RECLAMATION OF SALINE SOIL THROUGH APPLICATION OF NANOPARTICLES

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Soil is one of the important parts of environment which provides a critical ecosystem benefit for life. However, due to the urbanization, the rapid growth of industrializations has created side effects towards the soil. In recent decades, fertile soil has been converted into saline & alkaline by the hazardous and toxic pollutants that produced from the anthropogenic sources such as disposal of chemical-fertilizers wastes from industrial, abandoned use of fertilizers and pesticides, and other potential chemical sources which lead to the contamination of soil. For instance, 187 million tonnes of fertilizer and 4 million tonnes of pesticides have been used annually for agricultural crop in globally, which has led to the sources of soil salinization. There are several soil contaminants which include heavy metals, pesticides, mineral oil and solvents. Unscientific application of fertilizers in recent agricultural production was found to be the dominant source of soil salinization under major irrigation command areas in India. The attention towards the saline & alkaline soil problems has been raised with great concern as the contaminated soil will poses potential health impacts to the human, ecosystem, agricultural as well as the environment. Reclamation of these saline & alkaline soils gives huge opportunity to bring uncultivated lands in to agricultural & horticultural production. Many technologies like surface and subsurface drainage systems and use of gypsum as soil application were used reclamation of saline & alkaline soils. However, these technologies are high labour & initial investment and time consuming. Many agricultural scientists across the country used nanoparticles for reclamation of saline and other contaminated soils and reported positive results.

Nanotechnology and nanomaterials have been widely attracted the attentions from the industrial sector and was recently being used frequently in several fields such as agricultural, energy and environmental science. Small particle size of 1 to 100 nanometres was being used in the nanotechnology, with different types, high specific surface area, high reactivity and flexibility. With the vary properties of nanomaterials, they have the potential in removing the contaminants from soil, water and air. The high specific surface area of nanomaterials significantly increases the efficiency in decontamination process. The nanometres size of the nanoparticles enhanced their effectiveness in transported into the contaminated soil. The applications of nanotechnology techniques in remediation were investigated to have high efficiency, inexpensive, high flexibility and environmentally friendly.

Mechanisms of Nanotechnology

The application of in situ technique is widely used in soil remediation. The technologies used for remediation of saline soil is mainly adsorption, immobilization, Fenton and Fenton-like oxidation, reduction reaction and multiple combination of nanotechnology and bio remediation. The mechanism of combination of

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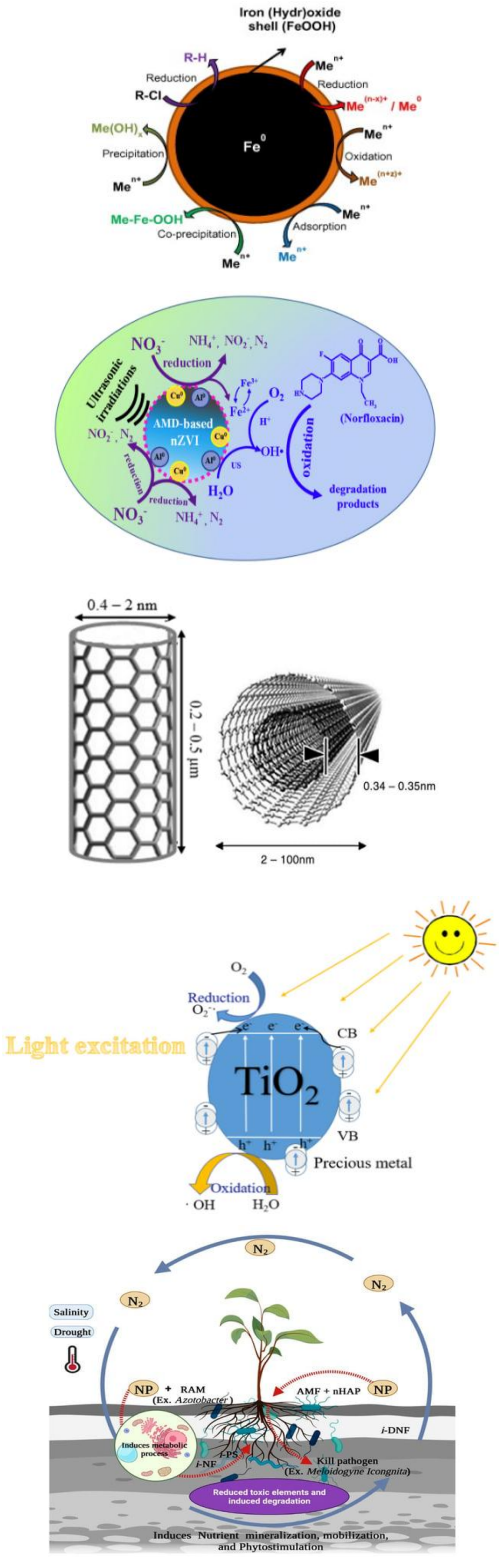


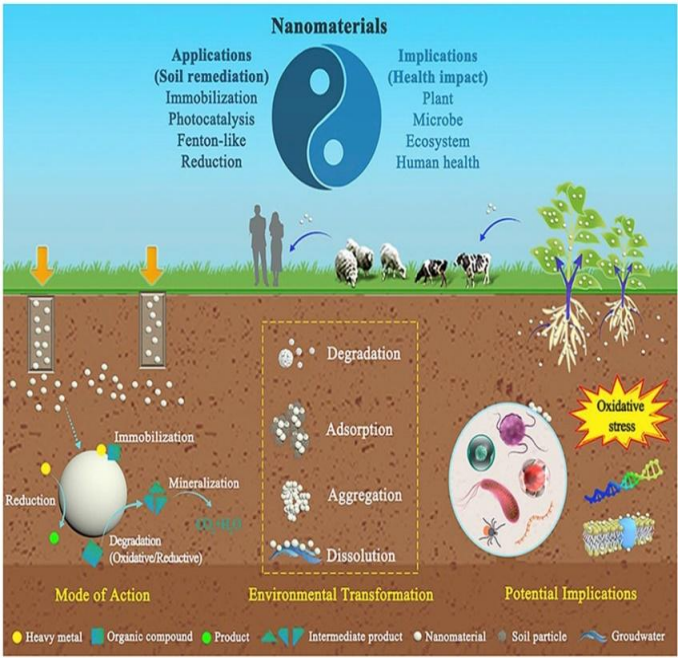
Different types of nanoparticles and their application in soil and water treatment

nanotechnology and bio remediation has arisen a great concern in recently. The inorganic contaminants such as heavy metals and metalloid were typically removed through the adsorption process by nanoparticles, while the organic contaminants were removed through reduction reaction and degradation with the presence of catalyses. With the implementation of nanomaterials, the process of adsorption and oxidation were able to degrade as well as remove the micro-pollutants that retained in soil environment. The applications of nanotechnology in soil remediation that are widely used in removing the contaminants include the carbon nanomaterials, Iron (III) oxide (Fe_3O_4), Titanium oxide (TiO_2), Zinc oxide (ZnO), nanoscale zero-valent iron (nZVI) and nano composites. Among the nanomaterials, nZVI was the most common used of nanoparticles in removing the heavy metal pollutants due to the high efficiency of nZVI in eliminating the contaminants such as toxic metals, chlorinated organic compounds and inorganic compound into less harmful compounds.

Pros and Cons of Nanotechnology

With the increasing of the application of nanotechnology in soil remediation, the number of nanomaterials will also be increased and entered the environment. The high number of nanomaterials may produce unpredicted risk towards the soil environment and ecosystem and indirectly threaten to human health. The main concern is the transportation of nanomaterials in the soil environment may transmitted into the groundwater system and pollute the water resources as well as the drinking water system and bring adverse impacts towards the terrestrial organisms and human health. The application of nanotechnology brings both benefits and

disadvantages towards the ecosystem and environment. The presence of nanomaterials in the soil environment could enhance the growth of seeds and plants due to the enrichment of useful nutrients and pesticides. For instance, the various nanomaterials such as carbon nanotubes, metal and metal oxide nanomaterials has the ability to enhance the nutrient in soil by delivering the nutrient to the roots and leaves of the crops and thus improve the growth of crops. The application of metal oxide nanomaterials such as CuO has the potential to enhance the crops yield as well as the growth of crops due to the presence of virulent pathogens in CuO nano material. The disadvantage of the application of nano technology is the potential of toxicity towards the terrestrial organisms and soil ecosystem. It was found that there is potential toxic from nanomaterials towards the plant's cells. For instance, the concentration of carbon nano materials such as fullerene was found to be high in the plant's cells due to the process of translocation as well as uptake process. The translocation of the hydrophobic nanomaterials was due to the natural phenomena in the xylem, where the transport of nano materials was through the uptake of water and nutrients. Through the life cycle system, the uptakes of toxic by the plants will indirectly impacts towards the human through the ingestion of toxic crops. Besides that, the nanomaterials will also impact towards the properties of soils due to the small size of nanomaterials and high specific surface area. The nanomaterials could increase the porosity of soil and enhance the interaction between soil particles and organic matter.



Application of nanotechnology in saline soil reclamation

Challenges of Nanotechnology

The major challenges of nanotechnology are the negative effect of the nanoparticles towards the microbes. The toxicity in nanomaterials will affect the microorganisms and inhibit the enzymes activities in the soil environment. Several studies have been done to reduce and prevent the toxicity of nanomaterials towards the soil organisms. However, various conflict results have been reported as some studies presented the inhibitory ability and some studies investigated the bio stimulation impacts towards the microbial in soil system. In order to overcome the negative impacts that cause by the application of nanotechnology, further research and experiment are required to be investigated.

Conclusion

In summary, the application of technology for soil remediation includes the mechanism of reduction reaction and

immobilization. Carbon nanomaterials, nZVI and metal oxide nanomaterials are the most efficient in removing or reducing the contaminants in the soils. The fate of contaminants in the soil environment is mainly linked to the pH value of the soil, the presence of clay mineral and content of organic matter. The application of nanotechnology has high efficiency in remediated the contaminated soils as well as enhance the useful nutrient to the plants and crops and increase the growth of yield. However, the nanomaterials could bring toxicity towards the plants cells and have negative impacts towards the soil environment as well as threaten human health. Thus, the application of nanotechnology in soil remediation is still require for further more investigation in order to promote the global environment.

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