To Maa...

For her advice, her patience, and her faith...

Without her nothing would have been possible....

DECLARATION

I, Koushik Barman, hereby state that the thesis entitled "**Electrochemical Sensing of Some Selected Bio-molecules Using Chemically Modified Gold Electrodes**" has not been submitted either in whole or in part earlier to any other institution for the award of any degree and does not contain any previously published material or written by other person, except where due reference is made in the text.

Koushik Barman

Place: Silchar Koushik Barman

Date: 05.09.2017

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Preface

The thesis entitled **"Electrochemical Sensing of Some Selected Bio-molecules Using Chemically Modified Gold Electrodes"** describes the results of a Ph.D. study initiated in September 2013. The study was on the modification of gold electrode surface with different aliphatic and aromatic thiol films having redox active species that include transition metal complexes and metal nanoparticles and the application of their electrochemical sensing of some selected biologically important molecules. The modified electrode surface was characterized by using microscopic (scanning electron microscopy), spectroscopic (energy dispersive X-ray analysis, Fourier transform infrared spectroscopy) and electrochemical (cyclic voltammetry, electrochemical impedance spectroscopy) techniques. The sensing property of the electrode material was investigated by two different electrochemical techniques, *viz*., differential pulse voltammetry and chronoamperommetry.

This thesis consists of seven chapters. In the introductory chapter (**Chapter 1)**, a brief description of bio-molecules, their sensing techniques, chemically modified electrodes, different electrode modifications and characterization techniques and a short review on the electrochemical sensing of some selected bio-molecules using self-assembled thiol monolayer modified gold electrodes along with the present investigation proposal. In **Chapter 2,** a brief account of the chemicals and reagents used for the synthesis purpose and a brief description of various techniques used for the characterization or electrochemical sensing application of the chemically modified gold electrode has been included. **Chapter 3** and **Chapter 4** contains the preparation and characterization of self-assembled aromatic thiols (4-(2′-imidazolylazo)thiophenol and 4-(pyridine-4′-amido)thiophenol) layer modified gold electrode containing transition metal (copper and vanadium) complexes, respectively. The copper(II) complex modified gold electrode was utilized for the sensing of purine bases - adenine and guanine, whereas, the vanadium(IV) complex modified electrode was applied for the detection of glucose and hydrogen peroxide. In **Chapter 5** and **Chapter 6**, we describe the synthesis of CTAB and PVP capped silver nanoparticles and their immobilization on self-assembled aliphatic thiols, L-cysteine, and penicillamine monolayer modified gold electrode, respectively. The

electrodes modified with nanoparticles were used for the electrochemical sensing of vitamin, ascorbic acid and catecholamine neurotransmitters, dopamine and epinephrine. In **Chapter 7**, the significant results of the research work have been summarized and the future scopes of the work stated.

I am happy to state that the work has been published in national and international journals (List of Publications).

As usual practice, findings of other investigators have been duly acknowledged throughout the thesis. Finally, I take the responsibility of any unintentional errors which might have escaped notice despite due precautions.

Abbreviations

PBS	Phosphate Buffer Saline
NPs	Nanoparticles
aq	Aqueous
CV	Cyclic Voltammetry
EIS	Electrochemical Impedance Spectroscopy
DPV	Differential Pulse Voltammetry
LSV	Linear Sweep Voltammetry
CA	Chronoamperommetry
EDX	Energy Dispersive X-ray
DC	Direct Current
FTIR	Fourier-transformed Infrared
HRTEM	High Resolution Transmission Electron Microscopy
AFM	Atomic Force Microscopy
QDs	Quantum Dots
SAED	Selected Area Electron diffraction
SEM	Scanning Electron Microscopy
SPR	Surface Plasmon Resonance
TEM	Transmission Electron Microscopy
UV-vis	Ultraviolet and visible
VSM	Vibrating-Sample Magnetometer
RSD	Relative Standard Deviation
LOD	Limit of Detection

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Symbols

2D	two dimensional
3D	three dimensional
Å	angstrom
t	time
µA	microampere
V	volt
mV	millivolt
C	velocity of light
°C	degree Celsius
cm	centimeter
C	concentration
Eg	band gap
eV	electron volt
E_{pc}	cathodic potentials
E_{pa}	anodic potentials
ΔE_P	potential difference
fcc	face-centered cubic
h	hour
s	second
I_{pa}	anodic peak current
I_{pc}	cathodic peak current
Ɵ	surface coverage
S/N	signal to noise ratio
D	diffusion coefficient
A	electrode area
n	number of electron
α	electron transfer coefficient
ν	scan rate
k_s	standard heterogeneous rate constant
mg	milligram
nM	nanomolar
µM	micromolar
mL	milliliter
nm	nanometer
N_A	Avogadro's number
R	average radii of the particles
M	molar
mM	millimolar
K_{cat}	catalytic rate constant
Λ_{max}	maximum wavelength
K	kelvin

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Consequent upon Arrear/ Betterment

INTEGRATED PRE PH.D. COURSE WORK EXAMINATION, 2013

MARK SHEET

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COURSE WORK Examination , held in May 2013

Course/Paper No	Name/Title of Course /Paper	Full Marks	Pass Marks	Marks Obtained
IPP-501	Research Methodology-I	100	50	66
IPP-502	Research Methodology-II	100	50	76 #
IPP-503	Chemistry	100	50	73
IPP-504	Term Paper	100	50	72

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RESULT : QUALIFIED for Ph.D./M.Phil admission.

Courses(s)/Paper(s) yet to clear :

Qualifying marks for :

i) Ph.D. Admission : Minimum 55% marks in each paper as well as in aggregate.

ii) M.Phil Admission : Minimum 50% to less than 55% in each paper as well as in aggregate

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