

Contents

List of Figures	IV-V
List of Tables	VI
Chapter 1	1-12
Introduction	
1.1 Introduction	1
1.2 Thin films	2
1.3 Dye sensitized solar cells (DSSCs)	4
1.3.1 Details of architecture of Dye sensitized solar cells	6
1.4 Cerium doped TiO ₂ thin films	8
1.4.1 Titanium Dioxide (TiO ₂)	8
1.4.2 Cerium oxide (CeO ₂)	10
1.5 Objectives	11
1.6 Outline of Thesis	11
Chapter 2	13-17
Literature Survey	
2.1 Introduction	13
2.2 Literature survey	13
2.3 Conclusion	17
Chapter 3	18-21

Experimental	
3.1 Introduction	18
3.2 Methods for synthesis of nano-materials and films	18
3.3 Materials	20
3.4 Synthesis Procedure	20
3.4.1 Preparation of TiO ₂ thin films	20
3.4.2 Preparation of Ce doped TiO ₂ thin films	21
3.5 Conclusion	23
Chapter 4	24-32
Characterization techniques	
4.1 Introduction	24
4.2 Characterization techniques	24
4.2.1 X-Ray Diffraction (XRD)	24
4.2.2 Fourier transform Infrared Spectroscopy	27
4.2.3 Photoluminescence (PL) spectroscopy	28
4.2.4 UV-vis. UV-vis diffuse reflectance spectra (UV-DRS)	30
4.2.5 Cyclic Voltammetry	30
4.3 Conclusions	32
Chapter 5	33-58
Results and Discussion	
5.1 Introduction	33
5.2 Characterization	33

5.2.1 X-Ray Diffraction (XRD)	33
5.2.2 Fourier transform Infrared spectroscopy (FTIR)	35
5.2.3 Photoluminescence (PL) Spectroscopy	37
5.2.4 UV-vis diffuse reflectance spectra (UV-DRS)	37
5.2.5 Cyclic voltammetry	41
5.2.5.1 Cyclic voltammetry in dark conditions (Set up I)	41
5.2.5.2 Cyclic voltammetry in visible light (set up II)	47
5.2.5.3 Variation of peak current with scan rate	52
5.2.5.3.1 Peak current (Charging current) of cyclic voltammetry scan in dark condition	52
5.2.5.3.2 Peak current (charging current) of cyclic voltammetry scan in visible light	53
5.2.5.4 Charge storage (surface charge density, q (C/cm ²))	54
5.2.5.4.1 Charge storage in thin films in dark conditions	54
5.2.5.4.2 Charge storage in thin films under visible light	55
5.2.5.5 Capacitance (C, μ F)	56
5.2.5.5.1 Variation of capacitance with scan rate in dark	56
5.2.5.5.2 Variation of capacitance with scan rate in visible light	57
5.3 Conclusion	58
Chapter 6	59-60
Conclusion	
6.1 Conclusion	59
References	61-64

List of Figures

Figure 1.1 Schematic representation of the dye-sensitized solar cell	5
Figure 1.2 Structure of (a) anatase (b) rutile and (c) brookite	9
Figure 3.1 Flow diagram of typical sol gel process	19
Figure 3.2 Preparation steps of TiO ₂ Film	22
Figure 3.3 Preparation steps of Ce doped TiO ₂ Films	23
Figure 4.1 Diffraction of the X-ray from consecutive layers of atom in crystal	25
Figure 4.2 Depiction of the mechanism of production of PL spectra	29
Figure 5.1 XRD of pure and doped TiO ₂ thin films	34
Figure 5.2 FTIR spectrums of pure and doped TiO ₂ thin films	36
Figure 5.3 PL Spectra of thin films at an excitation wavelength of 320nm	38
Figure 5.4 UV-DRS spectra of the prepared thin films	39
Figure 5.5 Optical band gap of the synthesized thin films	40
Figure 5.6 Cyclic Voltammetry of 0.00Ce doped TiO ₂ under dark	42
Figure 5.7 Cyclic Voltammetry of 0.05Ce doped TiO ₂ under dark	43
Figure 5.8 Cyclic Voltammetry of 0.20Ce doped TiO ₂ under dark	44
Figure 5.9 Cyclic Voltammetry of 0.50Ce doped TiO ₂ under dark	45
Figure 5.10 Cyclic Voltammetry of 1.00Ce doped TiO ₂ under dark	46
Figure 5.11 Cyclic Voltammetry of 0.00Ce doped TiO ₂ under visible light	47
Figure 5.12 Cyclic Voltammetry of 0.05Ce doped TiO ₂ under visible light	48

Figure 5.13 Cyclic Voltammetry of 0.20Ce doped TiO ₂ under visible light	49
Figure 5.14 Cyclic Voltammetry of 0.50Ce doped TiO ₂ under visible light	50
Figure 5.15 Cyclic Voltammetry of 1.00Ce doped TiO ₂ under visible light	51
Figure 5.16 Peak current v/s square root of scan rate	53
Figure 5.17 Peak current v/s square root of scan rate (visible light)	54
Figure 5.18 Variation of charge storage with scan rate in dark	55
Figure 5.19 Variation of charge storage with scan rate under visible light	56
Figure 5.20 Variation of Capacitance with scan rate in dark	57
Figure 5.21 Variation of Capacitance with scan rate in visble light	58

List of Tables

Table 5.1: Crystalline size of Ce-doped TiO ₂ thin films	35
Table 5.2: Band gaps of Ce doped TiO ₂ thin films	41
Table 5.3 Characteristics of 0.00Ce doped film under dark conditions	42
Table 5.4 Characteristics of 0.05 Ce film under dark conditions	43
Table 5.5 Characteristics of 0.20 Ce film under dark conditions	44
Table 5.6 Characteristics of 0.50 Ce film under dark conditions	45
Table 5.7 Characteristics of 1.00 Ce film under dark conditions	46
Table 5.8 Characteristics of 0.00 Ce film under visible light	47
Table 5.9 Characteristics of 0.05 Ce film under visible light	48
Table 5.10 Characteristics of 0.20 Ce film under visible light	49
Table 5.11 Characteristics of 0.50 Ce film under visible light	50
Table 5.12 Characteristics of 1.00 Ce film under visible light	51