

Contents

| | <i>page</i> |
|---|--------------|
| Abstract | i |
| Acknowledgements | iii |
| Contents | v |
| List of Figures | vii |
| List of Tables | ix |
| List of Symbols | x |
| List of Abbreviations | xi |
| Chapter 1: Introduction, Literature Survey, Motivation and Scope of Thesis | 1-23 |
| 1.1 Introduction of Hematite | 1 |
| 1.2 Application of Hematite | 3 |
| 1.3 Photoelectrochemical Water Splitting | 5 |
| 1.3.1 Introduction | 5 |
| 1.3.2 Solar to hydrogen (STH) conversion efficiency | 7 |
| 1.3.3 Bandgap | 7 |
| 1.3.4 Direct and Indirect Bandgap | 7 |
| 1.3.5 Mobility and Charge Carriers | 8 |
| 1.3.6 Fundamental Requirements for PEC Water Splitting | 8 |
| 1.3.7 PEC Water Splitting Materials | 8 |
| 1.3.8 Hematite for PEC Water Splitting | 13 |
| 1.4 Radar Absorption | 16 |
| 1.4.1 Introduction | 16 |
| 1.4.2 Literature Survey of Radar Absorbing Material in the Context of Iron and Iron oxide | 17 |
| 1.5 Uranium Removal from Waste Water | 17 |
| 1.5.1 Literature Survey of Uranium Removal Methodologies | 18 |
| 1.6 Motivation of Present Work | 20 |
| 1.6.1 Introduction of Surface Fluorination | 20 |
| 1.6.2 Advantages of Surface Fluorination | 20 |
| 1.6.3 Advancements in fluorinated materials and their application | 20 |
| 1.7 Scope of Thesis Work | 23 |
| 1.8 Closing Remark | 23 |
| Chapter 2: Synthesis and Characterization of Materials | 25-35 |
| 2.1 Introduction | 25 |
| 2.1.1 Analytical Grade Chemicals | 25 |
| 2.2 Synthesis of Surface Fluorinated Hematite | 26 |
| 2.2.1 Hydrothermal Synthesis of Fluorinated Hematite | 27 |
| 2.2.2 Chemical Reaction | 28 |
| 2.3 Physical Characterization Techniques | 29 |
| 2.3.1 X-ray Spectrophotometer | 29 |
| 2.3.2 Scanning Electron Microscopy and Elemental Detection | 30 |
| 2.3.3 Transmission Electron Microscopy Technique | 31 |
| 2.3.4 Raman Spectrum | 31 |
| 2.3.5 BET Surface Area Technique | 31 |
| 2.3.6 ¹⁹ F- NMR Spectra | 31 |
| 2.3.7 Fourier Transform Infrared Spectrum | 31 |
| 2.3.8 UV-Visible Spectrum | 32 |
| 2.3.9 X-ray Photoelectron spectrum | 32 |
| 2.3.10 Magnetic Characterization Technique | 32 |
| 2.3.11 Transmission and Reflection Loss Measurement | 33 |
| 2.3.12 Trace Elemental Analysis | 33 |
| 2.4 Electrochemical Characterizations Techniques | 34 |
| 2.4.1 Sample Preparation for Photo-Electrochemical Characterization | 35 |
| 2.5 Closing Remarks | 35 |

| | |
|--|-------|
| Chapter 3: Enhancement in Photo-electrochemical Properties | 37-54 |
| 3.1 Introduction | 37 |
| 3.2 Characterization of Surface Fluorinated Hematite | 38 |
| 3.2.1 pH Measurements | 38 |
| 3.2.2 NMR Studies | 39 |
| 3.2.3 SEM and TEM Studies | 40 |
| 3.3.4 X-ray Diffraction Studies | 40 |
| 3.3.5 XPS Analysis | 42 |
| 3.2.6 Raman Spectra | 44 |
| 3.3 Optical Characterization of Surface Fluorinated Hematite | 45 |
| 3.3.1 Uv Visible Diffused Reflectance Spectra | 45 |
| 3.3.2 Bandgap Calculation | 46 |
| 3.4 Electrochemical Characterization | 47 |
| 3.4.1 J-V Characterization | 47 |
| 3.4.2 Impedance Spectroscopy (EIS) Analysis | 50 |
| 3.4.3 Fluorination Impact on Dye Sensitized Solar Cell (DSSC) | 52 |
| 3.5 Conclusion | 54 |
| | |
| Chapter 4: Magnetic and Microwave Absorption Properties | |
| 4.1 Introduction | 55-67 |
| 4.2 Material Synthesis | 56 |
| 4.3 Physical Characterization | 57 |
| 4.3.1 X-ray Powder Diffraction Analysis | 57 |
| 4.3.2 Scanning Electron Microscope (SEM) Analysis | 59 |
| 4.4 Magnetic Characterization of Surface Fluorinated Hematite | 60 |
| 4.4.1 M-H Measurements | 60 |
| 4.4.2 M-T Measurements | 62 |
| 4.5 Microwave Absorption Properties | 64 |
| 4.5.1 Microwave Measurements | 65 |
| 4.5.2 Microwave Reflection Loss Measurements | 66 |
| 4.6 Conclusion | 67 |
| | |
| Chapter 5: Removal of Uranium from Waste Water | 69-82 |
| 5.1 Introduction | 69 |
| 5.2 Physicochemical Characterization | 70 |
| 5.2.1 Fourier Transform Infrared Spectra Analysis | 71 |
| 5.2.2 X-ray Diffraction Analysis | 71 |
| 5.2.3 X-ray Photo Electron Spectra | 72 |
| 5.2.4 FESEM Imaging and EDS Analysis | 73 |
| 5.2.5 BET Surface Area Analysis | 73 |
| 5.2.6 Inductively Coupled Plasma Optical Emission Spectrophotometer (ICP-OES) Analysis | 75 |
| 5.3 Batch Adsorption Experiments | 75 |
| 5.3.1 Effect of pH | 76 |
| 5.3.2 Effect of Fluorination on U(VI) Adsorption | 76 |
| 5.3.3 Effect of Initial Concentration of the U(VI) Ions | 77 |
| 5.3.4 Effect of Contact Time (Adsorption Kinetics) | 78 |
| 5.3.5 Adsorption Isotherm | 80 |
| 5.4 Conclusion | 82 |
| | |
| Chapter 6: Summary and Conclusion | 83-84 |
| 6.1 Summary | 83 |
| 6.2 Concluding Remarks | 84 |
| 6.3 Closing Comments | 84 |
| | |
| Appendix | |
| I List of Published Papers | 85 |
| II References | 87-96 |