Preface

Field of Nano science is continuously evolving and nanoparticles are in huge demand to benefit many practical and industrial applications. With a probable ambiguity in the choice of nanoparticles between synthetic and biological origins, recent interests of nanomaterial fraternity is showcasing a positive inclination towards usage of green, biological and ecofriendly sources for nanoparticles synthesis which not only benefits the material processing cost and brings in quality but also benefits the environment in the product life cycle. In this work, focus is laid on the synthesis of nanoparticles of two important materials such as titanium dioxide and silica through bottom-up approach and their applications in the field of waste water treatment by removing unwanted materials like heavy metals ions and dyes from the aqueous solution is explored. TiO2 is preferred widely in environmental purification applications due its simple, abundant, strong oxidizing and non-toxic nature whereas SiO2 nanoparticles due to their chemically inert nature, high surface areas, UV transparency and great physical stability act as one of the best support materials . Details of the experiments performed, characterization done and results obtained are included in detail and the subject matter contained in this thesis is organized in eight different chapters.

Chapter 1 presents an overview of nano technology and nanomaterials as well as their classification. Here nanoparticle synthesis techniques along with merits and demerits are discussed throughly. Also a mention about the synthesis of TiO2 and SiO2 nanoparticles with their utilization in various applications is given in this chapter.

Chapter 2 is focused on prior art literature of titania (TiO2) and silica (SiO2) nano-particles, their synthesis, characterization and applications. For TiO2 NPs, the plant parts

and their derivatives which act as reducing, capping and stabilizing agent are discussed. Also the mechanism behind the formation of nanoparticle is given with proper understanding. Nano-silica from bio-origin which can replace the chemical silica precursor is also discussed thoroughly. At the end of chapter, scope of the overall work and its objective is presented.

Chapter 3 presents the experimental work done to synthesize pure TiO2 nanoparticles. Usage of a novel green source like *Syzygium cumini* (Jamun) Leaf Extract as a stabilizing/ capping agent for nanoparticle synthesis is presented. Various characterization techniques involved for monitoring the physical, chemical and morphological behavior of nanoparticles are also well discussed. In addition, antibacterial study of the synthesized TiO2 against E. Coli is also presented.

Chapter 4 deals with the application study of synthesized TiO2 nanoparticles. Experimental details involving step by step reactions on usage of green synthesized titanium dioxide nanoparticles for photo-catalytic removal Lead (Pb) from industrial wastewater is well presented. In addition, contaminant removal kinetics is also evaluated.

Chapter 5 presents an improvised way of utilizing TiO2 nanoparticles driven from the limitations observed from previous chapter. Here, the nanoparticles before the application study are immobilized onto PDMS (polydimethylsiloxane) polymer matrix. Experimental details, characterizations and evaluation results focusing on the photo-catalytic dye degradation of methylene blue using nano TiO2 – PDMS composite is presented in detail. In addition, dye degradation kinetics is also evaluated.

Chapter 6 elucidates extended efforts to enhance the photo-catalytic degradation efficiency of methylene blue dye using nano SiO2 as support in nano TiO2 – PDMS composite. Synthesis and characterization of silica nanoparticles from a green source, i.e., *Bambusa*

bambos leaf is explained in detail. Dye degradation studies along with the kinetics evaluation on usage of SiO2 nanoparticles as a support material is presented in detail.

Chapter 7 brings in details about independent application of silica nanoparticles synthesized from *Bambusa bambos* leaf. Experimental efforts to improve the permeation flux and selectivity of PDMS membrane by incorporating nano silica is explained in detail. Characterization of nanoparticles and membranes is presented and pervaporation performance of PDMS membrane with and without nano silica with varying SiO2 content, feed composition and operating temperature is presented.

Chapter 8 rolls out concluding remarks elucidating all the key findings obtained from the above study on synthesis and application of TiO2 and SiO2 nanoparticles. A scope for future work based on the current study is also presented