

# Relative FTIR and XRD study on Blend of Conducting polymer via diverse oxidants

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## Abstract:

The procedure of oxidative polymerization of chemical nature was used with various oxidants in order to synthesize polypyrrole. Pyrrole monomer (each time being taken in a different mole). In the beaker, more oxidizing agent and surfactant were added. The different concentrations of the monomer utilized, as well as the surfactant and oxidizing agent concentrations such FeCl<sub>3</sub>, (NH)<sub>4</sub>S<sub>2</sub>O<sub>8</sub>, and C<sub>12</sub>H<sub>25</sub>SO<sub>4</sub>Na, are used. Every synthesized polymer will undergo comparative examination by FTIR.

**Keywords:** Conductive polymer, Polypyrrole (PPy), Chemical oxidative polymerization, Polymerization technique

## 1. Introduction

Materials with a polymeric foundation are generally thought to be lighter and more insulating. Since polymers have isolative qualities, they can be used as passive materials. However, they can also be used as active materials because they have optical, conducting, and electromagnetic properties. This is evident from the current development in the use of polymer materials. Furthermore, since polymer with magnetic characteristics has been revealed, polymer materials have expanded their prospective applications in the fields of energy storage devices and possibly magnetic applications<sup>1-2</sup>.

To date, there has been a lot of research done on polymers with connections to electronics and electrical properties. Examining its electrical conductivity is one of the goals; this can be achieved by ordered conjugation with extended  $\pi$  electrons and a high enough concentration of electric charge. Conjugated double bonds throughout the length of the polymer's backbone are therefore a crucial need for conductive polymers. Graphite, gold, and silver powders were examples of highly conductive particles that were embedded into a polymer matrix to give polymer-based materials their conductive qualities in the past. To produce electrical conductivity in polyaromatic backbone polymers, extensive research has been conducted throughout the past 20 years.<sup>3</sup>

Three of these are seen to be promising prospects for the creation of conducting polymer-type materials: polyaniline (PANI), polypyrrole (Ppy), and polythiophene (PT). Nonetheless, Ppy has drawn a lot of interest since, in addition to having a high electrical conductivity value, it can be produced using a straightforward procedure and has outstanding mechanical and chemical stability. Unsurprisingly, there are uses for the conducting Ppy in many different fields, including sensors, electrical devices, membrane separation, and lightweight batteries. Rechargeable batteries, supercapacitors, medication delivery, microwave shielding, and corrosion prevention are more possible applications for Ppy. Most commonly, an electrochemical process or a chemical reaction are used to prepare conducting polymers<sup>4-5</sup>.

## 2. Material and Methods

To create polypyrrole, a chemical technique known as oxidative polymerization was decided upon. A beaker was filled with one hundred milliliters of distilled water. Pyrrole monomer (added in varying moles each time) was added to it. In the beaker, more oxidizing agent and surfactant were added. The table below shows the different concentrations of the monomer used for the purpose, as well as the concentrations of the surfactant

and oxidizing agent. Due to the exothermic nature of the reaction, distilled water was supplied gradually. During this procedure, there was a lot of magnetic stirring to facilitate the easy dispersion of pyrrole.<sup>6-7</sup>

The reaction was carried out for four hours, with a constant temperature of 25 °C. Particles of fine nature that were black in color precipitated with promptness. The filtration procedure was started as soon as the polymerization process reached the necessary duration. Following filtration, distilled water and ethanol were used to thoroughly wash the precipitate that was produced. This washing procedure was repeatedly carried out. Following this stage, the synthesized polypyrrole was allowed to dry in an oven under vacuum. Overnight, the temperature was kept at 40°C for the purpose of drying<sup>8-9</sup>.

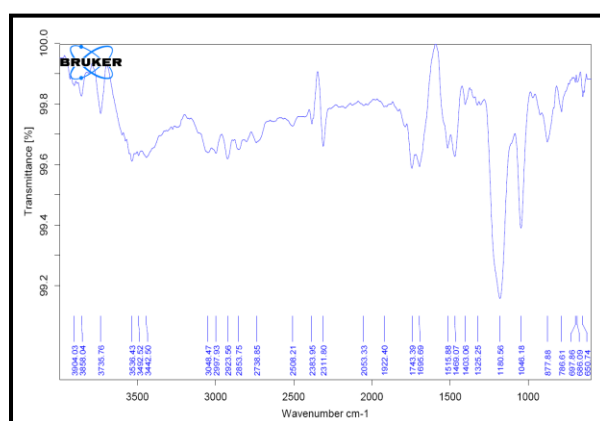
**Table 1: Different materials used along with their concentrations for synthesizing polypyrrole**

S.No.	Name	Designation	Concentration (M)
1	iPyrrole imonomer	imPPy	0.04, 0.08, 0.16, 0.24
2	iFerric ichloride	iFeCl <sub>3</sub>	0.04, 0.08, 0.16, 0.24
3	iAmmonium ipersulphate	i(NH <sub>4</sub> ) <sub>2</sub> S <sub>2</sub> O <sub>8</sub>	0.2
4	iSodium idodecyl isulphate	iC <sub>12</sub> H <sub>25</sub> SO <sub>4</sub> Na	0.044

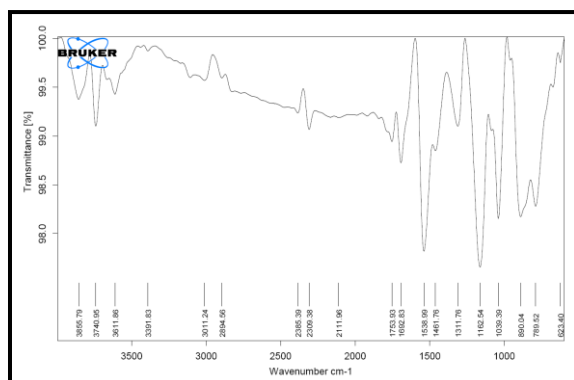
### 3.Result and Discussion

#### 3.1 Structural Characterization using FTIR technique of polypyrrole

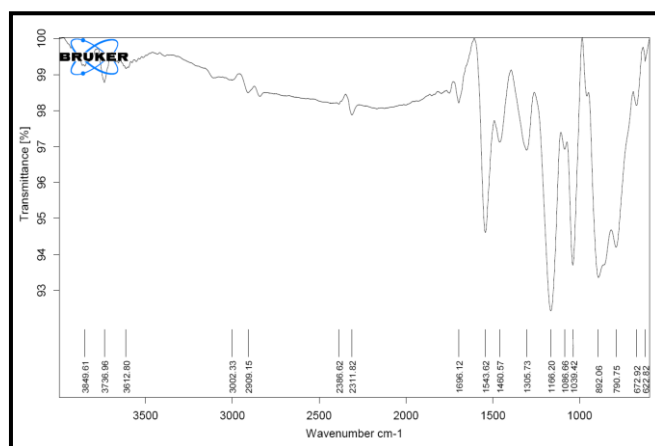
The figures shown below depict the FTIR of the polypyrrole which was synthesized using different oxidizing agents. There was a peak seen at 3400 cm<sup>-1</sup> which was wide in appearance. This was attributed to the vibrations of stretching nature found in N-H bond present in pyrrole ring. One band was observed at 2100 cm<sup>-1</sup> which had its origin due to stretching of C-H bond. The band which was seen at 1600 cm<sup>-1</sup> was thought to have originated owing to the stretching vibrations found in carbon double bonded with carbon atom. The deformation band due to C-N bond made its appearance at 1400 cm<sup>-1</sup> whereas same type of band due to C-H appeared at 1200 cm<sup>-1</sup>. The stretching of C-C bond gave a peak at 1100 cm<sup>-1</sup>. All these peaks established the fact that formation of polypyrrole has taken place.



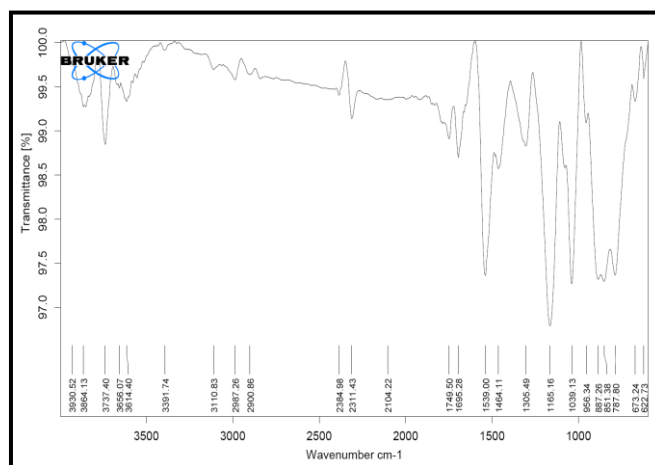
**Figure 1: FTIR Spectrum of the Monomer PY-I**



**Figure 2:** FTIR Spectrum of the PPY-II with  $\text{FeCl}_3$



**Figure 3:** FTIR Spectrum of the PPY-III with iAmmonium ipersulphate



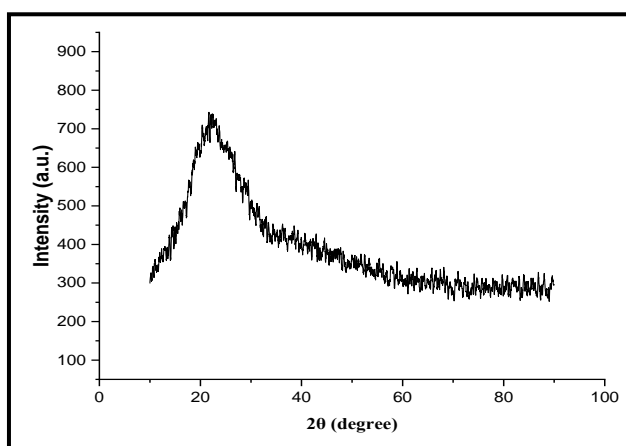
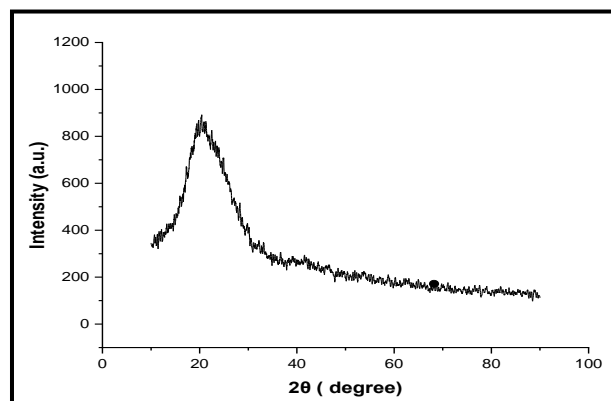
**Figure 4:** FTIR Spectrum of the PPY-IV with iSodium idodecyl isulphate

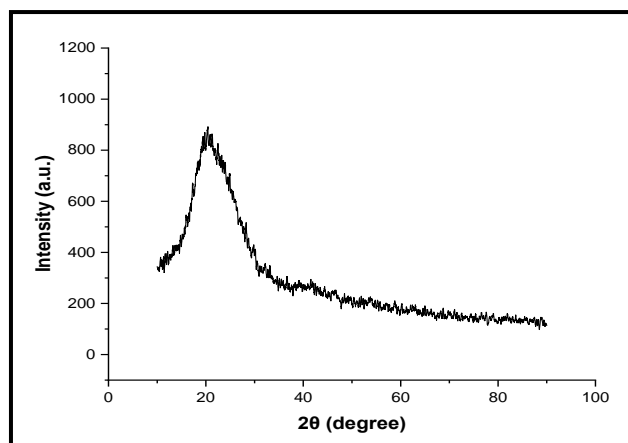
### 3.2 Structural Characterization using X-ray diffraction

For Ppy-I crystalline peaks are observed at 22.08, 48.3 respectively and crystallinity is found to be 22.96%, for Ppy-II crystalline peaks observed at 16.16, 21.22, 24.88 and crystallinity is found to be 32.73%, for Ppy-III- crystalline peaks are observed at 21.46 and crystallinity is found to be 20.23%, for Ppy-IV crystalline peaks are observed at 21.38, 23.52 and crystallinity is found to be 28.59%

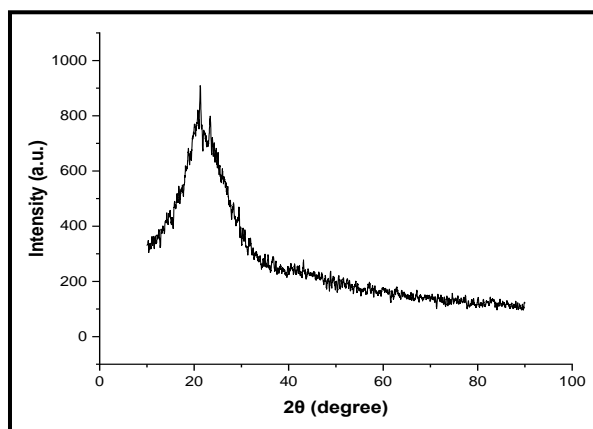
**Table 2: XRD data obtained for the polymers**

Sample	Peaks	Area of the peaks	Total area	Crystallinity(%)
PPY-I	22.08,48.3	4269.439	18593.16	22.96%
PPY-II	16.16,21.22,24.88	5788.687	17683.04	32.73%
PPY- III	21.46	3298.36	16298.42	20.23%
PPY- IV	21.38,23.52	5511.849	19273.99	28.59%

**Figure 5: XRD spectrum of the Monomer PY-I****Figure 6: XRD spectrum of the PPY-II with iFerric ichloride**



**Figure 7:** XRD spectrum of the PPY-III with Ammonium ipersulphate



**Figure 8:** XRD spectrum of the PPY-IV with iSodium idodecyl isulphate

## 4-Conclusion

### 4.5.1 Structural Characterization using FTIR technique of polypyrrole

FTIR of the polypyrrole which was synthesized using different oxidizing agents. There was a peak seen at  $3400\text{ cm}^{-1}$  which was wide in appearance. This was attributed to the vibrations of stretching nature found in N-H bond present in pyrrole ring. The stretching of C-C bond gave a peak at  $1100\text{ cm}^{-1}$ . All these peaks established the fact that formation of polypyrrole has taken place.

X-ray diffraction studies were carried out on the synthesized polymeric compounds. These studies showed that the synthesized polymers achieved certain level of crystalline nature. This level of orderness or disorderness in turn affects the properties of the molecule, particularly those affected by arrangement of constituent atoms or entities. Thus an idea of mechanical properties can be drawn from the crystalline nature of the polymer which subsequently can be made use of in deciding various types of applications in which the polymer is to be employed.

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