Chapter 8
Nanotechnology for Water Environmental Application: Functionalized Silica Hybrids as Nano-Sorbents

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ABSTRACT

In developing countries like Pakistan, industries do not allocate budget for control and treatment of pollution due to limited resources. Most of the pollutants emitted from these industries are usually re-usable but their capture from waste is highly uneconomical. This goal can be attained by synthesizing the advanced materials such as silica hybrids, the class of silica hybrids consisting of inorganic silica linked with organic ligands to form network structure. Their high porosity, surface area, and crystallinity provide a way for removing large amount of pollutants with small quantity of silica hybrids. These applications include the use of powder hybrids as adsorbent for removal of different pollutants such as heavy metals, persistent organic pollutants, and toxic organic chemicals. These functionalized hybrids can be further fabricated into thin films. This new form will be further used for catalytic degradation of various pollutants. Besides all these applications, these hybrids will have the potential to be used as sensors for detecting various pollutants in industries.

INTRODUCTION

Water is one of the most important natural resource and commodity on Earth, required for performing all vital activities of life. As water is indication of life. It is indispensable for domestic, agriculture and industrial activities as well as sustaining the earth's ecosystems. But this essential resource is under the threat. Two third portion of earth is covered with water. It is widely distributed into freshwater and

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saline water. About 97% of water is saline (oceans and seas), not usable and only 3% water is available as freshwater. Of this total freshwater, 2% is locked in glaciers and polar icecaps while only 1% is present as ground and surface water (UNESCO, 2003; U. S. Geological Survey, 2014) readily accessible for human consumption. Globally freshwater consumption has been increased due to rapid growth in population, industrial development, agricultural activities, geological and environmental changes (Ali & Aboul-Enein., 2004; Steduto et al., 2012).

According to fact sheet of FAO (2009), agriculture sector accounts 70%, industries 20% and domestic 10% of available 1% freshwater. When it is once used and discharged back into the environment, water quality is going to be changed. According to WHO (2012) and UNICEF (2008, 2010) reports, 780-900 million people rely on unimproved drinking water supplies to meet their basic needs and almost all of them are in developing regions. United Nation Development Program (2006) reported that about 50%of all people in developing countries suffer from health problem caused by water. Pakistan was considered as water surplus country, is now become water stress country (Ensink et al., 2004) due to depletion of natural water resources.

According to the report of Pakistan Strategic Country Environmental Assessment report, available water has been decreased from 1,299 m^3 /capita (1996-1997) to 1,100 m^3/ capita (2006). It is estimated that it become less than 700 m^3 / capita in 2025, that is against the international standard of 1500 m^3/ capita. Wastewater generated from domestic, municipal, industries and agriculture runoff dump directly into water bodies without any treatment causing water pollution. Hence, it has become core issue of today and its consequences are reflected back especially into the public health, biodiversity, aquatic condition and ecosystems, by putting them in danger.

Pollutants in Aqueous Media

Scientists gave serious attention on this current issue. Pollutant (inorganic, organic) in water in different form (soluble, suspended and colloidal), having accumulative and mobile nature, once enters into food chain affecting the human health because human being is on top of food chain. Human body cannot process and disposed of and deposited in various internal organs and cause adverse effect on body function. They showed toxic and carcinogenic nature even at low concentrations (Ali & Aboul-Enein, 2006, 2009). Cadmium causes renal disorder, itai-itai disease, bone fragility and destruction of erythrocytes (Hlihor et al., 2009), Copper causes gastrointestinal catarrh and haemochromatosis (Gündoğan et al., 2004), Nitroaniline causing methemoglobinemia and so on.

Polyaromatic hydrocarbons (PAHs) belong to class of organic pollutant are basically by-products of incomplete combustion or hydrolysis of organic materials containing one or two fused benzene rings (Gao et al., 2006; Alcántara et al., 2008; Muff & Søgaard, 2010). These are hydrophobic, volatile, low water solubility and non-biodegradable having carcinogenic and mutagenic effects. Due to its persistent nature once they enter into the water systems; it is difficult to be removed. PAHs are listed as US-EPA and EU priority pollutants (Falciola et al., 2012) and their concentrations need to be controlled. The most common sources of these pollutants are paint, rubber, cement, petrochemical, and solvent manufacturing industries, disposed of their large volumes of untreated wastewater into water reservoir. Few studies regarding removal of Naphthalene and pyrene using Industrial waste (Jonker et al., 2002), organoclay composite (Ake et al., 2003), Biopolymers derived chars (Wang et al., 2007), Immature coal (Zeledon et al., 2007), mineral naphthenic oil (Luna et al., 2008), plant residue material (Li et al., 2010), rice husk (Agarry et al., 2013) have been reported due to environmental importance.