solar cells to increase efficiency , in batteries for improved energy storage , and in catalytic converters to reduce emissions from vehicles.

III. WATER PURIFICATION

Nanotechnology has revolutionized water purification methods by offering efficient and cost-effective solutions. Technology used in water purification.

E. Nano filtration membranes

Nanomaterial-based membranes with nano pores are used to filter out contaminants including bacteria, viruses, heavy metals, and organic pollutants, from water. Nano filtration is a membrane filtration process that uses nanometer sized pores through which particles smaller than about 1–10 nanometers pass through the membrane. Nano filtration membranes have pore sizes of about 1–10 nanometres, smaller than those used in microfiltration and ultra filtration, but a slightly bigger than those in reverse osmosis. Membranes used are predominantly polymer thin films it is used to soften, disinfect, and remove impurities from water, and to purify or separate chemicals such as pharmaceuticals, as shown in Fig1.

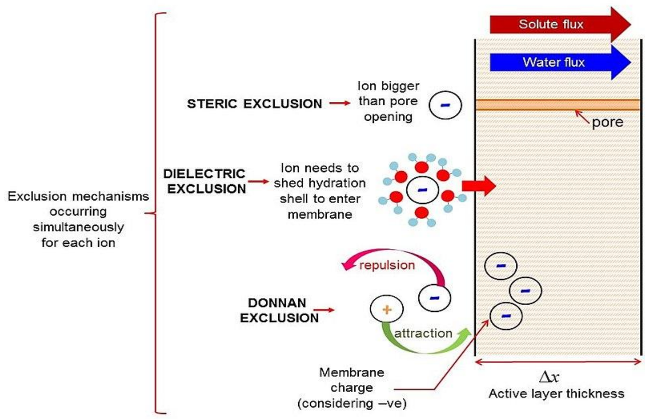

Fig 1: nano filtration methods

F. Nano particle based adsorbents

Nanotechnology is used in absorbing nano metals and nonmetal oxides, effective photocatalysis, membranes for filtering and hindering microbial growth, and disinfection. Nanotechnology enables us to make water purification with a low-cost approach to the popular RO membranes, especially for longer cycles of reuse and desalination. TFN membranes, Zeolite-coated ceramics, Carbon-based materials, Metal-Based Nano absorbents, Hybrid protein-polymer biomimetic membranes, Polymeric Nano absorbents, Nanofiber membranes, TiO2 Nanoparticles, Ag Nanoparticles, ZnO nanoparticles, Magnet based have made their contributions to the purification

TABLE I: Available nanomaterial and their effectiveness in the specific area

Nanomaterial	Effective in removing/ treating
Ag/TiO2 nano filter membrane	Bacteria
Alumoxane derived Alumina membrane	dye
Alumina membranes derived from polystyrene sulfonate	Cations with divalent nature
Amino acid homopolymers derived silica membranes	Metals
Polymeric or alumina membranes with Au nanoparticles	4- Nitrophenol
Titanium oxide filters	PAHs
TiO2/ Al2O3 compositive membranes	Direct black 168 dye
TiO2 nanophotocatylicnano membrane	Methyl orange, azo dye
Silicon carbon filters	Trihalogenmethanes, PHAs
Nanocrystalline zeolites	Tolerance, nitrogen dioxide
Synthetic zeolite	Humic acid
Graphitized CNT	1,2 Dichlorobenzene
CeO2-CNTs	Metal ions
CNT	p- Nitro-phenol
Polyethyleneimine with Carbon NPs	Metals
CNT hydride	arsenate
CNT sheets	Metal ions
CNT/Fe	Toluene, Benzene, dimethyl
MWCNTs and SWCNTs	Roxarsone, Trihalomethanes
Mesoporous aluminosilicate spheres with nanosized Fe3O4	mercury
Silica coated Fe3O4	Metal ions
Humic acid/Fe4O3	Metal

- Zeolite-based nanomaterials
- Inorganic–organic TFN [Thin Film Nano] membranes.
- Carbon nano tubes (CNT).
- Graphene
- Metal-based nano absorbents
- Polymeric biomimetic hybrid protein membranes.

- Polymeric nano absorbents.
- Nanofiber membranes.
- TiO2 Nanoparticles
- Ag nanoparticles.
- ZnO nanoparticles.
- 2D nanoparticles

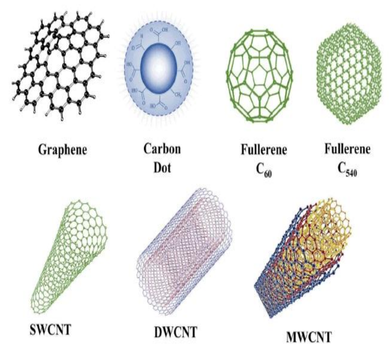

Figure 2: Types of organic nanoparticles [2].

G. Photcatalysis

In photo-catalysis, a photo catalyst is used. Reaction rate mainly depends on the crystal structure of catalyst and the energy of incoming photons of visible or UV light. As a catalyst which materials are used, they acts as a sensitizer for the irradiation of light-stimulated redox processes depending on their electronic structure. Electronic structure is described by the filled valence and vacant conduction band. If the band gap of the catalyst is equivalent or less than the energy of incident light, the electrons residing in valence band will absorb the photon and they will reach to the conduction band. Holes are left in valence band. They play the key role, Donor molecules are oxidized by these holes, also the hydroxyl (strong oxidizer) is produced when H_2O react with these holes. Electron present in conduction band is absorbed by water to make superoxide ion, which is a reducing agent. So we can say that, this free electron is causing redox reactions to occur. These pairs of free electrons and holes can perform oxidation reduction reaction with any material which comes in contact with the catalyst and convert it into the desired products.

H. Nano sensors for water quality monitoring

Water quality sensors are essential for ensuring availability and accessibility for quality water for human activities ranging from drinking to agricultural and industrial purposes. The sensors can be located at the point of use, at the water treatment facilities, or within the water distribution system. The information from Nanosensors are sensing devices that utilize nanomaterials as recognition elements to detect changes. In recent years, nanomaterials-based sensors have gained popularity. They provide high sensitivity, specificity, a large surface area to volume ratio, quantum confinement effects, rapid detection, and tunable magnetic, electrical, and optical properties. *They have wide applications in detecting toxic gases, food packaging, healthcare diagnostics, and water quality monitoring*

I. Links and Bookmarks

https://www.sciencedirect.com/science/article/abs/pii/B978032390763700010X

www.sciencedirect.com

Nanosensors for water quality monitoring | Nature Nanotechnology www.nature.com

https://biointerfaceresearch.com/wp-content/uploads/2021/10/20695837125.58215835.pdfbiointerfaceresearch.com

IV. CONCLUSIONS

The conclusion for nanotechnology in water purification is that it offers promising solutions to address water contamination challenges. Nanomaterials have shown great potential in removing pollutants and improving water quality due to their unique properties such as high surface area and reactivity. However furtherresearch is needed to address concerns regarding the potential environmental and health impacts of nanomaterials, as well as to develop scalable and cost effective nanotechnology based water purification technology for wide spread implementation. Overall, nanotechnology holds great promise for enhancing water purification processes and ensuring access to clean water for all.

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REFERENCES

1. *Nanoscience Nanotechnology ,B S Murty P Shankar Baldev Raj B B Rath James Murday Professor, Indian Institute of Technology Madras,*
2. *Wiki pedia: www.wikipedia.org*
3. www.sciencedirect.com
4. Nanosensors for water quality monitoring | Nature Nanotechnology www.nature.com