# TABLE OF CONTENTS

## Chapter 1

### 1.1 Background

1.1.1 Challenges of the 21st century  
1.1.2 Solar energy - a source of abundant energy  
1.1.3 Heterogeneous photocatalysis – a single step solution for future fuel and water treatment

### 1.2 TiO$_2$ “Photocatalyst of choice”

1.2.1 Structure of TiO$_2$  
1.2.2 Mechanism of photocatalysis on TiO$_2$  
1.2.3 Synthesis of TiO$_2$

A) Sol Gel method  
B) Hydrothermal method  
C) Solvothermal method  
D) Sonochemical method  
E) Microemulsion method  
F) Co-precipitation method

1.2.4 Applications of TiO$_2$

A) Application of photocatalysis in water treatment  
B) Application of TiO$_2$ as antimicrobial agents

1.2.5 Drawbacks of TiO$_2$

### 1.3 Ways to modify TiO$_2$

1.3.1 Morphological modification  
1.3.2 Chemical modification

A) Doping  
B) Coupling with semiconductor  
C) Noble metal deposition  
D) Anatase TiO$_2$ with exposed reactive {001} facets  
E) Addition of electron acceptor

### 1.4 Plan and scope of the research work

## References
Chapter 2

2.1 Experimental methodology

2.1.1 Synthesis of bare TiO₂
   A) Sol-gel method
   B) Sol-hydrothermal method
   C) Sonochemically activated sol-gel and sol-hydrothermal method

2.1.2 Synthesis of Nd doped TiO₂

2.1.3 Synthesis of Fe₃O₄ nanoparticles

2.1.4 Synthesis of Fe₃O₄-TiO₂ nanocomposites

2.1.5 Deposition of Ag on TiO₂ samples
   A) Photodeposition method
   B) Sonochemical method

2.2 Applications of synthesized nanoparticles

2.2.1 Photocatalytic activity

2.2.2 Antibacterial activity

2.3 Characterization and measurement techniques

2.3.1 X-ray diffraction analysis
   A) Instrumentation
   B) Applications

2.3.2 Fourier transform infrared spectroscopy
   A) Instrumentation
   B) Applications

2.3.3 UV-Visible spectroscopy-Diffuse reflectance UV-Visible spectroscopy
   A) Instrumentation
   B) Diffuse reflectance spectroscopy
   C) Applications

2.3.4 Photoluminescence spectroscopy
   A) Instrumentation
   B) Applications

2.3.5 BET Surface area an pore size analysis
Chapter : 3

3.1 Background 65

3.1.1 Why Ag,.....? 65

3.1.2 Methods of Ag deposition 66

3.2 Results and discussion 68

3.2.1 X-ray diffraction analysis 68

3.2.2 Fourier transformed infrared spectroscopy 74

3.2.3 Diffuse reflectance UV-Visible spectroscopy 75

3.2.4 Photoluminescence spectroscopy 76

3.2.5 Morphological analysis 78

References 63
Chapter: 4

Section 1

4.1.1 Background
A) Why Nd.....? 86
B) Why Silver.....? 86

4.1.2 Results and discussion
A) X-ray diffraction analysis 88
B) Fourier transform infrared spectroscopy 90
C) Diffuse reflectance UV-Visible spectroscopy 91
D) Photoluminescence spectroscopy 92
E) Scanning electron microscopy and Energy dispersive X-ray analysis 94
F) Transmission electron microscopy 95
G) Surface area analysis 96

4.1.3 Application as photocatalysts
A) Photocatalytic activity in UV light 97
B) Photocatalytic activity in sunlight 98

4.1.4 Conclusions 99
References 100

Section 2

4.2.1 Background
A) Why E. coli.....? 102
B) Why S. aureus.....? 103

4.2.2 Results and discussion 103

4.2.3 Application as antibacterial agents
A) Antibacterial activity in dark 105
B) Antibacterial activity in sunlight 106
Chapter: 5

5.1 Background

5.1.1 Why Fe₃O₄? 113
5.1.2 Why Ag? 113

5.2 Results and discussion

5.2.1 X-ray diffraction analysis 115
5.2.2 Fourier transform infrared spectroscopy 117
5.2.3 Diffuse reflectance UV-Visible spectroscopy 118
5.2.4 Vibrating sample magnetometry 119
5.2.5 Transmission electron microscopy 123
5.2.6 Magnetic force microscopy 124

5.3 Applications

5.3.1 Photocatalytic activity 125
5.3.2 Antibacterial activity 126

5.4 Conclusions 128

References 129

Summary of thesis

Publications