Chapter 11
Nanoparticles for Degradation of Organic Pollutants

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ABSTRACT

Water pollution is becoming a serious threat to the environment. The access to safe drinking water, especially for the poor, is reaching an alarmingly low level, and the number of people suffering from kidney, stomach, and liver diseases, etc. is increasing every day. Among various pollutants, organic pollutants have major contribution in the contamination of water. These pollutants include toxic dyes, pharmaceutical compounds, industrial chemicals, and organic solvents, etc. Various routes are being employed for the removal/degradation of these pollutants. The use of nanoparticles (i.e., metal nanoparticles, nanocomposites, carbon nanotubes, and graphene oxide-based nanocomposite materials) possesses significant position as photocatalysts. This chapter has a focus on the environment remediation using these nanomaterials and contains the recent work in this field.

INTRODUCTION

Fresh water is essential for the existence of life on the globe. The supply of fresh water has health, environmental, economical and social impacts. It is estimated that 10-20 million people die every year due to water borne diseases (Leonard *et al*., 2003). Moreover, about 0.78 billion population do not have access to safe drinking water (WHO and UNICEF, 2013). Diarrhea, a disease caused by polluted water is responsible for the deaths of five to six thousand children every day (Ashbol, 2004; Hutton *et al*., 2007). The situation is expected to become worse in coming years as there are no expectations to get increased the supply of safe and fresh drinking water. Moreover, according to UN population projection study, the world population is expected to increase by 2.5 billion from now to 2050. The increased population would have increased demands for fresh water and obviously, the health and quality of life would suffer even more (Rockstrom, 2003). The world has understood that the intensity of worse situation could be reduced or controlled by proper use of fresh water resources.

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The 20th century is recognized as a century of industrial revolution. The development of industrial products has huge impacts on the global life; both positive and negative impacts. So far the supply of fresh water is concerned; it has badly affected the access to safe water for aquatic life, plants and humans. Industrial waste water is accompanied by a number of organic and inorganic pollutants which are ultimately polluting the world's water resources. The major industries having major contribution in water contamination include textile, dye, leather, rubber, petrochemical, coal, plastics, pharmaceutical, paper and food industries *etc*. Moreover, intensified usage of pesticides in agriculture and aquaculture are another big source of water contamination (Njoku et al., 2014).

The main objectives of this chapter are;

- To introduce the role of organic pollutants in the contamination of water.
- To discuss the recent work on the synthesis of nanomaterials for water treatment.
- To discuss the recent developments in the titled field.

ORGANIC POLLUTANTS AND THEIR REMEDIATION

Organic pollutants are hazardous substances which have adverse effects on human health like dysfunction of liver, adverse effects on brain, reproductive system, kidney and central nervous system (Ali *et al*., 2012; Costa *et al*., 2012). Currently, effective and advance treatment techniques are used for the purification of wastewater like biological oxidation, chemical oxidation via oxidants (e.g. O_3 or H_2O_2), coagulation, flocculation, and sedimentation (Duran *et al*., 2011), advanced oxidation processes photo-Fenton treatment (Salman *et al*., 2011), membrane processes (Altınışık *et al*., 2010), adsorption, electrochemical (Ahmed *et al*., 2014) and photocatalytic oxidation/degradation and combined methods (Ahmaruzzaman & Gayatri, 2010).

The right choice of process for removal of organic pollutants depends upon the nature of the chemical moiety or functional groups to be removed like cationic and anionic species, carboxylic/sulfonic acids, condensed aromatic rings, zwitter ions and their concentration in waste water sample.

Despite the availability of variety of methodologies for hazardous organic substances removal, the adsorption technique is still considered as the most effective and best methodology. Moreover, both soluble and insoluble organic contaminants are removed without production of dangerous by-products.

Waste water treatment has become a promising field of research in recent days. Among various techniques mentioned above, the use of nanomaterials emerged as a worthwhile method.

Nanoparticles are generally classified into two major groups of inorganic and organic nanoparticles.

Organic nanoparticles include

1. Carbon nanoparticles (fullerenes).
2. Graphene oxide (GO) based on Nanomaterials.
3. Polymer based on Nanomaterials.
4. Photocatalyst based on Nanomaterials etc.

Whereas, inorganic nanoparticles include: