

Contents

Preface	xiii
1 Introduction to Nanoscience and Nanotechnology	1
1.1 Introduction	1
1.2 Materials at Nanoscale	2
1.3 Quantum confinement	3
1.3.1 One dimensional Confinement: Quantum wells . .	4
1.3.2 Two dimensional Confinement: Quantum wires .	5
1.3.3 Three dimensional Confinement: Quantum dots .	6
1.3.4 Confinement regimes	6
1.4 Density of states	9
1.4.1 Concept of quasi particle: electron, hole and exciton	11
1.5 Nanomaterials - synthesis and processing	12
1.5.1 Top-down approach	12
1.5.2 Bottom-up approach	13
1.6 Characteristics of nanomaterials	14

1.6.1	Mechanical properties	14
1.6.2	Physical properties	15
1.6.3	Chemical properties	15
1.6.4	Biological properties	16
1.6.5	Structural properties	16
1.6.6	Optical properties	17
1.6.7	Electrical properties	18
1.6.8	Magnetic properties	18
1.7	Wide band gap semiconductors	19
1.7.1	Wide band gap II-VI semiconductors	19
1.7.2	Dilute magnetic semiconductors (DMS)	21
1.8	ZnO: An overview	21
1.8.1	Characteristics of ZnO	22
1.8.2	Properties of wurtzite ZnO under high pressure	25
1.8.3	Other applications of ZnO	26
1.9	ZnO nanostructures: A literature review	27
1.10	Hydrothermal growth of ZnO nanostructures: A review of recent reports	29
1.10.1	ZnO nanostructures under hydrostatic pressure	31
1.11	Transition metal (TM) doped ZnO nanostructures (Mn/Co/Ni/Cu): An overview	32
1.11.1	Magnetic studies on ZnO based nanostructures	35

1.11.2	Photoluminescence studies on ZnO based nanostructures	36
1.11.3	Raman studies on ZnO based nanostructures	37

2 Experimental techniques: Hydrothermal synthesis and characterization tools 39

2.1	Introduction	39
2.2	Synthesis of nanostructures	39
2.2.1	Hydrothermal technique	40
2.2.2	Hydrothermal technique:-Instrumentation	41
2.3	Characterization tools	43
2.3.1	X-ray diffraction technique	43
2.3.2	Scanning electron microscope (SEM)	47
2.3.3	Transmission electron microscope (TEM)	49
2.3.4	Energy dispersive X-ray analysis (EDX)	51
2.3.5	X-ray photoelectron spectroscopy (XPS)	52
2.3.6	UV-Vis diffuse reflectance spectra (DRS)	54
2.3.7	Fourier transform infrared spectroscopy (FTIR)	57
2.3.8	Raman Spectra	58
2.3.9	Photoluminescence	60
2.3.10	Diamond anvil cell (DAC) technique	63
2.3.11	Superconducting quantum interference device magnetometer (SQUID)	66
2.3.12	Vibrating sample magnetometer (VSM)	67

3	Hydrothermal growth and PL investigation of ZnO nanoflow- ers	69
3.1	Introduction	69
3.2	Experimental	71
3.3	Results and discussion	72
3.4	Conclusions	82
4	Pressure dependent Photoluminescence and Raman in- vestigation of hydrothermally grown ZnO nanoflowers	85
4.1	Introduction	85
4.2	Experimental	86
4.3	Results and discussion	87
4.4	Conclusions	98
5	Optical and magnetic studies of Mn doped ZnO (ZnO:Mn) nanorods synthesized by hydrothermal method	99
5.1	Introduction	99
5.2	Experimental	101
5.3	Results and discussion	102
5.4	Conclusions	127
6	Optical and magnetic properties of hydrothermally grown ZnO:TM (Co/Ni/Cu) nanostructures	129
6.1	Introduction	129
6.2	Experimental	130

6.3	Result and discussion	131
6.4	Conclusions	149
7	Summary and future scope of the work	151
7.1	Summary of the present study	151
7.2	Future scope of the work	154
A	Abbreviations used in the thesis	155
	Bibliography	158