CONTENTS

LIST OF PUBLICATIONS ............................... i

LIST OF PAPERS PRESENTED IN SEMINARS AND ABSTRACT PUBLISHED ........................ iv

LIST OF TABLES ..................................... v

LIST OF FIGURES ................................... ix

CHAPTER – 1 General Introduction .................. 1

1.1 Composite Materials ............................. 2

  1.1.1 Classification of composite materials ......... 2

1.2 Organic-organic Conducting Composites ......... 8

1.3 Organic-inorganic Composite Materials .......... 10

  1.3.1 Organic-inorganic composite synthesis strategies 15

1.4 Chromatography .................................. 16

  1.4.1 Types of chromatography .................... 17

    1.4.1.1 Liquid chromatography .................. 18

    1.4.1.2 Adsorption chromatography ............... 18

    1.4.1.3 Paper chromatography ..................... 20

    1.4.1.4 Thin layer chromatography (TLC) ........ 20

    1.4.1.5 Partition chromatography ................. 22

    1.4.1.6 Molecular exclusion chromatography ....... 24

    1.4.1.7 Affinity chromatography .................. 24
1.4.1.8. Column chromatography 24
1.4.1.9. Ion-exchange chromatography 26

1.5. Ion-Exchange Properties of Materials 30
1.5.1. Ion-exchange phenomenon & its historical background 30
1.5.2. Ion-exchange process and its mechanism 33
1.5.3. Ion-exchange materials: An introduction and literature review 36
  1.5.3.1 Inorganic ion-exchange materials 36
    1.5.3.1.1. Natural inorganic ion-exchangers 36
    1.5.3.1.2. Synthetic inorganic ion-exchangers 37
  1.5.3.2 Organic Ion-exchange Materials 50
    1.5.3.2.1. Natural organic ion-exchangers 50
    1.5.3.2.2. Modified natural organic ion-exchangers 50
    1.5.3.2.3. Synthetic organic ion-exchangers 51
  1.5.3.3. Chelating ion-exchange materials 52
  1.5.3.4. Intercalation ion-exchangers 59
  1.5.3.5. ‘Organic-inorganic’ composite ion-exchange materials 63

1.5.4. Applications of Ion-exchange Materials 67

1.6. Electrical Properties of Materials 69
1.6.1. Electrical conduction in materials 69
1.6.2. Electrically conducting materials 70
1.6.3. Electrically conducting polymers 71
1.6.3.1 Polyaniline
1.6.3.2 Polypyrrole

1.6.4. Electrically conducting ‘organic-inorganic’ composites

1.6.5. Applications of electrically conducting polymers and composites
   1.6.5.1. Optical Devices
   1.6.5.2. Conductors
   1.6.5.3. Sensors
   1.6.5.4. Electrically conducting polymers and composites as ion-exchangers

1.7. Membranes: An Introduction

1.8. Electrochemical Sensors
   1.8.1. Ion-selective electrodes
   1.8.2. Physico-chemical properties of ion-selective electrodes
      1.8.2.1. Electrode response or membrane potential
      1.8.2.2. Selectivity coefficients
      1.8.2.3. Response time
      1.8.2.4. Effect of pH
      1.8.2.5. Life span of membrane electrode
   1.8.3. Literature review on membranes and ion-selective electrodes
   1.8.4. Applications of ion-exchanger based membranes and ion-selective electrodes

References
CHAPTER - 2 Preparation and characterization of new and novel organic-inorganic composite cation-exchange materials: polypyrrole Th(IV) phosphate & polyaniline Sn(IV) phosphate

2.1. Introduction 185
2.2 Experimental 189
2.3 Results and Discussions 205
> References 226

CHAPTER - 3 Studies on ion-exchange properties of polypyrrole Th(IV) phosphate & polyaniline Sn(IV) phosphate composite cation-exchangers

3.1. Introduction 232
3.2 Experimental 235
3.3 Results and Discussions 250
> References 280

CHAPTER - 4 Electrical conductivity measurement studies of "organic-inorganic" composites: polypyrrole Thorium(IV) phosphate & polyaniline Sn(IV) phosphate

4.1. Introduction 286
CHAPTER - 5 Preparation and characterization of ion-exchange membranes and ion-selective electrodes based on polypyrrole Th(IV) phosphate and polyaniline Sn(IV) phosphate

5.1. Introduction 318
5.2 Experimental 322
5.3 Results and Discussions 332
References 351

CHAPTER - 6 Analytical applications of polypyrrole Th(IV) phosphate and polyaniline Sn(IV) phosphate composite cation-exchangers in separation of metal ions, determination of Pb(II) & Hg(II) from samples of waste water using ion-selective electrodes, adsorption of pesticides

6.1. Introduction 358
6.2 Experimental 362
6.3 Results and Discussions 368
References 389
APPENDIX

Appendix - I  List of Abstracts Published in Seminars and Conferences  392
Appendix - II  Reprints of Research Papers  393