Mini Review
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Applications of nanomaterials for health and environment protection

Abstract

Nanomaterials have been reported to be useful for synthesizing several kinds of nanomaterials which show diverse advantages. The remarkable developments in nanotechnology and the crucial need to develop robust, economic, and green approaches for ecological conservation, this review highlights the promising applications of nanomaterial and provides a comprehensive view on benefits of nanotechnology regarding the healthcare and environmental safety systems. The concentration on nanotechnology in public debates has increased over the last few decades. Nanotechnology is found to be one of the crucial future knowledge. The current study concentrates on the applications of nanotechnology in ecological safety, particularly in the air and water sectors.

Keywords: nanomaterials, nanotechnology, ecological conservation, healthcare

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Introduction

Nanotechnology is one of the most auspicious techniques for revolutionizing the environmental remediation that can be defined as a collection of emergent advancements which work on the scale of nanometer (specifically, within the range of 1 to 100 nm) to produce devices, systems, and materials with primarily new functions and properties by controlling the shape and the size of matter.[1] The worldwide momentum of nanotechnology because of its promising applications which are encompassing several fields such as energy,[2] medicine, and treatment of pollution that is offering leaping predictions in the transformation and improvement of conservative remediation approaches[3] Air ution. Diverse developments comprising deposition precipitation (DP), photocatalytic deposition (PD), chemical vapor decomposition (CVD), wet chemical method, chemical solution decomposition (CSD), hydrothermal processes, thermal procedures, sol–gel, and ultrasonic irradiation.[4]

Nanomaterials have been reported to be useful for synthesizing several kinds of nanomaterials which show exclusive merits diverse from that of their huge equivalents.[5] The extraordinary characteristics for example thermal, mechanical, optical, electromagnetic, morphological, and structural features offer the nanomaterials with beneficial sorts for a lot of applications where they can be employed as nanoadsorbents, nanomembrane, disinfectants, and nanosensors.[6] Moreover, several attempts were published to manufacture more refined nanostructure (such as, nanorods, nanowires, nanobelts, and nanofibers) with the purpose of increasing the adaptability of nanomaterials and to overcome all the problems which obstruct their applications.[7] The nanotechnology research solutions, developments and products which are available already have been explained as follows (Figure 1):

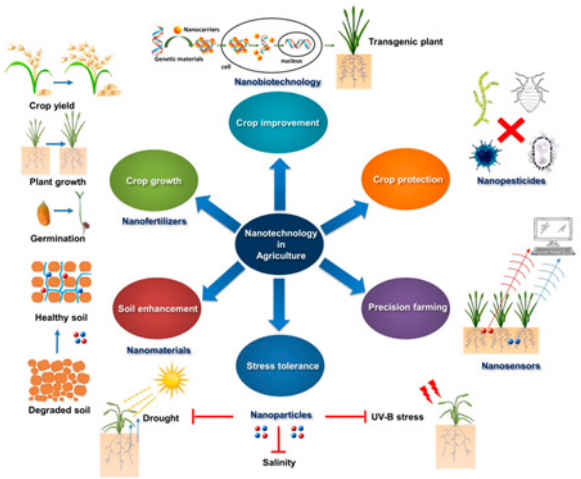

Figure 1 Application of nanomaterials in healthcare and ecosystem safety.

Water sector

Nanotechnology is functional for the treatment of waste water and drinking water along with the remediation of groundwater. Moreover many of the following techniques for commercialized applications and products are also under developing or in the testing phases.[8]

Separation or Filtration

Nanomembranes are one of the finest states of the art technologies. Since the membrane material substances of inorganic ceramics and organic polymers are useful for water treatment.[9] The Nano filtration applications have been working effectively such as in the treatment of

drinking water, food industry in addition to in the dyestuff and textile industries.[10] A higher potential for nanotechnology is predictable in the sectors of seawater purification.[11]

Surface treatment

Several developments have the aim of providing nanomaterial functions, for example specific mechanical or chemical characteristics. Nano-based coatings might minimize such as the fouling progressions and deposit on membranes, in heat reactors and exchangers and on hulls of ships.[12]

Adsorption

Nano-based adsorbents are often used for diverse purposes of water treatment. Instances are separation of arsenic from waste or drinking water and a paper like substance made from nanowire to absorb hydrophobic liquids from water for example mineral oils.[13]

Nanocatalysts

The titanium dioxide of nanoscale has been reported to be useful as a catalyst in the treatment of waste water. In the course of photo-catalysis, the brightness of the titanium dioxide occurs due to liberation of oxygen and water from the air which being transformed into reactive radicals of hydroxyl functional group and break organic contaminants resistant to natural degradation inside the water. Advancement is concentrated on applying photo-catalysis in the regions with strong sunlight and for the treatment of little proportion of marginally contaminated water. More research disquiets the catalyst development (nano-sized ferromagnetic carrier that contains palladium traces) for wastewater treatment polluted with halogenated hydrocarbons.[14]

Nanoreagents

Various kinds of nanoparticles based upon the zero-valent iron are being functional for in-situ remediation of groundwater. In addition, pure nano-sized iron is also bimetallic nanomaterials and nanoparticles of iron on activated carbon have been used in pilot and lab trials and used already partially for the remediation of groundwater. Applications and developments concentrate on the break of chlorinated organic components in the groundwater.[15]

Air sector

Since last 35 years, the nanotechnology has been functional in motorized catalytic exhaust converters. Moreover, products of nanotechnology are implemented in photocatalysis and in air filters for purification of air.[16]

Catalytic converters

In the automobile subdivision, catalytic converters are the piece of art development. The three-way catalytic converter has a body of stainless steel which comprises catalytic materials as the layers on different substrates also known as washing coats. The catalytic elements of the noble metals in the washing coats are also of nano size. Study is presently under way, among other material objects, to minimalize the quantity of noble metals but with the similar catalytic performances.[17]

Filtration

In the auto motor industry, the filtration media ruled with Nano-fibers are commonly used in filters for curbside cabin air. Nano-fibers coated filtration medium is also functional for air separation (for example dust removal) at industrialized plants and for purification of the inlet air for gas turbines. Study emphases, among other things, on the optimization and development of Nano-sized membranes for carbon dioxide capturing from flue gases of power plants (Figure 2).[18]

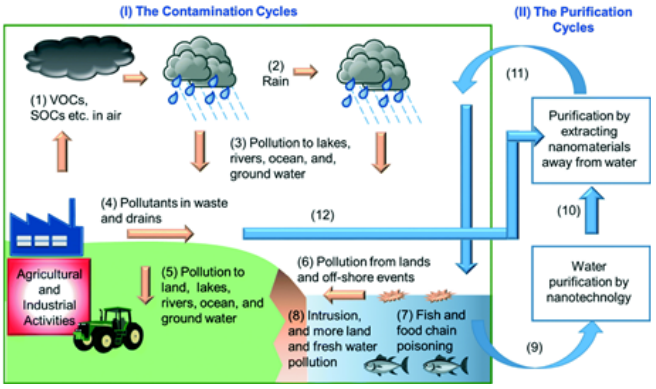

Figure 2 Nanomaterials for water treatment.

Soil pollution and remediation

Because of the fact that heavy metal activity in soils is controlled by desorption and sorption reactions with other ingredients of soil, extensive variety of adjustment agents have been used for manipulating the heavy metal bioavailability and to impeding their diffusions in soil by prompting several sorption procedures like mineral surface adsorption, establishment of stable organic ligand complexes, ion exchanges and surface precipitation.[19]

There are two major sorts of amendment mediators: (a) mobilizing agents that rise the mobility and bioavailability of heavy metals and improve their elimination through soil washing and plant intake (specifically, phytoextraction), and (b) restraining amendment mediators which reduce the mobility and bioavailability of heavy metals and decrease their transference to food chain by stopping their groundwater leaching (specifically, Phyto stabilization). Both Phyto stabilization and phytoextraction developments are part of phytoremediation method which is employed to cope polluted soils.[20]

Agricultural applications

The non-reestablished destruction to agriculture causes suffering because of numerous aspects for example fungi, weeds, and insects from several centuries, and leads towards the wide-ranging reduction in produces. The SiO2/QD/Au colloid particle based in vivo (IVIS) nanoparticles that has inserted into the chest wall of a rate also demonstrated to be suitable for pesticide diagnostics. Silicon matter has been significantly resolved by injecting the biochemical pesticides in the agricultural sectors. But due to the high management of chemical pesticides and eventual degenerate of such applications has justified for primarily substitutes for health and environmental anxieties. The ground water contamination and despoiled soils has caused nutritional wise imbalanced and unproductive lands (Figure 3).[21]

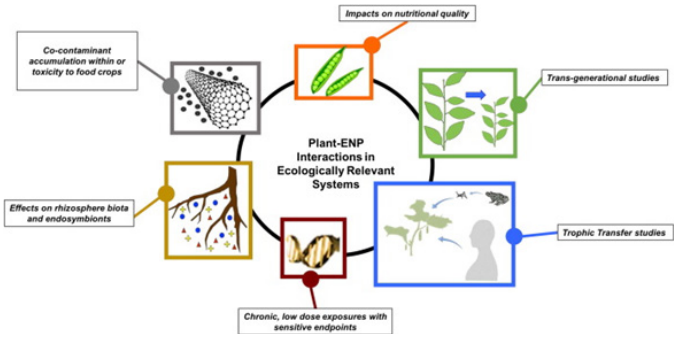

Figure 3 Nanomaterials for agricultural science.

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There are accumulation apprehensions of public health on the subject of using different chemical pesticides as they are related to different types of neurologic pathologies, respiratory difficulties, and cancers, hormonal and reproductive anomalies. As stated by few epidemiological reviews, therefore, environmental friendly insecticides are in the primary consideration in the current situations. In the warehouse food supplies the inactivity, is mostly caused by such elements together with fungi, insects, and rodents under compound storage settings. The approximation of yield costs by insects and diseases extended within the range of 50 to 100% in tropical regions and 5 to 10% in temperate regions.[22]

In recent years, a mesoporous honeycomb silica nanoparticle structure was manufactured in plant biotechnology with the pore sizes of 3nm that works as a nano carrier for genetic resources and chemicals into intact leaves and extracted plant cells. The scientists loaded the mesoporous silica nanoparticle accompanied by the genes and associated chemical inducers with capped over nanoparticles of gold that preserve the particles from leaking out. More developments of such elements such as multi-functional purposes and pore expansion may offer inventive potentials in directing particular distribution of chemicals, proteins, and nucleotides.[23]

Food and cosmetic applications

The development in protections, processing, productions, and packaging of foodstuffs is developed by incorporating nanotechnology. For example a covering of nano-composites in the course of the food packaging procedure can willingly brought the anti-bacterial ingredients on the layered films. The most protruding instance is the production of industrial canola oil taking into consideration the nano-drops that exist as a preservative considered to transmit the vitamins and minerals into the nutritious materials. The sunscreen encompassing nanoparticles such as titanium dioxide distributes copious advantages.[24]

Biomedical applications

Biomarkers should be very specific on the horizon to the biomolecules to detect and should have continuous signal transducer. Nanoparticles due to their small size and higher surface area to volume ratio are follows for perceiving even the miniature matters. Currently, Quantum dots are the most important nano-probes useful in imaging diagnostics.[25] Although Quantum dots are used extensively in the biomedical resolutions, there is a wide anxiety about the destructiveness of heavy metals for example cadmium and lead that exists in QD may impair the cells. Likewise, QD are inexplicable in water thus they have to be related to few polymers to use it in fluidic biological settings. Thus, alternative nanoparticles are unspoiled for biological imaging which reported to be less deadly.[26]

Silica nanoparticles are also found to be valuable to differentiate the living cells. They are also documented to express the human mesenchymal stem cells osteogenesis. Since the osteogenesis and adipogenesis are connected inversely, the silica nanoparticles decrease the differentiation of adipogenic.[27] Such properties of silica nanoparticles can be applied for the cure of obesity. In the meantime, another scholar recommends preparation strategies for core shell and quantum dots silica particles that immobilize gold nanoparticles (QD/Au/SiO_2) with an average size of 48 nm equipped with the support of a sol-gel technique under the reaction of tetraethyl orthosilicate along with the QDs with characteristic size of 10.5 nm. Both the internal and external surfaces of mesoporous silica nanoparticles can be functional with multiple effective clusters (Figure 4).[28]

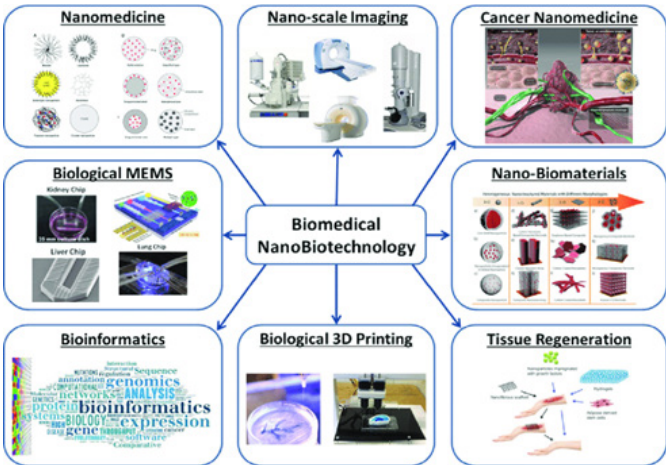

Figure 4 Nanomaterials for biomedical science.

Biotechnological applications

Nanotechnology has improved the medical subdivision with the amalgamation of nanomaterials for delivering drugs. The medications can be delivered to specific tissues with the help of nanomaterials.[29] The inclusive consumptions of medicine and side effects are reduced expressively by organizing the medicines in the particular body parts in prerequisite doses. This approach reduces the costs and contiguous effects. The repairing and reproductions of spoiled tissue also known as tissue engineering can be accomplished by nanotechnology development. Another parallel example is the development of carbon based framework nanotubes. An additional conventional treatment is to use gold-plated nanoparticles to increase the reminiscence. To advance the mental competence of the children, the gold is included in specific medical supplies.[30]

Conclusion

The intensified human activities are shaking the environment balance and human health by nourishing with large quantities of anthropogenic perilous toxic elements which pollute water, atmosphere, and soil and subsequently intimidate public health of human beings. Since an effort to accept a companionable treatment technology to clean up all the wastes which are left behind the industrialized revolution, it accounts basically compared the applications of auspicious nanotechnology to conservative approaches in ecological and health remediation. Furthermore, this review also emphasized the obstacles which restrict the applications of nanomaterials and subdue the benefits of their unequaled virtues; such difficulties comprise conditions of adjacent environments such as humidity, particle agglomeration, temperature, and separation complications. It has been presented that nanotechnology shows incredible characteristics for multifunctional, robust, and advanced treatment procedures which can improve treatment performance, pollution monitoring, in addition to overcome all the aforesaid barricades.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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