Engineered Nanomaterial's for Soil Conservation and Environmental Enrichment

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Abstract

The Soil is considered as highly concentrated materials of various partials of different sizes. The applications of natural and engineered nanomaterial are possible in environmental and agricultural sector. The use of engineered carbon-based nanomaterial's as sorbents for contaminants in soil systems will be emphasized in many ways. The new approach is proposed to use of the nanoparticle in soil sciences because the interaction of nanoparticle with soil particle take place efficiently due to advantages of their size.

Keywords: *Environmental pollutants, environmental pollutants, sorbents, water purification, Carbon based nanomaterial, fertilizers, pesticides, contaminants in soils.*

Introduction:

The researchers used many scientific studies to improve the modern technologies for reducing the pollution. The term Nanotechnology is the creation of functional materials devices and the system through the control of matter in Nano range. The Nanomaterials is the control of matter at dimensions between 1nm to 100 nm, where unique phenomena enable novel applications. Rapidly evolving and revolutionizing in the agriculture [1]. Nano science & Nanotechnology can play an important role in pollution sensing through surface-enhanced Raman scattering, surface Plasmon resonance, fluorescent detection, electrochemical detection and optical detection, treatment through adsorption, photo catalysis treatment of pollutants and reduction by nanoparticles. The Nanotechnology research is very much useful in the environment and agricultural development. Nanomaterial's like: carbon nanotubes, fullerenes, biosensors, controlled delivery systems, Nano filtration find relevant applications in agree and food areas like: natural resources management, delivery mechanisms in plants and soils. The agricultural waste and biomass are use in food processing and food packaging.

Nano sensors in the environment and agriculture begin to have wide applications due to the environmental monitoring of pollutants present in the atmosphere, in soils and in wastewater [2]. Various categories of sensors are used like: biosensors, electrochemical sensors, optical sensors for environmental improvement. The Nano-detection sensors and devices will be the main instruments for trace of heavy metals and these can be applied to real samples. In conventional water treatment methods include bio-sand, coagulation, reverse osmosis, distillation and adsorptive filtration through ion-exchange resins, active alumina or iron oxide cannot remove all the contaminants [3]. For that widely used sorbents for water treatment include: Nanostructured metal oxides, carbon based nanomaterial's. The Nano iron oxides are well known for removing of toxic ions and organic pollutants from water. Carbon nanostructures are generally studied because of their unique physical and chemical properties and their applications, presenting high capability for the removal of various inorganic and organic pollutants and radionuclides from large volumes of wastewaters [4, 5]. Heavy metal ions were removed from aqueous solutions being adsorbed on the surface of the oxidized carbon nanostructures. The adsorption isotherms show that different kinds of heavy metals have different affinity to the adsorbent depending on the material [6, 7]. Surface Nano-scale modified carbon black present good affinity for Cu (II) and Cd (II) and Fe nanoparticles for As (III) in groundwater [8].

Another application of nanomaterial's in environmental and agricultural treatment is the pollutant transformation from toxic to less toxic in water and soil or remediation. Researchers have focused their attention on the remediation of water and soil using Fe nanoparticles which can transform the pollutant without leaving the chlorinated intermediate byproduct [9]. Nano sorbents are very important for capturing heavy metal ions and organic contaminants. A smart application of carbon nanomaterial's for the removal of heavy metals from soils is also emphasized [10]. The Photo catalysis in agriculture is another direction in which nanomaterial's can play an important role. Different nanostructures of titanium dioxide (TiO2) and zinc oxide (ZnO) have been widely studied as photo catalysts [11]. Chemicals presented in pesticides are transformed in relatively harmless molecules such as CO2, N2 and H2O is in under progress [12]. Also the removal of pesticides and herbicides on plants and the soil through photo catalysis is possible [13]. Carbonate pesticides used in a variety of field crops are completely mineralized in the presence of ZnO and TiO2, being an example of an often used pesticide. The use of nanotubes and nanostructures thin films for degrading pesticides is also studied. The TiO2 nanotubes are used for atrazine degradation also [14]. The TiO2 thin films are also used for the degradation of organo-chlorine pesticides.

Nano materials are quite effective in detection and treatment systems of environmental pollutants [15]. Developing functional properties of nanomaterial's trace detection of inorganic and organic pollutants and treatment in water and soil can be tremendously improved. Nanomaterial's can be used to detect pesticides, to selectively capture target pollutants and to treat them through reduction or oxidation operation of the Nano materials. Through Nano-photo catalysis the removal of pollutants becomes another very important direction in environmental engineering, especially in treating pollutants from industrial areas.

Electronic Approach of Carbon Based Nanomaterial's:

The variations in synthesis technique, temperature, pressure, catalyst, electron field optimize nanomaterial structure, purity and physical orientation for specific applications. Diameter is an important dimension in determining the properties and applications of tubular carbon nanostructures [16]. Small single walled carbon nanotubes (SWNT) diameter is strongly correlated to synthesis technique, the diameter inducing higher strain energies, mixing of σ and α bonds and electron orbital re-hybridization [17]. The bond structure modifications in nanomaterial's induce fundamental alterations to the electronic, optical, mechanical, elastic and thermal properties of SWCNTs. The small inner diameter of nanotubes has found application in novel molding, separation and size exclusion properties. The combined characteristics of narrow diameters and long tubules also imply exceptional aspect ratios in Nano tubular structures [18, 19].

The spectrum of carbonaceous nanomaterials, indicates the high surface area to volume ratio distinguishes nanomaterial's from their macro or micro-scale counterparts. The ratio of ΔGsurface/ΔGvolume increases, where ΔG represents the difference in free energy between the bulk material and the Nano scale structure. The bonding in carbon based nanomaterial gives unique conductive, optical and thermal properties for applications in the electronic industry [20]. The new electronic properties of nanomaterial will contribute to environmental sensing devices and to new environmental remediation techniques of persistent organics. Tunable band gaps, remarkable stable and high-current carrying capacity, low ionization potential and efficient field emission properties are highly cited electronic properties of SWCNTs, these properties being linked to chirality, diameter, length and the number of concentric tubules [21]. It is demonstrated that band gaps are dependent upon the chirality and diameter of nanotubes. The Conduction in MWCNTS is dominated by the electronic structure of the outermost tubules and which is resembles the electronic behavior of graphite.

The ionization potential of SWCNTs is very low than other material of emitters used in the electronic industry, the ionization potential referring to the energy necessary to excite an electron from the ground state to an excited state [22]. The low ionization potential reduces the voltage necessary for exciting an electron from ground state to excited state. Further reduction in ionization potential is observed in the presence of certain adsorbents, including water.

Molecular interaction in Soil Science:

Molecular modeling can provide explanations about physical-chemical processes at the Nano scale. The potential energies of interaction between carbonaceous nanomaterial's are already described [23]. Hydrophobicity and capillarity will contribute to the adsorption behavior and orientation of sorbets in micro-porous carbon, physic-sorption being the dominant mechanism of sorption for not functionalized nanomaterial's [24]. These studies are complicated by the unique properties of adsorption in micro-pores. The Sorption of environmental contaminants to sorbents such as clay and activated carbon accounts for an important sink in natural and engineered environmental systems. The sorptive capacity of conventional carbonaceous sorbents is limited by the density of surface active sites, the activation energy of sorptive bonds, the slow kinetics and the non-equilibrium of sorption in heterogeneous systems.

The higher dimensions of traditional sorbents also limit their transport through low porosity environments. Carbonaceous Nano sorbents with their high surface area to volume ratio, controlled pore size distribution and their surface chemistry overcome many of these intrinsic limitations. An integration of innovative use and existing knowledge and technologies in agriculture with nanotechnology and innovative partnerships between agricultural research institutions with Nano science research institutions and universities and nanotech companies will help nanotechnology to be faster and efficient applied in agriculture [25]. Soil science is the complex mixture of chemicals and organisms some of which are organized at the Nano level and some of which are not. The analysis of natural nanoparticles in soils involves the sequence of detection, identification, quantification and detailed characterization. The of study of properties and behavior of different size fractions in soils is a difficult task, each size fraction of the soil matrix, the colloidal fraction, the clay fraction, the slit fraction, the sand fraction having specific properties and roles within this matrix.

The Nano fraction in soils can prove to control or to affect the soil physical or chemical properties, the understanding of the nanomaterial's behavior being far from complete from the physical chemistry point of view [26]. Natural nanoparticles in soils may occur as Nano minerals e.g. certain clays and Fe and carbon containing nanoparticles [27]. Soils and sediments contain many kinds of inorganic and organic particles such as: clay minerals, metal hydroxides and humic substances. Nano sheets are usually products of the weathering processes that occur in soils, having very diverse compositions. Nano rods result usually in the process of accelerated weathering of primary soil minerals induced by sediments at alkaline pH values [28]. Natural sediments behave as a natural sorbent, but its structure and composition is still a matter of debate [29]. Examples of natural NPs are fullerenes and carbon nanotubes (CNTs) of interstellar origin. The colloids in soils include humic substances and large biopolymers such as polysaccharides and peptidoglycans and even the knowledge of their structures increased in the last years.

Sorption in Soils:

In geochemical systems the term sorption is always used. Sorption is one mechanism that can be present in any aquatic or ground water system. Sorption has been traditionally divided into two systems, weak physic-sorption and strong chemisorption [30]. The specific sorption interaction is usually somewhere in-between these two. It can involve strong electrostatic interactions between ions or dipoles and surfaces, including ion exchange type reactions also. The Sorption can also involve only weak intermolecular forces such as van der Waals interactions present in molecule or atoms. The natural surfaces also generally includes adsorption on surfaces and absorption into the material. The interface of material depends on the nature of both the crystal phase and the solution or the gas phase. It is represented as a surface of continues sites and each one individually participates in a reaction resulting in sorption. In general, nanoparticles can be used as sorbent materials in two configurations: chemically bonded, through a covalent bond to micro particles or directly used as raw materials. When these materials are used as sorbents, the interaction of the analyst can be produced directly on the nanoparticle surface. The non-covalent interaction established between the analyst and the nanoparticles or the nanostructured materials includes ionic interactions (dipole-dipole), hydrogen bonds, π-π stacking, and dispersion forces. The presence of functionalized nanoparticles or supra-molecular aggregates allows the possibility of incorporating one or more of these interactions [31].

In recent years, a large number of allotropic carbon nanoparticles have been described including Nano diamonds, fullerene, Nano-onions, carbon nanotubes (CNTs), and graphite Nano sheets. The carbonaceous Nano sorbents with their high surface area to volume ratio, controlled pore size distribution and surface chemistry overcome many of these intrinsic limitations [32]. Sorption studies using carbon-based nanomaterial's report rapid equilibrium rates, high adsorption capacity, being effective over a broad pH range and consistency with BET, Langmuir or Freundlich isotherms [33]. The direct sorption of contaminants to the nanomaterial surface is driven by the same fundamental hydrophobic, dispersion and weak dipolar forces to determine sorption energies in conventional systems. The higher equilibrium rates of carbonaceous Nano-sorbents over activated carbon are attributed to π electron polarizability or π-π electron-donor acceptor interactions within aromatic sorbents, reduced heterogeneity of adsorption energies. The dominant physical and chemical adsorption forces via selective functionalization yields carbonaceous nanomaterial's that complement the existing suite of relatively unspecific conventional sorbents [34]. Functionalized Nano sorbents may provide an optimized approach for targeting micro pollutants, removing contaminants. The CNTs functionalized with hydrophilic –OH and –COOH groups exhibited superior sorption of low molecular weight and polar compounds [35]. Metal speciation or competing complexion reactions render sorption capacity sensitive to changes in pH.

Conclusion:

Today the most parts of different nanotechnologies are growing and find many applications in environmental and agriculture sector. Nano scale iron particles in rapid destruction of chlorinated hydrocarbons in soil and groundwater are known. Nano sensors studies in monitoring of heavy metals in soil have great importance. So, Nanotechnology plays very great roll in food safety and quality control and in the production of functional and nutritive food. The rapid advances in nanotechnology has made an important contribution in development in the environmental and agriculture Industry.

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