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Conjugated Polymer as Health Biosensor

Nur 'Izqa Ashiqin Mohd Najib, Siti Amira Othman*, Nur Amirah Elias, Siti Nursyakirah Idris and Fong Chui Nee

Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, Pagoh, 84600, Johor, Malaysia

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Abstract: This research was focused on the conductive polyaniline characterization and properties. The pH level is measured using a portable pH and the temperature were measured using a thermometerthe polyaniline was synthesized by using hydrochloric acid (the protonic acid) and ammonium persulfate (oxidation reagent). Synthesizing play an important role in this part of the research because more time synthesizes the polyaniline's higher conductivity to achieve. The drying process is also important to produce powder from the synthesis of aniline solution, which is polyaniline emeraldine salt (green powder) and polyaniline emeraldine base (blue powder). The electrical conductivity of doped samples was measured. The conductivity or electrical properties of the polyaniline film was investigated. Data and analysis was collected as the result.

Keywords: Conjugated, PANI, polyaniline, biosensor

1. Introduction

Biosensors are increasingly being used in a variety of healthcare settings. The researchers studied new improvements of biosensor applications with different methods and techniques. A range of transduction techniques such as electrochemical, optical and acoustic can be used for biosensors. The characteristics of the biosensors are selectivity, stability, sensitivity, duplicability and linearity [1]. To improve biosensor selectivity, high-affinity reagents like enzymes and synthetic biomolecules can be combined with the transducer. Nanotechnology has a significant influence on current biosensing technology advancements. Certain conducting polymers have exceptional electrical conductivity and transfer electrical charge from redox enzymes to electrodes. Highly conductive polymers are used as electrode materials for supercapacitors. Examples such as polypyrrole, polyanilline, polyacetylene, and polythiophene [2]. Polyaniline is one of the most popular conducting polymers because of its high sensitivity, ease of synthesis, flexibility and good performance in biosensor applications. The properties of polyaniline are the key elements of the successful biosensor in sensing various biomolecules. Electrically conductive conjugated polymers have been studied since the early 1960s, including René Buvet and Marcel Jozefowicz on polyaniline [3].

Polyaniline is a conducting polymer because of its conductivity towards biosensor applications. Its characteristics and behaviour are almost the same as the other conducting polymers such as polypyrrole,

**Corresponding author: sitiamira@uthm.edu.my*
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polythiophene and poly (p-phenylene). However, polyaniline is not entirely perfect with its poor physical and mechanical properties. There are some drawbacks such as poor solubility in many solvents, low adhesion to a different substrate and protonic acid doping's weak chemical reactivity which can only occur in a very acidic environment (pH≤4) and also low conductivity [4]. A doping approach using functionalized protonic acids such as hydrochloric acid or dodecylbenzene sulfonic acid (DBSA) can increase solubility and induce fusibility of the stiff chain of this polymer. Polyaniline powder is a conductive polymer that does not melt well in most solvents. As a result, it is not adhesive on various substrates, except for a few organic solvents such as Hydrofluoric acid and Dimethyl formamide. At the end of the research, the aim is to identify the electric conductivity of the polymer. Therefore, the study focuses on preparing ways to obtain the excellent conductivity of polyaniline.

This research is significant to encourage the following study to use as the reference to improve some new applications in conducting polymer regions. Furthermore, conducting polymers are one of the most promising materials that may be used to improve the analytical properties of sensors. Through this research, conjugated polymer-based molecular imprinted polymer-based sensors have been produced with selectivity and sensitivity that are almost identical to biosensors based on biological materials. Some conducting polymers have exceptional electrical conductivity and the ability to transmit electric charge from redox enzymes to electrodes uniquely. Hence, this kind of polyaniline grafted materials shows a great prospect, likely opening up new avenues for their remarkable uses.

2. Materials and Methods

2.1 Materials

These materials and chemicals are provided in completing all the procedures and producing the needed products at the experimental end. The main raw material is aniline solution which will be used to synthesise the polyaniline. Ammonium persulfate will be added as an oxidation reagent to produce polyaniline base and polyaniline salt. HCl will be used to produce conductive polyaniline and polyaniline. Next, the four-point probe will characterize the conductivity properties of polyaniline. Many acids and bases are available in highly concentrated solutions. To prepare each dilute solution, one needs to know the volume of the concentrated liquid that is required.

2.2 Synthesis of polyaniline

Although the synthesis procedures for producing polyaniline are straightforward, the polymerization mechanism is likely to be complicated. These procedures below will complete the synthesis of the polyaniline. First and foremost, 10mL of aniline mix with 100mL of hydrochloric acid. Then stir the solution at room temperature. A 22g of ammonium persulfate is dissolve in distilled water. Ammonium persulfate solution is added drop by drop into aniline solution at room temperature while stirring for 4 hours until green solvent produced. After that, the green solvent is filtered using filter paper to separate the solvent and precipitate. Hydrochloric acid, deionized water and acetone are used to distinguish the precipitation. Then, filter the precipitation until the liquid becomes colourless, followed by a drying process for 24 hours. Collect the drying precipitation above and weigh the product. 1 M of NaOH and HCl mix with the precipitation and then stirthesolutionfor 4 hours. Next, dry the mixture of the solution above in the furnace at 60°C to obtain polyaniline emeraldine base (PANI-EB) powder which will exist in blue colour.

2.3 Preparation of doped and undoped PANI-EB with HCl

This process of doped and undoped PANI-EB is to get the conductive polyaniline in green color. The first step is PANI-EB, the blue color powder is dissolved in 60mL of dimethylformamide (DMF). Next, 0.18 mL of 1M HCl is added to the solution of the PANI-EB and DMF. The result of the mixture will obtain a green solution and be label as a doped solution. The green solution indicates a conductive state. The steps are repeated in different concentrations of the HCl, which are 0.6% and 0.9%. Polyaniline without acid addition is known as a control solution undoped PANI. The polyaniline solution is centrifuged using a centrifuge machine for 30 minutes at 400 rpm of speed.

3. **Results and Discussion**

The conductivity of polyaniline with the different concentrations of acids was identified using fours of acids using a four-point probe. The values of conductivity increase as the concentration of acids increases.

Table 1: Conductivity of polyaniline with different concentrations of HCl

PANI-HCl	Conductivity (S/cm)
0.2M	$3.94x10^{-2}$
0.4M	$5.74x10^{-2}$
0.6M	$4.59x10^{-2}$
0.8M	$6.47x10^{-2}$
1.0M	$10.00x10^{-2}$

Table 2: Conductivity of polyaniline with different concentrations of H_2SO_4

PANI-H_2SO_4	Conductivity (S/cm)
0.2M	$1.86x10^{-2}$
0.4M	$4.52x10^{-2}$
0.6M	$5.28x10^{-2}$
0.8M	$6.00x10^{-2}$
1.0M	$10.37x10^{-2}$

4. **Conclusion**

Hydrochloric acid and sulphuric acid is the protonic acid that has been used in the doping process of polyaniline. The different concentrations of hydrochloric acid and the sulphuric acid act as a dopant and can help increase the conductivity of polyaniline.

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