

Contents

List of Abbreviations, Acronyms and Symbols.....	v
Abstract.....	xi
1 Introduction and Motivation	1
1.1 Review of Relevant Literature	2
1.1.1 Titanium Dioxide (TiO_2) and Control of Particle Characteristics.....	2
1.1.2 Zinc Oxide (ZnO) and Control of Composition	3
2 Theoretical Background	5
2.1 Chemical Vapor Synthesis (CVS).....	5
2.2 Particle Formation and Growth (CVSSIN Model).....	6
2.3 Materials.....	10
2.3.1 Titanium Dioxide, TiO_2	10
2.3.2 Zinc Oxide, ZnO	10
2.4 Particle Characteristics.....	11
2.4.1 Particle Agglomeration and Size Distribution	11
2.4.2 Magnetic Properties	14
3 Experimental Methodologies	17
3.1 Unit Operations of CVS	17
3.1.1 Precursor Delivery	17
3.1.2 Hot-Wall Reactors as Heat Sources.....	18
3.1.3 Particle Collection	21
3.2 Reactor Temperature Measurement	21
3.3 Synthesis of Nanoparticles	22
3.3.1 TiO_2 Nanoparticles	22

3.3.1.1 The Influence of the Time-Temperature Profiles on Particle Characteristics	23
3.3.1.2 The Influence of the Particle Number Concentration on Width of the Particle Size Distribution	24
3.3.2 Co-doped and Co,Li-doped ZnO Nanoparticles	26
3.4 Particle Characterization	26
3.4.1 X-Ray Diffraction (XRD) and Rietveld Refinement	26
3.4.2 Low-Temperature Nitrogen Adsorption	29
3.4.3 Transmission Electron Microscopy (TEM)	30
3.4.4 Photon Correlation Spectroscopy (PCS)	30
3.4.5 Atomic Absorption Spectroscopy (AAS)	31
3.4.6 Ultraviolet-Visible Spectroscopy (UV-Vis)	31
3.4.7 X-Ray Absorption Spectroscopy (XANES and EXAFS)	32
3.4.8 Superconducting Quantum Interference Device (SQUID) Measurements	35
4 Results and Discussion	37
4.1 Particle Size and Degree of Agglomeration	37
4.1.1 Results of the CVSIN Model.....	37
4.1.2 The Experimental Results.....	44
4.1.2.1 The ‘Flat’ Time-Temperature Profiles	44
4.1.2.2 The ‘Up’ Time-Temperature Profiles.....	52
4.1.2.3 Comparison of Different Time-Temperature Profiles	53
4.1.3 Comparison of the CVSSIN Model with Experimental Data	55
4.1.4 Conclusion.....	59
4.2 Particle Size and Size Distribution by Pulsed Precursor Delivery	60
4.2.1 Influence of Laser Pulse Repetition Frequency	61
4.2.2 Influence of Laser Duty Cycle.....	63
4.2.3 Conclusion	66
4.3 Structure and Properties of Doped ZnO Nanoparticles	67
4.3.1 Chemical Composition	67

4.3.2 Crystal Structure	69
4.3.3 Local Structure	75
4.3.4 Magnetic Properties	81
4.3.5 Conclusion	88
5 Conclusions	89
6 References	91
7 Appendix	97