TABLE OF CONTENT

Title		Page No.
Abstract		i-vii
Declarat	ion	viii
Certifica	te of Supervisor	ix
Acknow	ledgements	x-xi
Table of	Contents	xii-xvi
List of T	ables	xvii
List of F	igures	xviii-xix
List of S	chemes	XXX
СНАРТ	ER 1	
Introdu	ction	1-35
	Overview	1
1.2	Types of Nanomaterials	4
1.2.1	Carbon Based Material	4
1.2.2	Metal-Based Materials	5
1.2.3	Dendrimers	7
1.2.4	Nanocomposite Materials	7
1.3	Synthesis of Nanomaterials	8
1.3.1	Hydrothermal Synthesis	9
1.3.2	Solvothermal Synthesis	10
1.3.3.	Co-reduction Method	10
1.3.4.	Microwave Assisted Method	10
1.4	Nanomaterials as Catalysts	11
1.4.1	Metal NPs as Catalyst	12
1.4.2	Emerging Applications of Pd and Cu based NPs	13
1.4.2.1	Pd based NPs	13
1.4.2.2	Cu based NPs	19
1.5	Objectives of the Present Work	13
References		24-35

CHAPTER 2

Experim	nental Section	36-50
2.1.	Materials and Reagents used	36
2.2	Synthesis of the catalysts	37
2.2.1	Synthesis of Different Composition of Bimetallic $Pd_{4-x}Fe_x/C$ (x =	37
	1, 2 and 3) and Pd ₃ Fe _{0.5} Cu _{0.5} /C Nanoparticles (NPs)	
2.2.2.	Synthesis of Pd ₃ Cu _{0.5} Ni _{0.5} /C and Pd ₂ CuCo/C NPs	37
2.2.3.	Synthesis of Cu-CuFe ₂ O ₄ /C NPs	38
2.2.4.	Synthesis of CuCo/CuOCo ₃ O ₄ /C NPs	38
2.2.5.	Synthesis of Cu NPs	39
2.2.6.	Synthesis of CuNi NPs	40
2.3.	Characterization Techniques	40
2.3.1.	Thermogravimetric Analysis (TGA)	40
2.3.2.	X-ray Powder Diffraction (XRD)	41
2.3.3.	Ultraviolet-Visible (UV-Visible) Spectroscopy	42
2.3.4.	Scanning Electron Microscopy (SEM)	42
2.3.5.	Transmission Electron Microscopy (TEM) and High Resolution	43
	Transmission Electron Microscopy (HR-TEM)	
2.3.6.	Surface Area, Pore Size, Pore Volume (BET and BJH Method)	43
2.3.7.	Gas Chromatography-Mass Spectrometry (GC	43
2.3.8.	X-Ray Photoelectron Spectroscopy (XPS)	44
2.3.9.	Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-	44
	OES)	
2.3.10.	Electrochemical Characterization	44
2.3.10.1.	Cyclic Voltammetry (CV)	44
2.3.10.2.	Rotating Disc Electrode (RDE) Measurements	45
2.4.	Catalytic Activity	46
2.4.1.	Kinetics of Catalytic Reduction of Nitroaromatics	46
2.4.2.	Chemoselective Reduction of Nitroaromatics	47
2.4.3.	Catalytic Transfer Hydrogenation Reaction	48
Reference		48-50

CHAPTER 3		51-77
Synthesis	and Characterization of $Pd_{4-x}Fe_x/C$ (x = 1-3) and	
Pd ₃ Fe _{0.5} C	Cu _{0.5} /C Nanoparticles: Robust Non-Platinum Electrocatalysts for	
Enhance	d Oxygen Reduction Reaction	
OUTLINI	Ξ	51
3.1	Results and Discussion	
3.1.1	Characterization of the Synthesized $Pd_{4-x}Fe_x/C$ NPs (x = 1, 2 and	52
	3) and $Pd_3Fe_{0.5}Cu_{0.5}/C$ NPs	
3.2.	Electrocatalytic Activity	58
3.3.	Conclusion	69
Reference	es	69-77
СНАРТЕ	ER 4	
Synthesis	and Characterization of Pd ₃ Cu _{0.5} Ni _{0.5} /C and Pd ₂ CuCo/C	78-103
Nanopart	ticles and Their Oxygen Reduction Reaction Activity	
Outline		78
Section 4	A: Synthesis and Characterization of Pd ₃ Cu _{0.5} Ni _{0.5} /C Nanoparticles	79-87
and their	Oxygen Reduction Reaction Activity	
4A.1.	Results and Discussion	79
4A.1.1.	Characterization of Pd ₃ Cu _{0.5} Ni _{0.5} /C NPs	79
4A.1.2.	Electrocatalytic Activity	82
4A.2.	Conclusion	87
Section 4	B: Tuning the Electrocatalytic Activity of Pd ₂ CuCo/C towards Fuel	88-103
Cell Oxyg	gen Reduction Reaction	
4B.1	Results and Discussion	88
4B.1.1	Structural Characterization	88
4B.1.2	Electrocatalytic Activity	93
4B.2	Conclusions	99
References		99-103

Synthesis and Characterization of Noble Metal-Free Nanoparticle	s for
Enhanced Oxygen Reduction Electrocatalysis	
Outline	104
Section 5A: Synthesis and Characterization of Cu-CuFe ₂ O ₄ /C Nanopara	ticles 106-119
for Enhanced Oxygen Reduction Electrocatalysis	
5A.1 Results and Discussion	106
5A.1.1 Characterization of the Synthesized Cu-CuFe ₂ O ₄ /C NPs	106
5A.1.2 Electrocatalytic activity of Cu-CuFe ₂ O ₄ /C NPs	111
5A.2 Conclusion	119
Section 5B: Synthesis and Characterization of CuCo/CuO-Co ₃	O ₄ /C 120-129
Nanoparticles and Their Electrochemical Oxygen Reduction Rea	ction
Activity	
5B.1 Results and Discussion	120
5B.1.1 Characterization of theSsynthesized CuCo/CuO-Co ₃ O ₄ /C NPs	120
5B.1.2 Electrocatalytic Activity of CuCo/CuO-Co ₃ O ₄ /C NPs	123
5B.3 Conclusion	129
References	129-133
CHAPTER 6	
Synthesis and Characterization of Cu-Fe ₂ O ₃ and CuNi Nanoparticles	s and 134-164
their Catalytic Activity for the Reduction of Nitroaromatics Compou	nds
Outline	134-135
Section 6A: Facile Synthesis of embedded Cu/Fe ₂ O ₃ as magnetic	ically 136-137
recoverable nanoparticles for efficient reduction of nitroaromatics in aqu	ieous
medium at room temperature	
6A.1 Results and Discussion	136
6A.1.1. Characterization of the Synthesized Cu/Fe ₂ O ₃ NPs	136
6A.1.2 Catalytic Activity Studies Monometallic Cu, Fe and Cu/Fe ₂ O ₃	NPs 139
6A.1.3: Catalytic Performance of the Cu/Fe ₂ O ₃ NPs for the Reduction	on of 141
Various Nitroaromatics	

104-133

CHAPTER 5

6A.1.4:	Probable Reaction Mechanism for the Reduction of Nitroaromatics	144
	Catalyzed by the Cu/Fe ₂ O ₃ NPs.	
6A.1.4:	Reusability Studies of the Cu/Fe ₂ O ₃ NPs and Kinetic Analysis	145
6A.3	Conclusion:	147
Section	6B: Non-precious Magnetically Retrievable CuNi Alloy Catalyst:	148-156
Transfer	Hydrogenetion of Nitroaromatics in 2-Propanol.	
6B.1	Results and Discussion	148
6B.1.1	Characterization of the CuNi NPs	148
6B.1.2	Catalytic Performance of the CuNi NPs	151
6B.1.3	Plausible Reaction Mechanism for the Reduction of	153
	Nitroaromatics Catalyzed by the CuNi NPs Through Transfer	
	Hydrogenation	
6B.4.	Conclusion:	156
Referenc	es	156-164
CHAPT	ER 7	
Conclusions and Future Scopes		165-169
7.1	Conclusions	165
7.2	Future scope	169
List of P	ublications	