Chapter 6
Nanotechnology for Air Remediation

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ABSTRACT

The world around us is a gift of God. A thrust to know and reconnoiter the environment around us is innate. Man has drastically explored and utilized the resources hidden in nature, but unfortunately in this sprint of development, the natural environment is severely affected. It is the need of the hour to focus on methodologies for environmental remediation. Many technologies have been developed to reduce the pollution causing factors. Use of nanotechnology for the sake of saving environment is an emerging field. Nano-technology is based on nano-sized (smaller than 1 micron) materials. Nanosize particles have initiated the advancement in new and low cost techniques for environmental pollution control including air pollution.

INTRODUCTION

Latest trends in nanotechnology have been adopted for its use in environmental remediation. Nano-materials are different from other macro and micro- molecules in their chemical and physical properties and are found to be more effective. Various nano-sized materials have been synthesized to reduce many upcoming health issues based on air pollution.

Air pollution comes from many different sources depending upon the mobility of the pollution emitting source. Static or stationary sources include power plants, factories, smelters and in-door sources such as dry cleaning operations and degreasing operations. Mobile sources which kept on enhancing toxic chemicals in air over a larger area include cars, buses, trucks, planes and trains. All these sources contribute in deteriorating the natural air quality. Pollutants from these sources range from green-house gases to volatile organic compounds and even solid particulate matter.

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Attention to control the air quality in different regions has been made worldwide. Many countries have set limits in their regions for the emission of specific pollutants. Environmental protection agency (EPA), USA has categorized six major air pollutants as criteria air pollutants. This concept of "criteria air pollutants" is accepted worldwide.

A brief description of major air pollutants, their sources and health hazardous are discussed in Table 1.

Table 1. Criteria air pollutants

Pollutant	Description	Sources	Health hazard	Release	Effect on environment
Carbon Monoxide (CO)	CO is an odorless, colorless, and poisonous gas produced by the incomplete burning of fossil fuels (gasoline, oil, natural gas).	Cars, trucks, buses, small engines, and some industrial processes are major sources. Wood stoves, cigarette smoke, and forest fires are also sources of CO.	CO interferes with the blood's ability to carry oxygen, slowing reflexes and causing drowsiness. In high concentrations, CO can cause death. Headaches and stress on the heart can result from exposure to CO.	Direct	contribute to the formation of photochemical smog
Nitrogen Oxides (NOx)	Nitrogen and oxygen combine during combustion (burning) to form nitrogen oxides. Many nitrogen oxides are colorless and odorless gases.	NOx come from burning fuels in motor vehicles, power plants, industrial boilers and other industrial, commercial, and residential sources that burn fuels.	NOx can make the body vulnerable to respiratory infections, lung disease, and possibly cancer.	Direct	contribute to the formation of photochemical smog, formation of acid rain, visibility reduction, water quality deterioration,
Sulfur Dioxide (SO_2)	SO2 is a gas produced by chemical interactions between sulfur and oxygen.	SO2 comes largely from burning fossil fuels (gasoline, oil, natural gas). It is released from petroleum refineries, paper mills, chemical and coal burning power plants.	Eye irritant Damage to lungs	Direct	formation of acid rain, visibility reduction, plant damages
Particulate Matter (PM) also known as Particle Pollution	Particulate matter is a term used to describe very small solids. Smoke, ash, soot, dust, lead, and other particles from burning fuels are examples of some of the compounds that make up particulate matter.	Some particles are directly emitted from cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, and burning wood. Other particles are indirectly formed when gases from burning fuels react with sunlight and water vapor.	Particulate matter can reduce visibility and cause a variety of respiratory problems. Particulate matter has also been linked to cancer. It can also corrode metal; erode building and sculptures, and soil fabrics.	Direct and formed in the air	visibility impairment, impacts on trace gas cycles, cloud and fog formation, absorption and scattering radiation
Lead	Lead is a metal found naturally in the environment as well as in manufactured products. Small solid particles of lead can become suspended in the air. Lead can then be deposited on soil and in water.	The major source of lead is metal processing with the highest levels of lead generally found near land smelters. Other sources include waste incinerators, utilities, and leadacid battery manufacturers.	Exposure to lead can cause blood, organ and neurological damage in humans and animals. Lead can also slow down the growth rate in plants.	Direct	Contaminated crops and livestock Smog
Ozone (O3)	Ozone (O3) is a gas not usually emitted directly into the air. Ground level ozone is created by a chemical reaction between NOx and VOCs in the presence of heat and sunlight.	Motor vehicle exhaust, industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOCs.	Ozone can irritate lung airways and cause wheezing and coughing. Repeated exposure can cause permanent lung damage. Ozone damages leaves of trees and other plants. It decreases the ability of plants to produce and store food, and reduces crop yield.	Formed in the air	plant and ecosystem damage, visible injury, decreased productivity, crop yield, indirect effect on global warming

(Source: EPA, USA)