

## TABLE OF CONTENTS

| CHAPTER NO. | TITLE   | PAGE NO.     |
|-------------|---|--------------|
|             | <b>ABSTRACT</b>   | <b>iii</b>   |
|             | <b>LIST OF TABLES</b>   | <b>xii</b>   |
|             | <b>LIST OF FIGURES</b>  | <b>xv</b>    |
|             | <b>LIST OF SYMBOLS AND ABBREVIATIONS</b>                        | <b>xxiii</b> |
| <b>1</b>    | <b>INTRODUCTION</b>   | <b>01</b>    |
|             | 1.1 Nanostructured Materials                                    | 01           |
|             | 1.1.1 Classification of Nanostructured materials                | 03           |
|             | 1.1.2 Applications of nanostructured materials                  | 05           |
|             | 1.1.3 Nanoparticles   | 09           |
|             | 1.2 Metal oxide nanostructures                                  | 10           |
|             | 1.2.1 Structural Properties                                     | 11           |
|             | 1.2.2 Electronic properties                                     | 12           |
|             | 1.2.3 Optical Properties  | 12           |
|             | 1.2.4 Magnetic properties                                       | 14           |
|             | 1.3 Tin oxide (SnO <sub>2</sub> ) Nanoparticles: A brief review | 15           |
|             | 1.3.1 Crystal Structure of SnO <sub>2</sub>                     | 16           |
|             | 1.3.2 Properties of SnO <sub>2</sub>                            | 17           |
|             | 1.3.3 Applications of SnO <sub>2</sub> NPs                      | 24           |
|             | 1.4 Objectives of the Present Research Work                     | 25           |
| <b>2</b>    | <b>LITERATURE REVIEW</b>  | <b>27</b>    |
| <b>3</b>    | <b>EXPERIMENTAL METHODS AND TECHNIQUES</b>                      | <b>42</b>    |
|             | 3.1. Introduction   | 42           |
|             | 3.2. Synthesis methods for nanostructures                       | 44           |
|             | 3.2.1. High Energy Ball Milling                                 | 44           |
|             | 3.2.2. LASER ablation   | 47           |
|             | 3.2.3. Sol–gel method   | 47           |

| <b>CHAPTER NO.</b> | <b>TITLE</b>   | <b>PAGE NO.</b> |
|--------------------|--|-----------------|
|                    | 3.2.4. Hydrothermal method   | 49              |
|                    | 3.2.5. Chemical Precipitation Method   | 50              |
|                    | 3.2.6. Evaporation methods   | 51              |
|                    | 3.2.7. Spray Pyrolysis   | 53              |
|                    | 3.2.8. Molecular Beam Epitaxy (MBE)  | 54              |
|                    | 3.2.9. Solvothermal Method   | 55              |
|                    | 3.2.10. Microwave Assisted Synthesis   | 56              |
|                    | 3.2.11. Procedure for the preparation of our sample  | 58              |
|                    | 3.2.12. Antibacterial Study by well-diffusion method   | 60              |
| 3.3.               | Characterization techniques  | 61              |
|                    | 3.3.1. X-Ray Diffraction (XRD)   | 62              |
|                    | 3.3.2. Transmission Electron Microscope (TEM)  | 65              |
|                    | 3.3.3. SAED – Selected-area electron diffraction   | 66              |
|                    | 3.3.4. Scanning Electron Microscope (SEM)  | 68              |
|                    | 3.3.5. Energy Dispersive X-ray Analysis (EDAX)   | 71              |
|                    | 3.3.6. Fourier Transform Infrared Spectroscopy (FTIR)  | 73              |
|                    | 3.3.7. UV-Visible Spectroscopy   | 75              |
|                    | 3.3.8. Photoluminescence Spectrophotometer   | 78              |
|                    | 3.3.9. Vibrating Sample Magnetometer   | 81              |
| <b>4</b>           | <b>EXPLORING STRUCTURAL, OPTICAL<br/>AND MAGNETIC PROPERTIES OF<br/>PRISTINE SnO<sub>2</sub> NANOPARTICLES</b> | <b>85</b>       |
| 4.1                | Results and Discussion   | 85              |
|                    | 4.1.1 Structural Studies   | 85              |
|                    | 4.1.2 Functional Group Analysis  | 90              |
|                    | 4.1.3 Morphological Studies  | 91              |
|                    | 4.1.4 Band gap Analysis  | 94              |
|                    | 4.1.5 Photoluminescence Studies  | 96              |
|                    | 4.1.6 Magnetic Studies   | 98              |
| 4.2                | Conclusion   | 100             |

| CHAPTER NO. | TITLE  | PAGE NO.   |
|-------------|--|------------|
| <b>5</b>    | <b>INFLUENCE OF DOPANT CONCENTRATION ON THE STRUCTURAL, OPTICAL AND MAGNETIC PROPERTIES OF NICKEL DOPED SnO<sub>2</sub> NANOPARTICLES</b>    | <b>101</b> |
| 5.1         | Results and Discussion   | 101        |
| 5.1.1       | Structural Studies   | 101        |
| 5.1.2       | Functional Group Analysis  | 105        |
| 5.1.3       | Morphological Studies  | 106        |
| 5.1.4       | Band gap Analysis  | 112        |
| 5.1.5       | Photoluminescence Studies  | 115        |
| 5.1.6       | Magnetic Studies   | 116        |
| 5.2         | Conclusion   | 118        |
| <b>6</b>    | <b>DOPANT INDUCED STRUCTURAL, OPTICAL, MAGNETIC PROPERTIES AND ANTIBACTERIAL ACTIVITIES OF Mn DOPED SnO<sub>2</sub> NANOPARTICLES</b>        | <b>119</b> |
| 6.1         | Results and Discussion   | 119        |
| 6.1.1       | Structural Studies   | 119        |
| 6.1.2       | FT-IR Analysis   | 123        |
| 6.1.3       | Morphological Studies  | 124        |
| 6.1.4       | Band gap Analysis  | 130        |
| 6.1.5       | Photoluminescence Studies  | 133        |
| 6.1.6       | Magnetic Studies   | 135        |
| 6.1.7       | Antibacterial activity   | 138        |
| 6.2         | Conclusion   | 140        |
| <b>7</b>    | <b>EFFECT OF Co<sup>2+</sup> SUBSTITUTION ON STRUCTURAL, OPTICAL, MAGNETIC AND ANTIBACTERIAL ACTIVITIES OF SnO<sub>2</sub> NANOPARTICLES</b> | <b>142</b> |
| 7.1         | Results and Discussion   | 142        |

| <b>CHAPTER NO.</b> | <b>TITLE</b>  | <b>PAGE NO.</b> |
|--------------------|---|-----------------|
|                    | 7.1.1 Structural Studies  | 142             |
|                    | 7.1.2 Functional Group Analysis   | 147             |
|                    | 7.1.3 Morphological Studies   | 148             |
|                    | 7.1.4 Band gap Analysis   | 154             |
|                    | 7.1.5 Photoluminescence Studies   | 158             |
|                    | 7.1.6 Magnetic Properties   | 160             |
|                    | 7.1.7 Evaluation of antibacterial activity  | 163             |
|                    | 7.2 Conclusion  | 165             |
| <br>               |   |                 |
| <b>8</b>           | <b>IMPROVED STRUCTURAL, OPTICAL AND MAGNETIC PROPERTIES OF COPPER DOPED SnO<sub>2</sub> NANOPARTICLES</b> | <b>167</b>      |
|                    | 8.1 Results and discussion  | 167             |
|                    | 8.1.1 Structural Studies  | 167             |
|                    | 8.1.2 Functional Group Analysis   | 171             |
|                    | 8.1.3 Morphological Studies   | 172             |
|                    | 8.1.4 Band gap Analysis   | 176             |
|                    | 8.1.5 Photoluminescence Studies   | 179             |
|                    | 8.1.6 Magnetic Properties   | 181             |
|                    | 8.2 Conclusion  | 184             |
| <br>               |   |                 |
| <b>9</b>           | <b>CONCLUSION AND FUTURE SCOPE</b>  | <b>185</b>      |
|                    | <br>  |                 |
|                    | <b>REFERENCES</b>   | <b>193</b>      |
|                    | <br>  |                 |
|                    | <b>APPENDICES</b>   |                 |
|                    | <br>  |                 |
|                    | <b>i. LIST OF PUBLICATIONS</b>  |                 |
|                    | <br>  |                 |
|                    | <b>ii. REPRINT OF JOURNAL PUBLICATION</b>   |                 |
|                    | <br>  |                 |
|                    | <b>iii. BIO-DATA</b>  |                 |