

TABLE OF CONTENT

ENDORSEMENT PAGE	i
ACKNOWLEDGEMENT	ii
TABLE OF CONTENT	iv
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF APPENDICES	xiii
ABSTRACT	xv
CHAPTER I INTRODUCTION	1
I.1 Background.....	1
I.2 Research Objectives.....	6
CHAPTER 2 LITERATURE REVIEW	7
II.1 Microbial Fuel Cell (MFC)	7
II.1.1 Microorganisms as Biocatalysts in Microbial Fuel Cells (MFCs)	11
II.1.2 <i>Saccharomyces cerevisiae</i>	13
II.1.3 Electron Transfer in <i>Saccharomyces cerevisiae</i>	17
II.2 Gold Nanoparticles.....	21
II.3 Lime Juice (<i>Citrus aurantifolia</i>) as a Bioreductor	25
II.4 Polyethyleneimine (PEI)	28

II.5 Carbon Nanotube (CNT).....	31
II.6 Phytochemicals Analysis.....	34
II.6.1 Phenolic Compound.....	34
II.6.2 Tannins.....	35
II.6.3 Flavonoids.....	36
II.6.4 Terpenoids.....	38
II.6.5 Alkaloids.....	39
II.6.6 Saponin.....	40
II.7 High Performance Liquid Chromatography (HPLC).....	41
II.8 Physicochemical Characterization.....	43
II.8.1 UV-Visible (UV-Vis) Spectroscopy.....	45
II.8.2 Fourier Transform Infrared (FTIR).....	47
II.8.3 X-ray Diffraction (XRD).....	50
II.8.4 Field Emission Scanning Electron Microscope (FE-SEM), EDX, and Mapping.....	51
II.8.5 Transmission Electron Microscopy, High-Resolution Transmission Electron Microscopy, and Fast Fourier Transform (TEM, HRTEM, and FFT).....	53
II.9 Electrochemical Characterization of Half and Full Cells.....	54
II.9.1 Cyclic Voltammetry (CV).....	57

II.9.2 Donor–Acceptor Mechanism in Electron Transport.....	60
II.9.3 Rate Determining Step (RDS).....	61
II.9.4 Rate Constant for Electron Transfer (k_s).....	63
II.9.5 Voltage.....	64
II.10 Polarization and Maximum Power Density (MPD)	66
II.11 Biofilm in MFC	68
CHAPTER 3 RESEARCH METHODOLOGY	73
III.1 Materials and Apparatus.....	73
III.1.1 Materials.....	73
III.1.2 Apparatus.....	74
III.2 Procedures	75
III.2.1 Coating of Carbon Nanotubes (CNT) with Polyethyleneimine (PEI) 75	
III.2.2. Decoration of CNT/PEI with Gold Nanoparticles (AuNPs)	76
III.2.3 Initial Characterization of <i>Citrus aurantifolia</i> Extract.....	78
III.2.4 Physicochemical Characterization	81
III.2.5 Preparation of <i>Saccharomyces cerevisiae</i> Culture Media.....	87
III.2.6 Half-Cell and Full-Cell Configurations	87
III.2.7 Half-Cell Characterization	89
III.2.8 Full-Cell Characterization.....	91
CHAPTER IV RESULT AND DISCUSSION	95

IV.1 Phytochemical Analysis of Lime Juice (<i>Citrus aurantiifolia</i>).....	96
IV.1.1 Phenolics Content.....	96
IV.1.2 Terpenoids Content.....	97
IV.1.3 Flavonoids Content.....	99
IV.1.4 Alkaloids Content.....	100
IV.2 Ascorbic Acid Confirmation via High-Performance Liquid Chromatography (HPLC).....	104
IV.3 Visual Observation During Nanoparticle Synthesis.....	106
IV.4 UV–Visible Spectroscopy Analysis of Gold Nanoparticle Formation....	107
IV.6 FT-IR Analysis.....	111
IV.7 X-Ray Diffraction Analysis.....	114
IV.8 Field Emission Scanning Electron Microscopy (FE-SEM) Analysis.....	118
IV.9 Transmission Electron Microscopy (TEM).....	122
IV.10 Suggested Interaction between CNT, PEI, and AuNPs.....	131
IV.11 Analysis Half-Cell.....	136
IV.12 Cyclic Voltammetry (CV) Analysis Results.....	136
IV.13 Rate-Determining Step (RDS) Analysis Results.....	144
IV.14 Electron Transfer Rate Constant (K_s) Analysis Results.....	147
IV.15 Full-Cell Analysis.....	149
IV.15.1 Voltage Analysis.....	150

IV.15.2 Polarization and Maximum Power Density.....	152
IV.15.3 Biofilm Analysis.....	154
CHAPTER V CLOSING	151
V.1 Conclusion	151
V.2 Suggestion.....	152
REFERENCE	153
APPENDIX	167