

Contents

- 1 Introduction 1**
 - 1.1 Motivation and Main Contributions 1
 - 1.2 Thesis Outline 2
 - Reference 3
- 2 Bio-Electronics Interfaces 5**
 - 2.1 Micro Electrode Arrays 6
 - 2.1.1 Metal-Electrolyte Interface 7
 - 2.1.2 Cell/Planar Microelectrode Electrical Model 9
 - 2.2 Field Effect Devices for Electrophysiological Application 11
 - 2.2.1 ISFET Transduction Principle 12
 - 2.2.2 ISFET-Based Sensors for Extracellular Monitoring of Excitable Cells: The Bergveld Model 14
 - 2.2.3 ISFET-Based Sensors for Extracellular Monitoring of Neurons Activity: The Fromherz Model 17
 - 2.2.4 Cell-FET Hybrids 21
 - 2.3 High-Density FEDs: The APS MEA 23
 - 2.4 Extended Gate Transistors for Electrophysiological Applications 24
 - References 25
- 3 Organic Devices for Electrophysiological Applications 29**
 - 3.1 Organic Field Effect Transistors 30
 - 3.1.1 OFETs for Cell Electrical Activity Sensing 33
 - 3.2 Electrolyte-Gated Organic Field Effect Transistors 36
 - 3.2.1 EGOFETs for Cell Electrical Activity Sensing 39
 - 3.3 Organic Electrochemical Transistors 41
 - 3.3.1 OEETs for Cell Electrical Activity Sensing 43
 - References 45

4	The Micro Organic Charge Modulated FET Array	47
4.1	The Charge Modulated FET	47
4.2	The Organic Charge Modulated FET	51
4.2.1	OCMFET Working Principle	51
4.2.2	OCMFET for pH Sensing.	52
4.2.3	OCMFET for DNA Hybridization Sensing	52
4.3	Low-Voltage OCMFETs.	54
4.4	OCMFET for Cell Electrical Activity Sensing: The Micro OCMFET Array, Conception and Development.	55
4.4.1	Self-aligned Transistors: Toward High Frequency Applications	57
4.4.2	Passive Microelectrode Integration.	57
4.4.3	Titanium MOAs	58
4.4.4	Device Passivation.	60
4.4.5	Endurance Assessment.	65
4.4.6	MOA Evolution	66
4.5	Conclusions	70
	References	70
5	Experimental Results	73
5.1	Cells Viability Assessment	74
5.2	Cardiomyocytes Activity Detection	74
5.3	Neuronal Activity Recordings	82
5.3.1	Striatal Neurons	82
5.3.2	Hippocampal Neurons	83
5.4	Toward Metabolic Activity Recordings.	86
5.5	Conclusions	88
	References	88
6	Conclusions	91
	Appendix A: Sensor Fabrication	93
	Appendix B: Readout Electronics	101
	Appendix C: Electrophysiological Basis of the Action Potential	113

<http://www.springer.com/978-3-319-28879-6>

Organic Transistor Devices for In Vitro
Electrophysiological Applications

Spanu, A.

2016, XIV, 120 p. 82 illus., 62 illus. in color., Hardcover

ISBN: 978-3-319-28879-6