Novel Submicron and Nanosized Carbon Based Materials for the Remediation and Sensing of Selected Organic Pollutants

Industrial and commercial growth in many countries around the world in the past decades has been accompanied by rapid generation of toxic waste, which creates the most serious environmental problems.

Among the emerging contaminants that have been detected in landfill leachates, wastewater, ground water and surface water are phenols, bisphenols, substituted phenols, nitroaromatics and organophosphates commonly present in industrial wastewater from oil refineries, coal gasification, petrochemicals, polymeric resins, coal tar distillation, pharmaceuticals, plasticizers, pesticides, biocides, etc. They have potential toxicity towards humans and animals, and are suspected mutagens, carcinogens, and endocrine disruptors even at a low concentration. The effective removal of these toxic pollutants from water is an issue of great importance. Further, because of their accumulation and vast scale distribution in the ecological environment, their separation and determination also have become topics of intense research in environmental analysis.

These issues emphasize the importance of developing reliable, highly sensitive, user-friendly and cost effective techniques for the removal as well as constant monitoring and detection of pollutants in different media which still remains a challenge.

Chapter 1 provides the overview of the different techniques adapted for removal and sensing of selected priority pollutants and endocrine disrupting compounds. Numerous studies have reported that the conventional wastewater treatments are not effective to remove these pollutants, therefore alternative treatments are necessary. The adsorption process is widely used to eliminate such compounds from aqueous solution. Activated carbon derived from agricultural waste has emerged as a promising adsorbent for removal of toxic organic and inorganic pollutants. Recently, catalytic **hydrogenate reduction method** has also received increased attention for remediation of Nitrophenols.

Carbon quantum dots and Graphene quantum dots have drawn increasing attention in sensor application due to their low toxicity, excellent photostability, highly tunable photoluminescence property and chemical inertnes making them suitable for sensing of nitrophenols.

With this background, the present work aimed to investigate the elimination of the above selected contaminants through different technologies such as adsorption on ACs as well as

by catalytic reduction. Our another objective was to investigate the use of carbon and graphene quantum dots as sensors for the model pollutants under study.

Chapter 2 presents the preparation of several ACs denominated as SPAC, PSAC, PCAC and PAC using palm shell powder as precursor and investigation of their potential for the removal of selected model pollutants Bisphenol-A, 4-Chlorophenol, 4-nitrophenol, 2,4-Dinitrophenol 2,4,6-Trinitrophenol and Monocrotophos. The overall adsorption rate of selected contaminants on PSAC and PCAC was interpreted using kinetic models and intraparticle diffusion model. The kinetic models were satisfactorily fitted to experimental data and pseudo-second order and Elovich models better fitted these data than the first-order and liquifilm diffustion model kinetic models. The ACs used in this study had a high adsorption capacity which was largely attributable to dispersion, hydrogen bonding and electrostatic adsorbent-adsorbate interactions. The solution pH had a major effect on adsorption of model pollutants under study using both PSAC and PCAC; however, adsorption was not affected much by the presence of electrolytes (ionic strength) in solution.

Chapter 3 focuses on $NaBH_4$ catalytic reduction process using nano silver supported on SPAC, PSAC, PCAC and PAC. The results showed that the catalytic reduction was effective for nitrophenols wherein increased amount of $NaBH_4$ was required with increasing number of nitro groups. The kinetics was very slow when $NaBH_4$ alone was used to reduce nitrophenols to their respective aminophenols.

Chapter 4 presents the preparation of carbon quantum dots (CQDs) using triflic acid activated carbon prepared from palm shell powder and graphene quantum dots (GQDs) from diethylenetriamine pentaacetic acid. The CQDs and GQDs were characterized and investigated for sensing of the model pollutants under study. However they were found to be effective for sensing of nitrophenols quantitatively.

The overall conclusions of the investigations undertaken and the areas where further investigations would throw more light and would be interesting are summarized in *Chapter 5*.