

Table of Contents

Abstract	i
Declaration	vi
Certificate	vii
Acknowledgements	ix
Contents	xii
List of tables	xvii
List of figures	xix
List of abbreviations	xxxi
List of symbols	xxxii
Chapter 1: Introduction	1-50
1.1. Materials	1
1.1.1. Conducting polymers	1-8
1.1.2. Two dimensional layered nanostructures	8-11
1.1.3. Noble metal nanoparticles	11-12
1.2. Biosensors: Principles, components and types	12-13
1.3. Types of biosensors based on different transducers	13
1.3.1. Electrochemical biosensor	14-15
1.3.1.1. Amperometric biosensor	15
1.3.1.2. Potentiometric biosensor	15
1.3.1.3. Impedimetric biosensor	16
1.3.1.4. Conductometric biosensor	16
1.3.2. Optical biosensor	16-17
1.3.3. Calorimetric biosensor	17
1.3.4. Piezoelectric biosensor	17
1.3.5. Colorimetric biosensor	17-18
1.4. Enzyme/Antibody based electrochemical biosensors	18
1.4.1. Enzyme and antibody	18-21
1.4.2. Preparation of enzyme electrodes	21-23
1.4.3. Preparation of antibody based electrodes	23-24
1.5. Sensing activity of an electrochemical biosensor	24-25

1.6. Statement of problem and scope of the thesis	25-31
1.7. References	31-50
Chapter 2: Experimental details and theoretical concepts	51-92
2.1. Parent materials	51-54
2.2. Synthesis steps and optimization-system I (Au/GO/PEDOT-PSS)	55
2.2.1. PEDOT-PSS over ITO electrode	55
2.2.2. 2D material (Graphene oxide)	56
2.2.3. GO/PEDOT-PSS over ITO electrode	57
2.2.4. AuNPs over GO/PEDOT- PSS/ITO electrode	58-59
2.3. Synthesis steps and optimization-system II (Au/WS ₂ /PEDOT-PSS)	59
2.3.1. 2D material (WS ₂ nanosheets)	59-60
2.3.2. WS ₂ /PEDOT-PSS over ITO electrode	60-61
2.3.3. AuNPs on to WS ₂ /PEDOT-PSS/ITO electrode	61-62
2.4. Mechanism behind electrochemical polymerization and electrode fabrication	62-63
2.5. Synthesis steps and optimization-system III (PANI-PVA)	63
2.5.1. Polyaniline powder	63-64
2.5.2. PANI nanofibers	64-65
2.5.3. PVA-PANI solution	65-66
2.5.4. PANI-PVA solution	66
2.6. Nano-bio interface and biofunctionalization	67
2.6.1. Preparation steps of enzymatic Glucose sensors	67-68
2.6.2. Preparation of Aflatoxin B ₁ sensors	68-69
2.7. Analytical tools and techniques	70
2.7.1. X-ray diffraction (XRD)	70-71
2.7.2. Fourier Transform Infrared Spectroscopy (FTIR)	71-72
2.7.3. Field emission scanning electron microscope (FE-SEM)	72-73
2.7.4. Evaluation of electrochemical properties using Potentiostat	73-74
2.7.4.1. Cyclic Voltammetry (CV)	75-76
2.7.4.2. Electrochemical Impedance Spectroscopy (EIS)	76-83
2.7.5. Chronoamperometry (CA)	83
2.7.6. Differential pulse voltammetry	83-84

2.7.7. Transient capacitance technique	84
2.7.8. Electrospinning unit	84-85
2.8. Conclusion	85-86
2.9. References	86-92
Chapter 3: Physical and electrochemical characterization of conducting polymer-based nanocomposites	93-117
3.1. XRD analysis	93
3.1.1. AuNP/GO/PEDOT-PSS	93-94
3.1.2. AuNP/WS ₂ /PEDOT-PSS	94-95
3.1.3. PANI-PVA	95
3.2. FTIR analysis	96
3.2.1. AuNP/GO/PEDOT-PSS	96-97
3.2.2. AuNP/WS ₂ /PEDOT-PSS	97-98
3.2.3. PANI-PVA	98-99
3.3. Morphological studies	99
3.3.1. AuNP/GO/PEDOT-PSS	99-101
3.3.2. AuNP/WS ₂ /PEDOT-PSS	102-103
3.3.3. PANI-PVA	103-105
3.4. Electrochemical properties of different PEDOT-PSS based composite electrodes	105
3.4.1. Cyclic voltammetry analysis	105-106
3.4.2. Electrochemical impedance spectroscopy	107-109
3.4.3. Estimation of electroactive area	110-111
3.5. Conclusion	112-113
3.6. References	113-117
Chapter 4: Relevance of electrochemically synthesized AuNP decorated GO functionalized PEDOT- PSS based electrodes for electrochemical sensing of Glucose and Aflatoxin B₁	118-155
4.1. Introduction	118-120
(A) Glucose sensor	120
4.2. Electrochemical studies of the Glucose biosensors	120

4.2.1. Cyclic voltammetry (CV) studies of Glucose sensor	120-122
4.2.2. Electrochemical Impedance studies of Glucose sensor	123-125
4.3. Chronoamperometry studies of glucose sensor	125-128
4.4. Performance of glucose sensors towards real sample	128-130
(B) Aflatoxin B ₁ sensor	130
4.5. Electrochemical studies of the AF-B ₁ immunosensors	130
4.5.1. Cyclic voltammetry studies of Aflatoxin B ₁ sensor	130-131
4.5.2. Electrochemical Impedance Studies of Aflatoxin B ₁ sensor	132-134
4.6. Capacitive immunosensing of AF-B ₁	134-141
4.7. AF-B ₁ sensor response using Differential Pulse Voltammetry	141-143
4.8. Performance of the Aflatoxin sensor towards real sample	144-148
4.9. Conclusions	148-150
4.10. References	150-155

Chapter 5: Application of PANI-PVA nanofiber based electrodes for electrochemical biosensing of Glucose and Aflatoxin B₁ **156-184**

5.1. Introduction	156-157
(A) Glucose sensor	158
5.2. Electrochemical studies of the Glucose biosensors	158
5.2.1. Cyclic voltammetry (CV) analysis of Glucose sensor	158-159
5.2.2. Impedance studies of the sensor electrodes	159-161
5.3. Glucose oxidizing activity of the fabricated sensor electrode	161-162
5.4. Amperometric detection of glucose	162-164
5.5. Selectivity and repeatability	165
5.6. Real sample analysis	166-167
(B) Aflatoxin B ₁ sensor	167
5.7. Electrochemical studies of the AF-B ₁ immunosensors	167
5.7.1. Cyclic voltammetry studies of fabricated Aflatoxin B ₁ sensor	168-169
5.7.2. Electrochemical Impedance Studies of Aflatoxin B ₁ sensor	169-171
5.8. Transient capacitance measurement of AF-B ₁ sensor and selectivity	171-173
5.9. Repeatability	173-174
5.10. Differential Pulse Voltammetry response of AF-B ₁ sensor	175-176
5.11. Repeatability and selectivity	176-177

5.12. Real sample analysis	178-180
5.13. Conclusions	180-181
5.14. References	182-184
Chapter 6: Application of PANI-PVA nanofiber based electrodes for electrochemical biosensing of Glucose and Aflatoxin B₁	185-215
6.1. Introduction	185-186
(A) Glucose sensor	187
6.2. Electrochemical studies of the glucose biosensors	187
6.2.1. Cyclic voltammetry (CV) studies of glucose sensor	187-188
6.2.2. Electrochemical impedance studies of glucose sensor	188-190
6.3. Glucose oxidation performance of the fabricated sensor electrode	190-191
6.4. Sensing of glucose via chronoamperometry	191-192
6.5. Selectivity and repeatability of the sensor electrode	192-193
6.6. Real sample test	194-195
(B) Aflatoxin B ₁ sensor	196
6.7. Electrochemical studies of the AF-B ₁ immunosensors	196
6.7.1. Cyclic voltammetry studies of Aflatoxin B ₁ sensor	196-197
6.7.2. Electrochemical impedance studies of Aflatoxin B ₁ sensor	197-199
6.8. Detection of AF-B ₁ via Capacitive immunosensing and selectivity test	200-202
6.9. Repeatability	202-203
6.10. Detection of AF-B ₁ via Differential Pulse Voltammetry	204-205
6.11. Reliability and selectivity test	205-207
6.12. Real sample test	207-210
6.13. Conclusions	211-212
6.14. References	212-215
Chapter 7: Conclusions and future direction	216-220
7.1. Conclusion	216-219
7.2. Future outlook	220