

# NANOTECHNOLOGY AN APPROACH IN “ENVIRONMENTAL REMEDIATION”

## Abstract

Nanotechnology is widely used in many forms. The recent advancement in nanotechnology is its use in environmental remediation. Different types of pollutant are causing harm to environment and to minimize them nanoremediation can be done using variety of metal, carbon, polymer, silica based. This chapter deals with the major source of environmental pollution and their cure through the route of nanotechnology.

**Keywords:** Nanoparticles;  
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## I. INTRODUCTION

Deterioration of the environment without a question is one of the largest problems that society is now facing. Contaminated water, soil, and air pose serious threats to both the ecosystem and public health [1]. Just a few of the numerous alarming pollutants include pesticides, herbicides, fertilizers, heavy metals, pesticides, herbicides, oil spills, toxic gases, industrial effluents, sewage, and organic compounds [2,3]. Traditional methods like, and developing technologies like Pump-and-treat, oxidation by chemical, and treatment with heat "nano remediation" are among the developed remediation strategies [4,5]. Engineered nanomaterials are used in nano remediation, which is less expensive and more efficient than the majority of conventional approaches.

Nanotechnology has garnered a lot of interest nowadays because of the unique physical properties of materials at the nanoscale. Due to their larger surface-to-volume ratios compared to their bulkier counterparts, nanomaterials exhibit improved reactivity and consequently superior efficacy. Additionally, nanomaterials can make advantage of specific surface chemistry in comparison to conventional approaches, enabling them to be modified or coated with functional groups that can specifically target desired pollutant compounds. Moreover, the purposeful modification of the nanoparticles' physical traits (such as size, shape, porosity, and chemical composition) may impart additional advantageous properties that directly impact the efficiency of the substance for pollution cleanup [6,7].

The properties of the nanostructure, as well as how affordable they are, determine interest in employing nanomaterials for environmental cleanup. According to Corsi et al. (2018) [8], nanoparticles offer excellent electrical properties, sensitivity, high surface-to-mass ratio, and catalytic activity. The two main methods for NP cleanup can be characterized as catalysis and chemical reduction. Furthermore, Nanoparticles have been employed in adsorption-based removal methods because of their extensive surface area, random distribution of active sites, and variety of coating modification choices [9]. Additionally, NPs can spread in restricted areas, boosting their usage in water and soil cleanup. Because the membrane holes can contain significant components in water waste water, nanomaterial-based membranes have also been used in water nanofiltration. In addition, selective elimination of the less significant molecules occurs upon contact with the membrane. Among the nanomaterials used to clean up polluted water, soil, and air are oxides of metal, carbon nanotubes, quantum dot particles, and bio polymers. Since different materials may be used in environmental rehabilitation, a broad range of strategies can be used to achieve this goal. Given that the complex combination of various chemicals, high volatility, and low reactivity of environmental contaminants can make it challenging to collect and degrade them, recent research have focused on the use of nanomaterials for the development of innovative environmental remediation methods [10].

## II. DIFFERENT POLLUTANT TYPES

Particles that pollute the environment are referred to as pollutants. Life may be harmed by exposure to these toxins, and the effects on people and other living things are well known. There are several routes for pollutants to enter the environment, natural processes as well as human action both [11].

- 1. Dyes:** A family of synthetic organic compounds called dye is used in a variety of industries including the textile industry. As a result, they frequently cause industrial environmental contamination both during their production and afterward while coloring fabrics [12]. Synthetic colors in textile effluent reduce river light penetration, changing aquatic vegetation's ability to photosynthesize and as a consequence, the aquatic life's supply of nourishment. The thin layer of emitted dyes that may build up on the surface of the receiving waters dramatically reduces the amount of dissolved oxygen, which is harmful to aquatic life.
- 2. Heavy Metals:** Heavy metals are characterized as such due to their substantial densities or high gram atomic weights. Heavy metals are now used to describe hazardous artificial metallic atoms, molecules, and the metalloids that are harmful to both humans and the natural environment [13]. Heavy metal pollution is an issue that is getting worse and a source of concern because of the negative impact it is having on individuals throughout the globe [14]. These are inorganic pollutants which are being dumped in our rivers, soil, and atmosphere as a result of fast-expanding agriculture and metallurgical sectors, improper waste management, fertilizers, and pesticides.
- 3. Pesticides:** Since many years ago, chemicals like pesticide were used. in agriculture to defend plants animals that protect against insect infestations to maintain productivity. Pesticides are compounds used to get rid of unwanted organisms in gardens, farms, and other public areas. Pesticides may endanger the environment, every living thing, and food safety despite being widely used [15]. The World Health Organization (WHO) surveyed to determine the number of persons who are critically exposed to pesticides and were poisoned. Many organic micro pollutants that have detrimental impacts on the environment are caused by pesticides. The two main pollution mechanisms are bio-concentration and bio-magnification [16].
- 4. Hydrocarbons with Multiple Aromas:** Due to its toxin, mutagenic, and carcinogenic potential, poly aromatic hydrocarbons constitute a type of persistent and widespread environmental pollutants that are also harmful to people. Both the demand for and the emissions from petroleum products have grown. Coal and fire wood are two examples of biological materials that may burn without oxygen [17]. Poly aromatic has high thermal stability and breakdown resistance. The melting and boiling temperatures of these aromatic molecules are quite high. Normal water solubility of lower molecular weight hydrocarbons with polyaromatic properties decreases with each additional ring, making them more hydrophobic and aqueous insoluble [18].

### III. NANOREMEDIATION

- 1. Nanomaterials Based On Metal:** In spite of their strong reactivity, photolytic capabilities, adsorbent qualities resulting from their extensive surface area and affinities to various groups of chemicals, several types of water filtration systems employ nanoparticles made of metal oxide such as iron oxide, zinc oxide, and titanium dioxide [19]. The nanoparticles of iron have been utilized to neutralize colors in wastewater from the textile, paint, and paper industries because of their potent adsorption power and consistency in suspended media. Methylene blue and methyl orange, two of the most frequently used industrial dyes and those with the greatest effects on the environment and

human health, have recently been shown to be extremely effective in being adsorbed by these NPs.

At the nanoscale, a nano zero valent iron (nZVI) is an electron donor with a negative reduction capacity. Sequestration is advantageous because it allows for the oxidation and reduction change of pesticides, chlorine organic solvents, and poly chlorinated biphenyls [20] , One of the substances most frequently employed in pilot research is nZVI [21]. Trichloroethene, chromium hexavalent, nitrates cadmium, lead, and DDT cleanup have all been successfully treated with high cleaning percentages of nZVI [7].

- 2. Nanomaterials Based On Carbon:** A few examples of nanoporous materials made from carbon that demonstrate physical and chemical characteristics which make them suitable for water purification procedures to remove impurities like toxic heavy metals, fluorides, textile dyes, or pharmaceutical products include activated carbons, carbon nanotubes , which includes multi-walled and single-walled nanotubes, graphene, and its oxide. For instance, Mpouras et al. evaluated the hexavalent chromium adsorption by multi-walled and single-walled nanotubes in contamination of groundwater in their research from 2021 [22].

Carbonaceous nanoparticles are distinctive due to the fact they possess a substantial surface area, an elevated degree of microporosity, excellent sorption characteristics, and an environmentally friendly constitution. In different configurations, graphene, fullerene C540, MWCNTs (multi walled carbon nanotubes), fullerene C60, SWCNTs and activated carbon nanoparticles are all utilized [23].

Activating or functioning of nanomaterials made from carbon also has extra benefits, which are similar in other remediation applications. CNTs (carbon nanotubes) have currently risen in favor since they possess an improved capacity for adsorption than granular activated carbon, graphene oxides, and graphene [24]. The field of nanotechnology has advantages that decrease pollution in the air, including cleanup and therapy, avoiding pollution, evaluation, and detecting. By managing the temperature of the reaction with the addition of water, it is feasible to regulate the amount of functional groups that contain oxygen on the outermost layer of graphite oxide during the process [25]. This material has been used to create ammonia gas detectors that function at varied temperatures. Nanocomposites, which combine many features into a single new material, may be created using carbon-based nanomaterials in addition to other types of nanomaterials [26].

- 3. Nanomaterials Based On Polymers:** The use of nanoparticles, nanocomposites, or NF membranes, among other polymer nanotechnology-based options, might be used to purify water [27]. More specifically, polymeric tiny membranes are used for filtering out undesirable nano particle from the watery stage by capturing tiny particles within the membrane's apertures and by chemically interacting with the pollutants and immobilizing them. In this scenario, chitosan is a frequently used polymer for the uncomplicated solvent-based casting manufacturing facilities of NF filters. The aforementioned membranes are an innovation for washing textile debris and repel electroneutral and negative-charged colors more quickly than those with positively charged dye [28].

Polyethersulfone membrane customized with grapheme, MWCNTs, or other polymers have illustrated remarkable heavy metal and dye resistance in environments containing water.

- 4. Silica-Based Materials:** Silica-based nanoparticles possess a substantial surface area, adaptable size of pores, and easily adjustable surfaces, to name only a few among the multiple beneficial characteristics which render them extremely adaptable [29]. Further, because of these nanostructures' tendency for catalytic processes and the adsorption there has been an increase in attention over the past few years for the elimination of harmful substances from the gaseous phase and the purification of polluted air [9]. Silica nanoparticles may have their physical and chemical characteristics upgraded through surface alteration.

#### IV. CONCLUSION

Environment is major source of our livelihood and destruction in it cause threat for all organism that live in it .Disturbances in environment is caused by human's over exploitation. Various process are done to protect these environment from contamination include nanoremediation. There are many types that are responsible for environmental remediation i.e, Inorganic, organic, polymeric nanoparticles etc. selection of nanoparticles depend on particular pollutant and their efficiency on remediation is important for these full analysis of type of contamination and their site is required. A variety of investigation is done to use nanoparticles for application in environment remediation.

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