# CONTENTS

<table>
<thead>
<tr>
<th>SYNOPSIS</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>6</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>15</td>
</tr>
</tbody>
</table>

## CHAPTER 1 INTRODUCTION

1.1 An overview of conducting polymers 18
1.2 Types of conducting polymers 20
   1.2.1 Broad classification 20
   1.2.2 Polypyrrole 21
   1.2.3 PCDTBT 26
1.3 Charge transport in conducting polymers 27
1.4 Conducting polymer thin films: preparation methods 32
1.5 Application of conducting polymers 34
   1.5.1 Organic field effect transistors 36
   1.5.2 Conducting polymer gas sensors 44
1.6 Motivation and outline of the thesis 50

## CHAPTER 2 EXPERIMENTAL TECHNIQUES

2.1 Deposition of flexible polypyrrole films 54
   2.1.1 Materials 54
   2.1.2 Freestanding films by interfacial polymerisation 55
   2.1.3 PPy-Ag nanocomposites films on flexible BOPET substrates 56
2.2 Fabrication of flexible devices 57
   2.2.1 Gas sensors 57
   2.2.2 FET fabrication 57
2.3 Techniques for film characterization 59
   2.3.1 Spectroscopic characterisation 59
   2.3.2 Morphological characterisation 66
2.3.3 Contact angle measurement 70
2.3.4 Electrochemical characterisation 71
2.4 Electrical measurements 73
  2.4.1 Metal deposition 73
  2.4.2 OFET characteristics and low temperature conductivity measurement 74
  2.4.3 Gas sensing measurement 74

CHAPTER 3 FREESTANDING POLYPYRROLE FILMS 76
  3.1 Overview of freestanding conducting polymer films 78
  3.2 Freestanding PPy films at liquid/air interface using in-situ template 79
    3.2.1 Growth process of PPy nanosheets 79
    3.2.2 Morphology of freestanding PPy films 80
    3.2.3 Charge transport measurements 85
    3.2.4 Gas sensors 90
    3.2.5 Fabrication of OFET 93
  3.3 Freestanding PPy films via acidic oxidation of terpyrrole at air/liquid interface 94
    3.3.1 Formation mechanism 94
    3.3.2 Current-voltage characteristics and memory effect 98
  3.4 Conclusions 105

CHAPTER 4 FLEXIBLE POLYPYRROLE/Ag NANOCOMPOSITE FILMS 107
  4.1 Introduction to nanocomposites films 109
  4.2 Photopolymerization of flexible nanocomposite films 110
    4.2.1 Hydroxylation of BOPET surface 110
    4.2.2 Silanization of OH-terminated BOPET surface by self-assembly 111
    4.2.3 Formation of polypyrrole-silver composite films 115
  4.3 Characterization of composite films 116
    4.3.1 Microstructure evolution 116
    4.3.2 Structural characterization 123
  4.4 Electrical conductivity and electron transport mechanism 129
4.5 Flexibility and adhesion 133
4.6 Chemiresistive gas sensing characteristics 135
4.7 Conclusions 139

CHAPTER 5 FLEXIBLE OFETs BASED ON PCDTBT 141

5.1 Overview of current research on flexible OFETs 143
5.2 Fabrication process of OFET 145
5.3 Characteristics of active PCDTBT layer 147
  5.3.1 AFM studies 147
  5.3.2 UV/Vis and Raman studies 147
  5.3.3 XPS studies 148
5.4 OFET characteristics 151
  5.4.1 Output and transfer characteristics 151
  5.4.2 Field effect mobility, subthreshold voltage and density of trap states 152
5.5 Environmental stability of OFETs 155
5.6 Electromechanical properties of OFETs 158
5.7 Gas sensing characteristics of OFETs 160
5.8 Conclusions 161

CHAPTER 5 SUMMARY 163

BIBLIOGRAPHY 169