Chapter 7
Nanomaterial Surface Modifications for Enhancement of the Pollutant Adsorption From Wastewater:
Adsorption of Nanomaterials

Hamidreza Sadegh
West Pomeranian University of Technology Szczecin, Poland

Gomaa A. M. Ali
Al-Azhar University, Egypt

Hamid Jafari Nia
Islamic Azad University, Khorramabad Branch, Iran

Zahra Mahmoodi
Islamic Azad University, Science and Research Branch, Iran

ABSTRACT

With the development of dyeing, textile, leather, paper, and other chemical industries, an increasing amount of dye wastewater containing refractory organic dyes is discharged. Undoubtedly, much high content dye wastewater will lead to serious environmental issues such as color pollution, light penetration interference, and virulence to aquatic organisms, even endanger human health. Therefore, it is an imminent problem and has become a global concern to degrade dye wastewater efficiently. So far, many techniques have been used to degrade dyeing wastewater, such as chemical degradation, biological degradation, photochemical degradation, coagulation, membrane filtration, and combined methods. These methods have certain impacts on the degradation of dye wastewater, but usually with slow degradation rate, complex and high operation costs, as well as easily causing secondary pollution. The adsorption process is a simple, effective, and low-cost way to remove dyes.

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INTRODUCTION

Urbanization of fast human industrial civilization has resulted in the destruction of various and dangerous contaminations in water currents. This wastewater includes toxic waste materials such as metals, organic impurities, etc., which straightly produce harmful and toxic effects on biological resources. Zn(II), Cu(II), Ni(II), Cd(II), Pb(II) and Cr(VI) are the metal ions required to be eliminated from the environment and need immediate concern (Al-Degs et al., 2006; Molinari et al., 2004; Moradi et al., 2010). Heavy metal ions, azo dyes, etc. were the most general toxic ions in sewage responsible for certain problems (Babel & Kurniawan, 2003). Notwithstanding the fact that the human body needs small doses such as Zn(II), it may be too prominent health problems such as depression, lethargy, increased thirst and cause neurological symptoms. Exposure to such toxic ions can cause health problems such as liver or kidney damage, Wilson's disease, insomnia, cancer, diarrhea, nausea, vomiting, rash, asthma, cough and headache (Ernhart, 1992).

Removing these poisonous ions from wastewater is essential for protecting the health and the environment. Traditional treatments have been used to remove the ions such as reduction, precipitation, adsorption, oxidation and ion exchange. Nonetheless, due to its high efficiency and economic considerations the process of attracting is the most appropriate method (Habeeb et al., 2017a; Hagen & Hertel, 2003). Nevertheless, a part from the low adsorption efficiency of some adsorbents including activated carbon (AC), zeolites, biomaterials, nanoparticles, polymers, these adsorbents have been widely used for wastewater treatment (Arias et al., 2002; Lingamdinne et al., 2016). In order to find effective and efficient adsorbents, it has been the focus of attention of various research groups.

Significant potential to improve environmental practices has been indicated by progressing of nanoscience and nanotechnology (Brumfiel, 2003; Rickerby & Morrison, 2007). Nanostructured adsorbents have represented efficiencies and faster rates of water treatment in comparison with traditional materials (Sadegh et al., 2017b; Theron et al., 2008). Eco-efficient, affordable and environmentally friendly nanomaterials have been expanded with unique features for potential applications in detoxification of industrial waste water, groundwater, surface water and drinking water (Cloete, 2010; Machida et al., 2006).

Nanomaterials like AC, carbon nanotubes (CNTs) and graphene (Feng et al., 2010; Singh et al., 2013) are widely used in many scientific and industrial fields, including sewage treatment, catalytic treatment and have depicted a substantial role in this regard (Chen & Wang, 2006; Moradi et al., 2015).

According to the purpose of this chapter, clarify a surface modification of nanomaterials for utilizing in water purification. In particular, the important applications of nanomaterials will be focused and distinguished in the field of wastewater treatment.

SURFACE MODIFICATION TECHNIQUES

Surface modification includes a number of chemical and physical methods (Figure 1). The chemical methods are involved protonation, saturation of metal oxide bonding amine groups and organic modification of aluminosilicates. The physical methods deal with the thermal treatment of the adsorbent, thereby increasing its surface area and porosity and where impurities are removed to expose surface functional groups that were not accessible to the adsorbate earlier. Enhanced nitrate removal by surface chemical