

Table of Contents

Abstract	II
Declaration by the candidate	IX
Certificate of Supervisor	X
Certificate of ODEC	XI
Acknowledgement	XII
List of Publications	XIII
Table of Contents	XV
List of Figures	XIX
List of Tables	XXVI

Chapter 1 Introduction

1.1 Ion sensitive field effect transistor and Enzyme field effect transistor	2
1.2 Motivation	3
1.3 Thesis outline	5
Bibliography	8

Chapter 2 Overview on Ion Sensitive Field Effect Transistor and Enzyme FET

2.1 Introduction	12
2.2 Theory on ISFET	16
2.2.1 Site binding theory	18
2.2.2 Electrical double layer	19

Table of Contents

2.3	ISFET modeling	24
2.4	Enzyme Field Effect Transistor	30
2.4.1	Enzyme catalyzed reaction of substrate	32
2.4.2	Diffusion –reaction equation	34
2.5	Results and Discussion	42
	Bibliography	48

Chapter 3 Threshold voltage modeling using capacitance voltage characteristics

3.1	Introduction	59
3.2	Theory	60
3.3	Proposed model description	61
3.4	Current voltage characteristics	65
3.5	Model extended to ISFET device	66
3.6	Results and Discussion	67
	Bibliography	71

Chapter 4 Long term drift in ISFET due to Hydrogen ion diffusion

4.1	Introduction	74
4.2	Model Formulation considering only the diffusion of protons	76
4.2.1	Change in threshold voltage due to diffused hydrogen ion in the oxide layer	76
4.3	Mathematical modeling considering the electric field due to diffusion	80
4.4	Experimental Details	84

Table of Contents

4.5	Results and Discussion	85
	Bibliography	91
Chapter 5	Fabrication of a Schottky based ISFET immobilized with enzyme CYP450	
5.1	Introduction	94
5.2	Principle of operation	95
5.3	Fabrication of the ISFET	97
5.3.1	ISFET made into an ENFET	100
5.3.1.1	Partial purification of the enzyme	103
5.3.1.2	Enzyme immobilization	103
5.3.2	Mercury (Hg) MOSFET	104
5.4	Circuit diagram	105
5.5	Results and Discussion	108
5.5.1	Transfer Characteristics	110
5.5.2	Output Characteristics	116
5.5.3	Sensitivity	117
5.5.4	Stability	120
5.5.5	Hysteresis	121
5.5.6	Detection limit and change in pH after reaction	123
5.5.7	Reproducibility of the sensor system	124
5.5.8	Procedure for measurement of n hexadecane	125
5.5.9	Convertibility of the fabricated ISFET	126
5.5.10	Comparative analysis	128
	Bibliography	129

Table of Contents

Chapter 6	Modeling and experimental validation of the optimal positioning of reference electrode for a Silicon Nitride pH ISFET	
6.1	Introduction	134
6.2	Theory	134
6.3	Mathematical modeling	137
6.3.1	Model description	138
6.3.2	Model formulation	139
6.4	Experimental set up	144
6.4.1	Generation of gate voltage	151
6.5	Results and Discussion	155
	Bibliography	165
Chapter 7	Conclusion	168
	Future Scope	172