Development of soluble π - conjugated polymers and evaluation of their electroluminescence properties

ABSTRACT

The present thesis deals with synthesis, characterization and evaluation of thermal, electrochemical, photoluminescence and electroluminescence properties of a few new ester substituted polythiophenes. A considerable effort has been devoted to the synthesis of polymers with special emphasis on the solubility of π- conjugated polymers. The thesis also provides an account of fluorescence quenching and sensor application of ester substituted polythiophenes. The contents of the thesis have been compiled into five chapters.

Chapter 1 deals with the general introduction of π- conjugated polymers and their application in light emitting diode. A brief review on substitute polythiophenes with special emphasis on solubility, band gap and color tuning, fluorescence efficiency, electrochemical behavior and electroluminescence properties has been described in this chapter. This chapter also describes the scopes and objectives along with the plan and methodology of the present investigation.

Chapter 2 describes the synthesis and characterization of monomers and polymers and their thermal properties. We have synthesized the following 3-ester substituted thiophene.

- Hexyl 2-(thiophene-3-yl) acetate (HTA)
- Octyl 2-(thiophene-3-yl) acetate (OTA)
- Decyl 2-(thiophene-3-yl) acetate (DTA)
- Dodecyl 2-(thiophene-3-yl) acetate (DDTA)
- 3-pentadecylphenyl 2-(thiophene-3-yl) acetate (PDPTA)
- 3-pentadecylcyclohexyl 2-(thiophene-3-yl) acetate (PDCHTA)
- Quinoline -8-yI 2-(thiophene-3-yl) acetate (QTA)

The monomers were synthesized by esterification reaction of 3-thiophene acetic acid and corresponding alcohols and characterized by $^1$H NMR, FTIR and UV-Vis analysis. The polymerization was accomplished by oxidative coupling in the presence of FeCl$_3$. The
synthesized polymers were characterized by $^1$H NMR, FTIR, UV-Vis, XRD and GPC analysis. The polymers were found to be soluble in THF and CHCl$_3$. Thermal properties of the polymers were studied by TGA and DSC technique. Polymers have found good thermal stability.

In Chapter 3, electrochemical, photo and electroluminescence properties of synthesized polymers have been discussed. The oxidation and reduction potential of polymers were assessed in cyclic voltammetry method. Redox stability of polymers was tested by cyclic voltammetry up to 10 cycles. Furthermore, band gap of polymers was measured by electrochemically and compared with optical method. Photoluminescence properties of polymers in solution and solid state were investigated. The relative quantum yield of polymers with respect to Rhodamine B dye was measured. The electroluminescence properties of polymers were studied by fabricating LED device. The device configuration was ITO / PEDOT: PSS / Polymer / LiF / Al.

Chapter 4 includes the fluorescence quenching and application of polymers as chemical sensor. The behaviour of photoluminescence property was studied in presence of acids, metals ions, nucleotides and protein (l-proline). The polymers showed both fluorescence quenching in the presence of acids, copper, cadmium and lead metal ions and enhancement in presence of analytes such as aluminium and zinc metals ions, nucleotides and protein (l-proline). The detection limit of HCl acid, copper, lead and cadmium ions has been evaluated by optical quenching method.

Chapter 5, the last chapter of the thesis includes the concluding remarks, highlights of the findings and future scopes of the present investigation. A series of ester substituted polythiophenes has been developed by FeCl$_3$ oxidative coupling polymerization technique, resulting in soluble and high thermal stable polymers. A correlation of structure - property has been drawn with respect to their optical properties. Finally these polymers have been utilized in light emitting diode and in chemical sensors.