

CONTENTS

<i>a. Abstract</i>	<i>i</i>
<i>b. Declaration</i>	<i>vii</i>
<i>c. Certificate</i>	<i>viii</i>
<i>d. Dedication</i>	<i>ix</i>
<i>e. Acknowledgement</i>	<i>x</i>
<i>f. Contents</i>	<i>xii</i>
<i>g. List of tables</i>	<i>xviii</i>
<i>h. List of figures</i>	<i>xxi</i>
<i>i. List of schemes</i>	<i>xxxv</i>
<i>j. List of abbreviations</i>	<i>xxxvi</i>
<i>k. Symbols</i>	<i>xxxvii</i>
CHAPTER 1: Introduction	[1-40]
1.1 Conducting Polymers	1
1.1.1 Historical development	3
1.1.2 Band Theory	4
1.1.3 Doping in Conducting Polymers	7
1.1.3.1 Chemical doping	9
1.1.3.2 Electrochemical doping	9
1.1.3.3 Photo-doping	10
1.1.3.4 Charge injection doping	10
1.1.4 Charge carriers in doped conducting polymers	10
1.2 Synthesis of conducting Polymers	14
1.2.1 Chemical Synthesis	14
1.2.2 Electrochemical Synthesis	15
1.3 Application of Conducting Polymers	17
1.4 Biosensor	21
1.4.1 Biocomponent	23
1.4.2 Types of Biosensors based on different transducers	23
1.4.3 Enzyme based electrochemical sensors	26

1.4.3.1 Enzymes	27
1.4.3.2 Preparation of enzyme electrodes	29
1.4.4 Affinity electrochemical Biosensors	31
1.4.4.1 Antibody	31
1.4.4.2 Preparation of antibody based electrode	33
1.5 Poly (3,4-ethylenedioxythiophene) (PEDOT)	34
1.6 Scope of the thesis and statement of the problem	36
CHAPTER 2: Theoretical Aspects	[41-61]
2.1 Electrochemical Impedance Spectroscopy	41
2.1.1 Different impedance components in an electrochemical cell system	43
2.1.2 Common Equivalent Circuit Models	44
2.2 Cyclic Voltammetry	46
2.2.1 Randles- Sevcik theory	48
2.2.2 Surface concentration of adsorbed electro active species	50
2.2.3 The variation of E_p with pH (Pourbaix diagram)	52
2.3 Laviron's Theory	53
2.3.1 Determination of k_s and α	55
2.4 Enzyme Kinetics Theory	56
2.4.1 Michelis Menten theory:	56
2.4.2 Lineweaver-Burk (LB) Plot	59
2.5 Theory of Enzyme immobilization or carbodiimide coupling	60
CHAPTER 3: Experimental Techniques	[62-84]
3.1 Parent materials	62
3.2 Synthesis of Poly(3,4-ethylenedioxythiophene) (PEDOT) matrix functionalized with gold nanoparticles (AuNPs)	64
3.2.1 Synthesis of PEDOT/GC electrode	64
3.2.2 Deposition of AuNPs on PEDOT/GC electrode	65
3.2.3 Immobilization of anti-AFB ₁ and AChE onto the matrix of AuNPs/PEDOT/GCE	66

3.2.4	Synthesis mechanism and Biosensor fabrication	68
3.3	Synthesis of PEDOT-GO composite functionalized with AuNPs	68
3.3.1	Electrochemical Synthesis of PEDOT-GO/GCE	68
3.3.2	Electrochemical deposition of AuNPs over PEDOT-GO/GCE	69
3.3.3	Immobilization of anti-AFB ₁ and AChE onto the matrix of AuNPs/PEDOT/GCE	70
3.3.4	Mechanism of Electrochemical deposition and electrode fabrication	70
3.4	Synthesis of PEDOT-PSS composite functionalized with <i>f</i> MWCNTs	74
3.4.1.	Electrochemical Synthesis of PEDOT-PSS/GCE	74
3.4.2	Electrochemical synthesis of PEDOT-PSS- <i>f</i> MWCNTs/GCE	75
3.4.3	Immobilization of monoclonal anti-Aflatoxin B ₁ and Acetylcholine esterase on to PEDOT-PSS- <i>f</i> MWCNTs/GCE.	75
3.4.4	Mechanism of Electrochemical deposition and electrode fabrication	75
3.5	Preparation of analyte and Real samples	77
3.6	Preparation of solutions used during experiments	78
3.7	Characterization techniques	78
3.7.1.	Field emission Scanning electron microscopy	78
3.7.2.	Scanning electron microscopy	79
3.7.3.	Contact Angle Measurements	80
3.7.4.	FTIR spectroscopy	80
3.7.5.	Potentiostat	81
CHAPTER 4: Gold nanoparticles (AuNPs) functionalized electrochemically polymerized PEDOT and its application for the detection of Aflatoxin B₁ and organophosphates		[85-119]
4.1	Introduction	85
4.2	Morphological study	88
4.3	Contact angle measurement	89

4.4 FTIR spectra	90
4.5 Electrochemical Impedance Spectroscopy	91
4.6 Cyclic Voltammetry	94
4.6.1 Electrocatalytic behaviour of modified electrodes towards redox species	94
4.6.2 Variation of Anodic (I_{pa}) and Cathodic Current (I_{pc}) vs. scan rate (v)	96
4.6.3 Variation of Anodic (E_{pa}) and Cathodic (E_{pc}) peak potential vs. Scan rate (v):	100
4.7 Application of BSA/anti-AFB ₁ /AuNPs/PEDOT to detect AFB ₁	102
4.7.1 Optimization of experimental parameters	102
4.7.2 Analytical Performance of the Immuno-electrode BSA/anti-AFB ₁ /AuNPs/GCE	105
4.7.3 Performance of the Immunosensor towards real sample	107
4.8 Application of AChE/AuNPs/PEDOT/GCE to detect Organophosphate (methyl parathion)	109
4.9 Summary	118
CHAPTER 5: Gold nanoparticles (AuNPs) modified surface of PEDOT doped with graphene oxide (GO) and its application for the detection of Aflatoxin B1 and Organophosphate	[120-153]
5.1 Introduction	120
5.2 Morphological analysis	123
5.3 Contact angle measurements	124
5.4 FTIR spectra	124
5.5 Electrochemical Impedance spectroscopy	126
5.6 Cyclic Voltammetry Studies	128
5.6.1 Electrocatalytic behavior of modified electrodes towards redox species:	128
5.6.2 Variation of cathodic (I_{pc}) and anodic (I_{pa}) current vs. scan rate	131
5.6.3 Variation of Anodic (E_{pa}) and Cathodic (E_{pc})	135

	peak potential vs. Scan rate (v):	
5.7	Application of BSA/anti-AFB₁/AuNPs/PEDOT-GO/GCE to detect AFB₁	137
5.7.1	Optimization of Experimental parameters	137
5.7.2	Analytical Performance	141
5.7.3	Specificity and recovery of BSA/anti-AFB ₁ /AuNPs/PEDOT-GO/GCE towards real sample:	143
5.8	Application of AChE/AuNPs/PEDOT-GO/GCE to detect Organophosphate (methyl parathion)	145
5.9	Summary	151
CHAPTER 6: PSS doped PEDOT functionalized with fMWCNTs for the detection of Aflatoxin B₁, Organophosphate and Carbamate		[154-193]
6.1	Introduction	154
6.2	Morphological Analysis	156
6.3	Contact Angle Measurements	157
6.4	FTIR Spectroscopy	158
6.5	Electrochemical Impedance Spectroscopy	159
6.6	Cyclic Voltammetry Studies	162
6.6.1	Electrocatalytic behaviour of modified electrodes towards redox species:	162
6.6.2	Variation of Anodic (I _{pa}) and Cathodic Current (I _{pc}) vs. Scan rate (v):	164
6.6.3	Variation of Anodic (E _{pa}) and Cathodic (E _{pc}) peak potential vs. scan rate (v):	167
6.7	Application of BSA/anti-AFB₁/PEDOT-PSS-fMWCNTs/GCE to detect AFB₁	170
6.7.1	Optimization of Experimental parameters	170
6.7.2	Analytical Performance of the BSA/anti-AFB ₁ /PEDOT-PSS-fMWCNTs/GCE towards detection of AFB ₁	173
6.7.3	Specificity and recovery of BSA/anti-AFB ₁ /PEDOT-PSS-fMWCNTs/GCE towards real sample	176
6.8	Application of BSA/anti-AFB₁/PEDOT-PSS-fMWCNTs/GCE to detect Methyl parathion and Carbofuran	178
6.9	Summary	191

CHAPTER 7: Conclusions and Future Prospects	[194-200]
7.1 Conclusions	194
7.2 Future Prospects	199

References

List of Publications