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FABRICATION OF CONDUCTING POLYMER BASED ELECTROCHEMICAL BIOSENSOR FOR ENVIRONMENTAL MONITORING

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ABSTRACT

The strategy and useful applications of electrochemical sensors for environmental monitoring are surveyed. The electrochemical properties of the composite electrodes are investigated by Cyclic Voltammetry. Much effort in this area has been based on utilizing the redox properties of conducting polymers, particularly polyaniline (PANI) and polythiophene. Biosensors show the potential to complement laboratory-based analytical methods for environmental applications. Cyclic voltamogram shows clear oxidative and reductive peak due to hydrazine present in the analyte. Detection of hydrazine hydrate and other environment pollutants are possible with the help of conducting polymer based electrochemical biosensor.

Keywords: Conducting Polymer, Electrochemical Biosensor, Environmental Monitoring.

I. INTRODUCTION

In recent years, a growing number of initiatives and legislative actions for environmental pollution control, with particular emphasis on water quality control, have been adopted in parallel with increasing scientific and social concern in this area. Traditional environmental monitoring approaches are based upon discrete sampling methods followed by laboratory analysis [1]. Electrochemical transducers have been widely used in biosensors for pollutants detection due to their high sensitivity [2- 4]. These harmful effects highlight the need for instituting a rapid systematic and continuous monitoring of pollutants. Electrochemical platform detection and biosensors are such devices that can be implemented [5]. A biosensor is defined by IUPAC as a self-contained integrated device that is capable of providing specific quantitative or semi-quantitative analytical information using a biological recognition element (biochemical receptor), which is retained in direct spatial contact with a transduction element. A biosensor should be clearly distinguished from a bio analytical system, which requires additional processing steps, such as reagent addition. A device that is both disposable after one measurement, i.e., is single use, and unable to monitor the analytic concentration continuously or after rapid and reproducible regeneration should be designated a single-use biosensor [6- 10].

Organic conjugated polymer (conducting polymers) are mainly organic compounds that have an extended π-orbital system, through which electrons can move from one end of the polymer to the other [11- 13]. Many types of analytical applications of the conducting polymers have been reported since their discovery. These compounds have useful applications in the development of chemical sensors. During the last two decades, conducting polymers have emerged as one of the most interesting materials for the fabrication of electrochemical sensors [14]. Modification of electrodes with polyaniline and other conducting polymers is commonly carried out by means of electro-polymerization of the monomer aniline from aqueous media [15].

II. MATERIAL AND METHODOLOGY

2.1 Synthesis of conducting polymer

Conducting polymers were synthesized by the free oxidation method. Conducting polymers Polyaniline and polythiophene are more conductive, stable and biocompatible than other polymer materials.

2.2 Synthesis of Conducting Polymer Polyaniline

Conducting polymer polyaniline was synthesized by aniline monomer as a precursor (Loba Chemie 99.8%), $FeCl_3$ (CDH), HCl (Himedia) and distilled water. Polythiophene was synthesized by thiophene monomer (Loba Chemie).

2.3 Characterization of Conducting Polymers

Characterization of conducting polymer was by using UV– Visible spectroscopy and FT– IR techniques.

2.4 Fabrication of Working Test Electrode

A carbon paste working electrode was prepared by using slurry of graphite powder, carbon nanotubes, hexacynoferrate, polyvinylpyrrolidone (PVP) and Copper wire (2.0 mm) dipped into it for making electrical connections. Three electrodes assembly i.e. a working test electrode, Ag/AgCl reference electrode and a platinum electrode as an auxiliary electrode was assembled to acts as an Electrochemical cell.

2.5 Electrochemical Characterization by using three electrodes based glass cell

Electrochemical characterization experiments were performed by using Cyclic voltametry technique.

III. RESULT AND DISCUSSION

The characterization of conducting polymers was carried out by using UV- Visible spectroscopy and FT- IR techniques. Figure 1 represents the FT- IR of polyaniline. Figure 2 represents the FT- IR of polythiopehene. Figure 3 represents the UV- Visible spectra of polyaniline. Figure 4 represents the UV- Visible spectra of polythiophene. FTIR spectra of conducting polyaniline and polythiophene shows characteristics absorption peak in finger print region of the spectrum. UV-visible absorption spectra of conducting polymer i.e. polyaniline and polythiophene shows characteristics absorption peak in visible region of the spectrum. Cyclic voltamogram shows clear oxidative and reductive peak due to hydrazine present in the analyte. Detection of hydrazine hydrate and other environment pollutants are possible with the help of conducting polymer based electrochemical biosensor.

IV. CONCLUSION

A carbon (Graphine) based working electrode was specially designed having Ferrocene, aq. KOH, carbon nanotubes and Polyvinyl pyrrolidone (PVP) and conducting polymer. Characterization of conducting polymers was carried out by UV – Visible spectroscopy and FT– IR techniques. Cyclic voltametric experiments were performed for electrochemical characterization of hydrazine hydrate in the environment as a pollutant. Detection of hydrazine hydrate and other environment pollutants are possible with the help of conducting polymer based electrochemical biosensor. Conducting polymer based biosensor offers a very quick, reliable and cost effective method for the estimation of environment pollutants present in the water, air and soil.

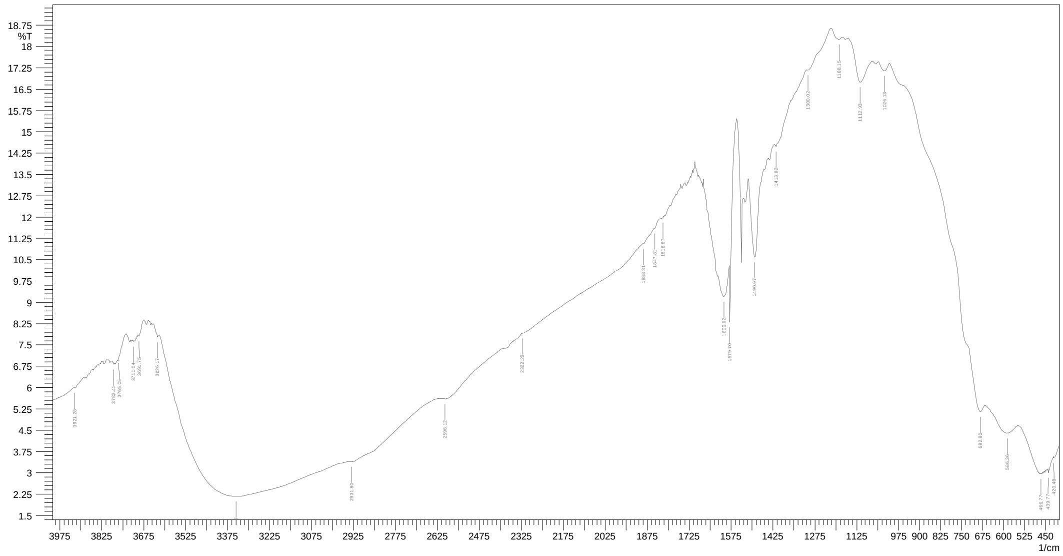

Fig.1. FTIR Spectra f Conducting Polymer Polyaniline.

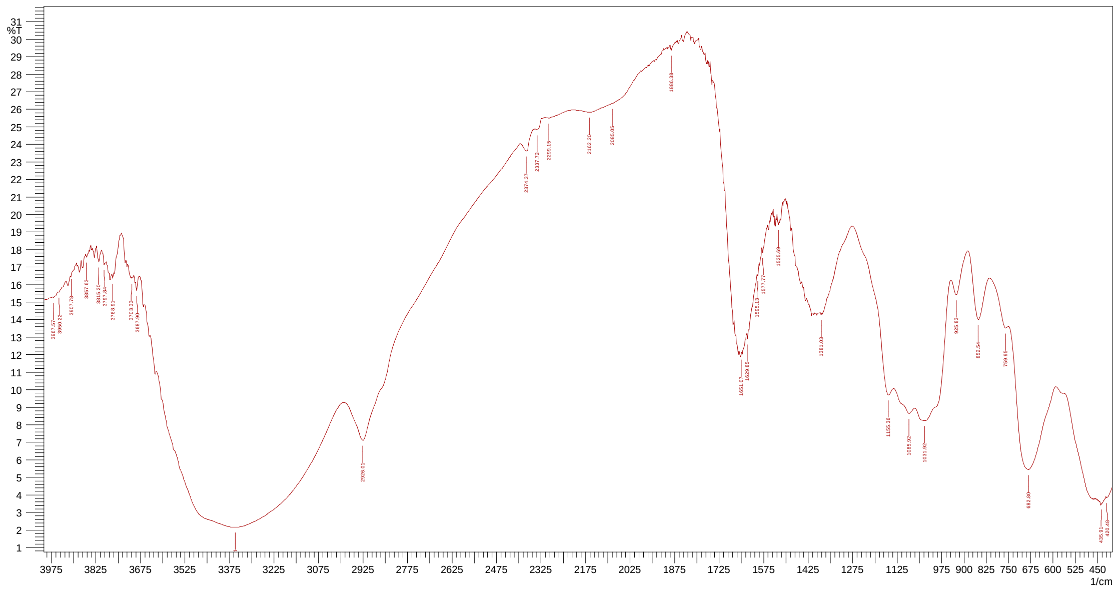

Fig.2 FTIR Spectra of Conducting Polymer Polythiphene.

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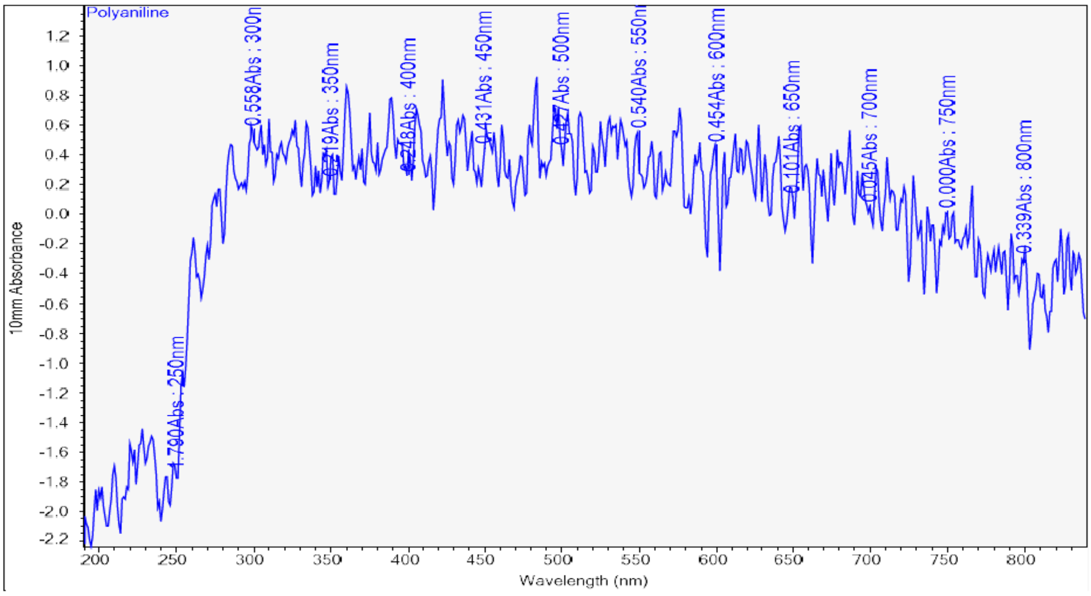

Figure 3. UV- Vis spectra of Polyaniline.

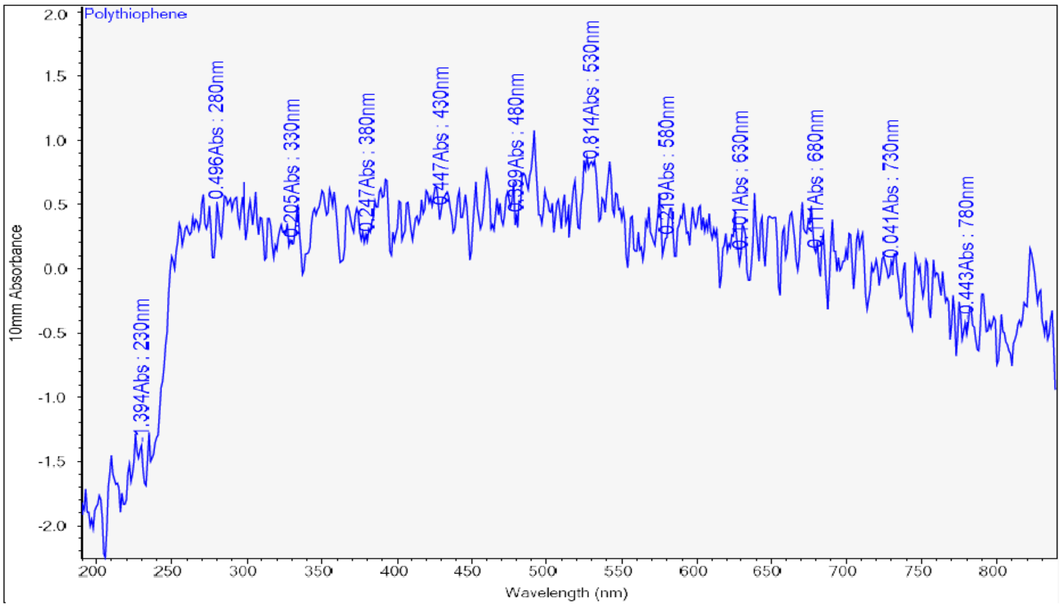

Figure 4. UV- Vis spectra of Polythiophene

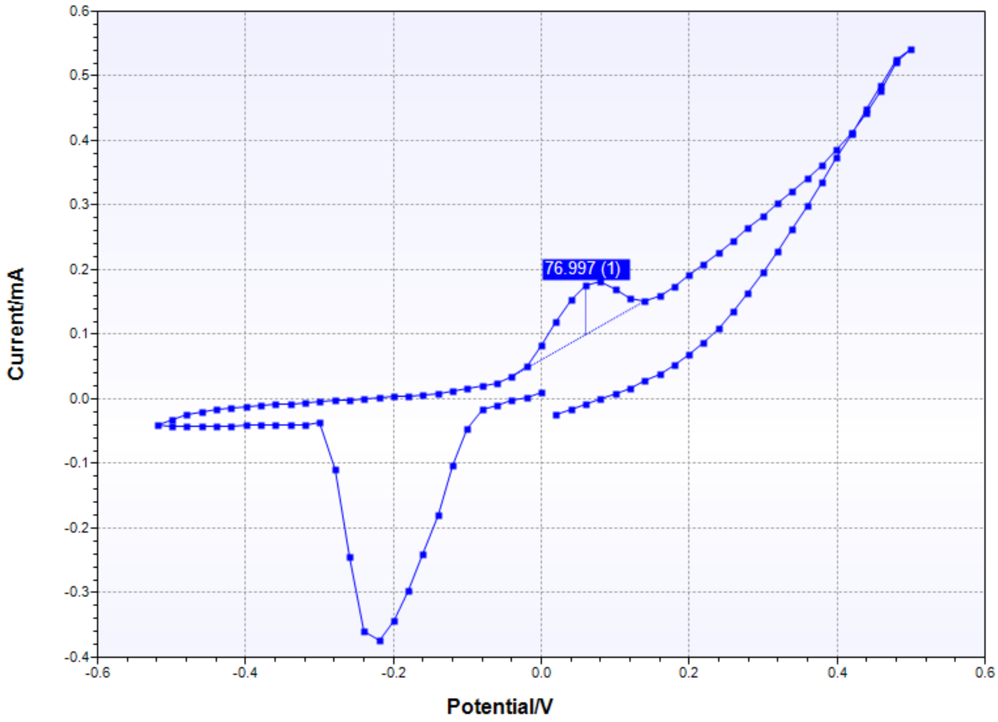

Figure5. Cyclic Voltametry Experiments for the Determination of Hydrazine as a Pollutant in the Environment

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