Applications of Nanotechnology in the Environment: Soil, Water, and Air

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ABSTRACT

The global deterioration of water, soil, and air due to the release of toxic chemicals from human activities has become a serious environmental concern, posing significant risks to ecosystems and human health while limiting the effectiveness of conventional treatment technologies. In this context, nanotechnology has emerged as a promising solution, offering cost-effective, energy-efficient, and highly efficient approaches for monitoring and treating hazardous pollutants. This review highlights recent advancements in nanotechnology and its advantages over traditional methods, focusing on the application of nanomaterials such as carbon-based nanoparticles, antibacterial nanoparticles, and metal oxide nanoparticles in environmental remediation. These nanomaterials have shown great potential in air purification (removing greenhouse gases, volatile organic compounds, and bioaerosols through adsorption, photocatalysis, and filtration), soil improvement (enhancing phytoremediation through amendment agents and stabilizers), and water treatment (eliminating organic pollutants, heavy metals, and pathogens via adsorption, membrane processes, and disinfection). By addressing these critical environmental challenges, nanotechnology paves the way for more sustainable and effective remediation strategies.

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