

TABLE OF CONTENT

Contents	Page No.
LIST OF FIGURES	i–xii
LIST OF TABLES	xiii–xiv
LIST OF SCHEMES	xv
CHAPTER 1: INTRODUCTION	1-43
1.1 Overview	1
1.2 Catalysis Perspective	2
1.3 Concepts in Nanocatalysis	3
1.4 Metal Nanoparticles as Catalysts	6
1.4.1 Noble Metal Nanoparticles	7
1.4.2 Transition Metal Nanoparticles	9
1.5 Bimetallic Nanoparticles as Catalysts	11
1.6 Supported Catalysts	13
1.7 Pd-based Catalysts	16
1.7.1 Aqueous phase reduction reaction	17
1.7.1.1 Reduction of nitroaromatics	18
1.7.1.2 Reduction of organic dyes	19
1.7.1.3 Reductive conversion of toxic Cr(VI) to less toxic Cr(III)	21
1.7.2 Electrocatalytic Applications	23
1.8 Objectives of the present work	27
References	28-43

CHAPTER 2: EXPERIMENTAL SECTION	1–17	
2.1	Materials and Reagents used	1
2.2	Synthesis of the catalysts	2
2.2.1	Synthesis of different composition of bimetallic Pd _x Cu _{10-x} (x=1, 2, 3) nanoparticles	2
2.2.2	Synthesis of different composition of Pd _x Ni _{10-x} and Pd _x Co _{10-x} (x=1, 2, 3) nanoparticles	3
2.2.3	Synthesis of monometallic Pd, Cu, Co and Ni nanoparticles	3
2.2.4	Synthesis of CeO ₂ nanoparticles	3
2.2.5	Synthesis of Pd/CeO ₂ nanoparticles	3
2.2.6	Synthesis of Pd _x M _{10-x} /CeO ₂ (x=1, 2, 3 and M=Cu, Co, Ni) nanoparticles	4
2.2.7	Synthesis of carbon supported various composition of PdM (M=Cu, Co, Ni) nanoparticles	4
2.3	Characterization Techniques	5
2.3.1	X-ray diffraction (XRD)	5
2.3.2	Fourier Transform Infra-Red (FTIR) Spectroscopy	6
2.3.3	Thermogravimetric (TG)	6
2.3.4	Ultraviolet-visible (UV-Visible) Spectroscopy	7
2.3.5	Scanning Electron Microscopy (SEM)	7
2.3.6	Energy Dispersive X-ray (EDX)	7
2.3.7	Transmission Electron Microscopy (TEM)	8
2.3.8	Raman Spectroscopy	8
2.3.9	Surface area, pore size, pore volume (BET and BJH)	9

method)	
2.3.10	Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) 10
2.3.11	Gas Chromatography-Mass Spectrometry (GC-MS) 10
2.3.12	X-Ray Photoelectron Spectroscopy (XPS) 10
2.3.13	Electrochemical Characterizations 11
2.3.13.1	Cyclic Voltammetry (CV) 11
2.3.13.2	Rotating Disc Electrode (RDE) measurements 12
2.4	Catalytic Activity 12
2.4.1	Aqueous phase reduction of nitroaromatics 12
2.4.2	Chemoselective reduction of nitroaromatics 13
2.4.3	Catalytic reduction of azo dyes 13
2.4.4	Reductive conversion of Cr(VI) to Cr(III) 13
2.4.5	Radical scavenging activity 14
2.5.9	Electrocatalytic Activities 15
References	15-17
CHAPTER 3: COMPOSITION DEPENDENT PdM (M=Cu, Ni, Co)	1-51
NANOPARTICLES FOR THE AQUEOUS PHASE REDUCTION REACTIONS	
OUTLINE	1-2
Section 3A: Composition dependent Pd _x Cu _{10-x} (x=1, 2, 3)	
nanoparticles for reduction of nitroaromatics and hexavalent chromium	3-18
3A.1	Results and discussion 3

3A.1.1	Characterization of the synthesized Pd _x Cu _{10-x} (x=1, 2, 3) nanoparticles	3
3A.2	Catalytic activity	8
3A.2.1	Catalytic reduction of 4-NP to 4-AP	8
3A.2.2	Catalytic reduction of 4-nitroaniline (4-NA)	15
3A.2.3	Reductive conversion of toxic Cr(VI) to less toxic Cr(III)	16
Section 3B: Synthesis, characterization and catalytic evaluation of Pd _x Ni _{10-x} (x=1, 2, 3) nanoparticles for reduction reactions		19-35
3B.1	Results and discussion	19
3B.1.1	Structural Characterization	19
3B.1.2	Catalytic Reduction of Nitroanilines	24
3B.1.3	Catalytic Reduction of 4-Nitrophenol	30
3B.1.4	Catalytic Reduction of Cr(VI) to Cr(III)	33
Section 3C: Pd _x Co _{10-x} (x=1, 2, 3) nanoparticles as efficient catalysts for reduction of various nitroaromatics		36-46
3C.1	Results and discussion	36
3C.1.1	Structural Characterization	36
3C.1.2	Catalytic Reduction of Nitroanilines	40
References		46-51
CHAPTER 4: SYNTHESIS, CHARACTERIZATION AND ACTIVITY STUDIES OF CeO ₂ ; Pd/ CeO ₂ AND PdM/CeO ₂ (M=Cu, Ni, Co) NANOPARTICLES		1-56
Outline		1
Section 4A: CeO ₂ Nanoparticles and Their Radical Scavenging		2-17

Activity	
4A.1	Results and discussion 2
4A.1.1	Characterization of CeO ₂ nanoparticles 2
4A.1.2	DPPH scavenging activity 12
4A.1.3	Hydroxyl radical scavenging activity 15
Section 4B: Pd/CeO ₂ Nanoparticles for Room Temperature Chemo-	
selective Reduction of Nitroaromatics	18–30
4B.1	Results and discussion 18
4B.1.1	Structural Characterization 18
4B.1.2	Catalytic Activity 24
Section 4C: Synthesis and Characterization of PdM/CeO ₂ (M= Cu,	31–4-49
Ni, Co) Nanoparticles and Their Catalytic Evaluation	
4C.1	Results and discussion 31
4C.1.1	Structural Characterization of the synthesized Pd _x Cu _{10-x} - x/CeO ₂ nanoparticles 31
4C.1.2	Catalytic Activity Studies 35
4C.1.2.1	Reductive Degradation of Methyl Orange 35
4C.1.2.2	Reductive Degradation of Congo Red 42
4C.1.3	Characterization of Pd ₁ Ni ₉ /CeO ₂ and Pd ₁ Co ₉ /CeO ₂ nanoparticles 44
4C.1.4	Catalytic activity of Pd ₁ Ni ₉ /CeO ₂ and Pd ₁ Co ₉ /CeO ₂ nanoparticles for the reduction of 4-nitroaniline (4-NA) 49
References	52–56

CHAPTER 5: PdM/C (M=Cu, Ni, Co) NANOPARTICLES FOR ELECTROCHEMICAL OXYGEN REDUCTION AND OXYGEN EVOLUTION REACTIONS	1–35
Outline	1
Section 5A: Tuning the Electrocatalytic Activity of PdCu/C Nanoparticles toward Oxygen Reduction and Oxygen Evolution Reactions	3–12
5A.1 Results and discussion	3
5A.1.1 Characterization of the synthesized PdCu/C nanoparticles	3
5A.1.2 Electrocatalytic activity of PdCu/C nanoparticles	8
Section 5B: Composition Dependent Electrocatalytic Activity of PdNi/C Nanoparticles	13–21
5B.1 Results and discussion	13
5B.1.1 Characterization of the synthesized Pd _x Ni _y /C nanoparticles	13
5B.1.2 Electrocatalytic activity of PdNi/C nanoparticles	17
Section 5C: Synthesis and Characterization of PdCo/C Nanocatalysts and Their Electrochemical Activity	22–30
5C.1 Results and discussion	22
5C.1.1 Characterization of the synthesized PdCo/Cnanoparticles	22
5C.1.2 Electrocatalytic activity of PdCo/C nanoparticles	27
References	31–35

CHAPTER 6: CONCLUSIONS AND FUTURE SCOPE	1–4
6.1 Conclusions	1
6.2 Future scope	3
APPENDIX I	i-xviii
APPENDIX II	xix
APPENDIX III	xx