Table of Contents

LIST OF FIGURES i-ix
LIST OF TABLES x-xi
LIST OF SCHEMES xi

CHAPTER 1: INTRODUCTION

1.1. Zinc Oxide: a step towards smart nanomaterials 1
   1.1.1. Zinc oxide as gas sensor and bio sensor 2
   1.1.2. Zinc oxide in biomedicine 6
   1.1.3. Zinc oxide as catalyst 9
1.2. Dyes 12
1.3. Literature survey 20
   1.3.1. Fabrication of zinc oxide nanostructures 20
   1.3.2. Modifications of zinc oxide 28
   1.3.3. Zinc oxide as versatile photocatalyst 35
1.4. Aims and Scope of present work 40
References 42

CHAPTER 2: CHEMICALS AND EQUIPMENTS

2.1. Chemicals used 53
2.2. Equipments employed 54
   2.2.1. pH Meter 55
   2.2.2. Powder X-Ray Diffractometer 56
   2.2.3. Transmission Electron Microscope 58
   2.2.4. Scanning Electron Microscope 61
   2.2.5. Surface Area Analyzer 64
   2.2.6. UV-vis Spectrophotometer 65
   2.2.7. Fluorescence Spectrophotometer 67
   2.2.8. Liquid Chromatograph-Mass Spectrometer 70
References 72
CHAPTER 3: ZINC OXIDE NANOPOWDERS: SYNTHESIS, CHARACTERIZATION AND ROLE AS PHOTOCATALYST

3.1. Introduction 73
3.2. Synthesis of zinc oxide nanopowders 76
   3.2.1. Solution process (sample identifier: Z-1) 76
   3.2.2. Hydrothermal process (sample identifier: Z-2) 77
   3.2.3. Sol-gel process (sample identifier: Z-3) 78
   3.2.4. Gelatin assisted sol-gel process (sample identifier: Z-4) 79
   3.2.5. Thermal decomposition process (sample identifier: Z-5) 79
3.3. Characterization of zinc oxide nanopowders 80
   3.3.1. Phase analysis 80
   3.3.2. Morphological studies and composition analysis 82
   3.3.3. Surface area analysis 91
   3.3.4. UV-vis Diffused Reflectance spectra analysis 93
   3.3.5. Photoluminescence studies 97
3.4. Zinc oxide as photocatalyst 98
   3.4.1. Exposure procedure 98
   3.4.2. Estimation of hydroxyl radicals 100
   3.4.3. Photocatalytic activity of synthesized zinc oxide nanopowders 102
   3.4.4. Mechanism of dye degradation 108
3.5. Conclusions 109
References 111

CHAPTER 4: INFLUENCE OF PROCESS VARIABLES ON THE PHOTOCATALYTIC ACTIVITY OF ZINC OXIDE

4.1. Introduction 119
4.2. Degradation of different classes of dyes 121
   4.2.1. Degradation of a xanthene dye (rose bengal) 122
   4.2.2. Degradation of a triarylmethane dye (brilliant green) 135
   4.2.3. Degradation of an azo dye (methyl orange) 148
4.3. Degradation of textile wastewater 163
4.4. Conclusions 164
References 166
CHAPTER 5: TAILORED ZnO NANOPOWDERS FOR PHOTOCATALYTIC DEGRADATION OF DYES

5.1. Introduction 173

5.2. Photocatalytic activity of tailored ZnO nanopowders 175
   5.2.1. Transition metal doped ZnO nanopowders 175
   5.2.2. Metal-decorated ZnO nanopowders 191
   5.2.3. Composites of ZnO nanopowders 217

5.3. Conclusions 237

References 240

SUMMARY 245

ANNEXURES

(i) List of Publications
(ii) Contribution in national/ international symposia/ conferences