SULPHURIC ACID DOPED POLYANILINE AND STUDY IT'S DIVERSE PROPERTIES

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Abstract: Application of polyaniline increased extensively in diverse fields due to its excellent structural, optical and electrical properties. This report focused on the synthesis of sulphuric acid doped polyaniline and study its structural, optical properties and functional groups. Sulphuric acid doped polyaniline was synthesized via chemical oxidative polymerization technique at room temperature. The synthesized sulphuric acid doped polyaniline were characterized via X-ray diffraction (XRD), ultraviolet-visible (UV-vis.) and Fourier transform infrared (FTIR) spectroscopy. The XRD study of the sulphuric acid doped polyaniline shows as an amorphous nature without any crystalline sharp peak in the studied range of 2θ. The optical absorption bands were visualized at 284 and 432 nm in the UV-Vis. spectrum. The all expected functional groups peaks are observed to the synthesized sulphuric acid doped polyaniline.

Index Terms – Organic Conducting Polymer, Sulphuric Acid, Polyaniline, XRD, UV-Vis., FTIR.

1. INTRODUCTION:

Technology in the present era has been growing extensively and the backbone of these technologies are the different types of materials synthesized by the scientific community. Distinguishing properties of the materials can be explored in the various types of applications. Moreover, nanosized synthesized materials get more attention in the present days due to their excellent structural, optical, electrical and magnetic etc. properties [1]. Conjugated conductive polymers or organic polymeric conductors are common names for conducting polymers. Letheby first described the chemical oxidative polymerization of aniline in 1862, and Mohilner et al. studied it in depth in 1962 [2]. The promising applicability or productivity of conducting polymers begins with the outstanding work of the Shirakawa and Heeger/MacDiarmid groups [2,3]. Generally, conducting polymers are composed of C, H, and simple heteroatoms such as N and S, and their properties vary due to -conjugation. Conductivity in conducting polymers can be achieved using chemical oxidative or electrochemical techniques. Aside from this doping process, other methods such as reducing anionic or cationic species can be used. Conductive properties in conducting polymers are commonly provided by both the oxidation and reduction processes. Chemical oxidation generates a positive charge in conducting polymers, whereas reduction generates a negative charge. The provided charges are highly delocalised across the polymer monomer units. The entire process works similarly to the doping process in semiconductors. [4-6].

Various types of conducting polymers have recently been synthesized and used in a variety of fields. Polyaniline, polypyrrole, and polyacetylene have received the most attention among the various types of conducting polymers due to their exceptional properties. Polyaniline is a conducting polymer with excellent properties such as better structural, optical, and morphological properties that can be tuned using the appropriate synthesis technique [7,8]. Polyaniline also has high electrical conductivity, good thermal and environmental stability, and can be synthesized using a low-cost and simple synthesis technique. Polyaniline can be used in applications such as gas sensing, solar cells, microelectronics, pharmaceutics, photovoltaics, and catalysis due to its exceptional properties [9].

Thus, for the exploration of the structural, optical properties of the sulphuric acid doped polyaniline, herein we have been synthesized it and studied. The synthesized sulphuric acid doped polyaniline was studied with XRD, UV-Vis. FTIR characterizations techniques and explored the various properties.

2. EXPERIMENTAL:

2.1 MATERIALS:

Aniline was purified and all other chemicals used in present study and used without any further purification. Sulphuric acid and ferric chloride were procured from Loba chemical India. Aniline was purchased from molychem India.

2.2 CHARACTERIZATION:

X-ray diffractometer (XRD) (Mini Flex II, Rigaku, Japan) with CuKα radiations of wavelength 1.5406 Å was used to study the structural properties. Ultra-violet-visible (UV-vis) portable spectrophotometer BLACK-Comet-SR (Stellar Net, USA) was used to explore the optical properties. Functional groups study was carried out by via FT-IR spectroscopy using α-ATR IR-spectrophotometer (Brucker, Japan).

2.3 SYNTHESIS OF PPY AND PPY-ZNO:

Sulphuric acid doped polyaniline was synthesized via chemical oxidation method. Firstly, aniline 0.01 mol was mixed with 50 ml distilled water in beaker. In another beaker of 50 ml distilled water same concentration of $fecl_3$ was well dispersed by stirring. The sulphuric acid 1 molar concentration was mixed in the aniline solution. Then the solution of $fecl_3$ was slowly added into the mixer

of aniline and oxalic acid. The mixed of all stirred constantly for three hours at room temperature and filter with filter paper. The filtered powder then dried and used for the further characterization.

3. RESULT AND DISCUSSION:

3.1 STRUCTURAL PROPERTIES (XRD):

Fig. 1 shows the XRD pattern of sulphuric acid doped polyaniline. Generally, polyaniline shows the amorphous nature with small crystallinity. The observed broad bump peaks confirmed that the synthesised materials show the successful polymerization and highly amorphous in nature [10].

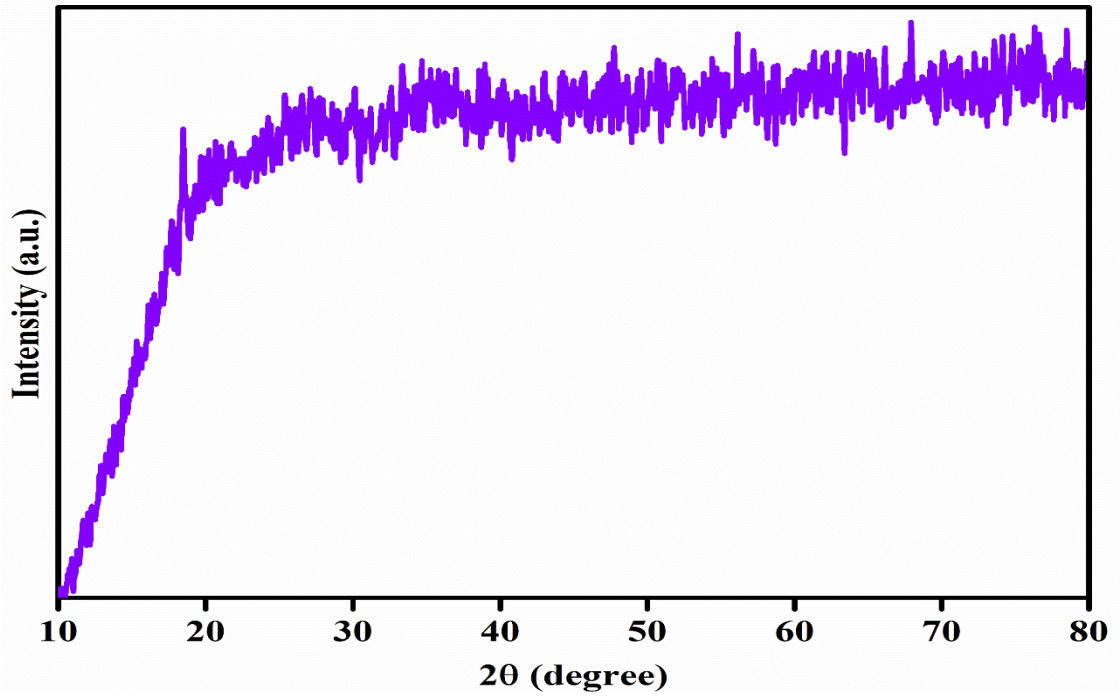

Fig.1 XRD pattern of sulphuric acid doped polyaniline

3.2 OPTICAL STUDY:

3.2.1 UV-VISIBLE ABSORPTION:

Optical properties of the sulphuric acid doped polyaniline were evaluated by Ultraviolet–visible (UV-Vis.) spectroscopy. Fig. 2 shows the UV–vis. absorption spectrum of sulphuric acid doped polyaniline shows the two optical absorptions peaks at 284 and 432 nm. The absorption at 284 nm is corresponding to the $\pi \rightarrow \pi^*$ band transition and others at 432 nm is assigned to polaron band [11]. The optical properties of the synthesized materials show the better transparency in the materials which confirmed the lower bandgap also. The better optical properties of the can be applicable for the various applications in optoelectronics, solar cells etc.

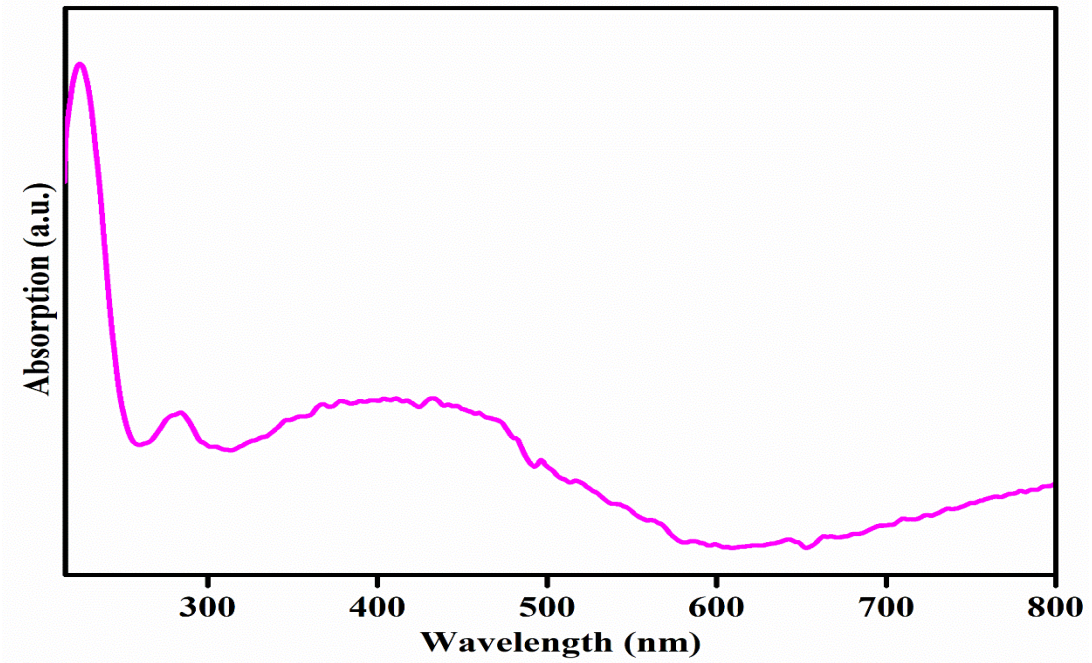

Fig. 2 UV-vis. absorption spectrum of sulphuric acid doped polyaniline

3.2.1 FTIR SPECTROSCOPY:

Fig. 3 shows the FTIR spectrum of sulphuric acid doped polyaniline in the range 500- 4000 cm^{-1}. The peaks at 719 and 1234 cm^{-1} corresponding to the C–N stretching and C–H out of plane vibration of 1,4-disubstituted benzene ring respectively. The characteristic peak in range of 1459 cm^{-1} attribute for benzenoid ring vibration. The peaks at 3000-3500 cm^{-1} are features of the sulphuric acid doped polyaniline material due to the extending frequency of –OH and NH groups. The peak around 1704 cm^{-1} attribute for the stretching frequency of –COOH group due to the oxalic present in the polyaniline. The peaks at 1234 and 1343 cm^{-1} are attributes due to the C–O group moieties present in oxalic acid. The peaks between 1400-1700 cm^{-1} is obtained because of C=O group presence [12,13]. Thus, the all-corresponding peaks are observed corresponding to the sulphuric acid doped polyaniline which confirmed its proper formation.

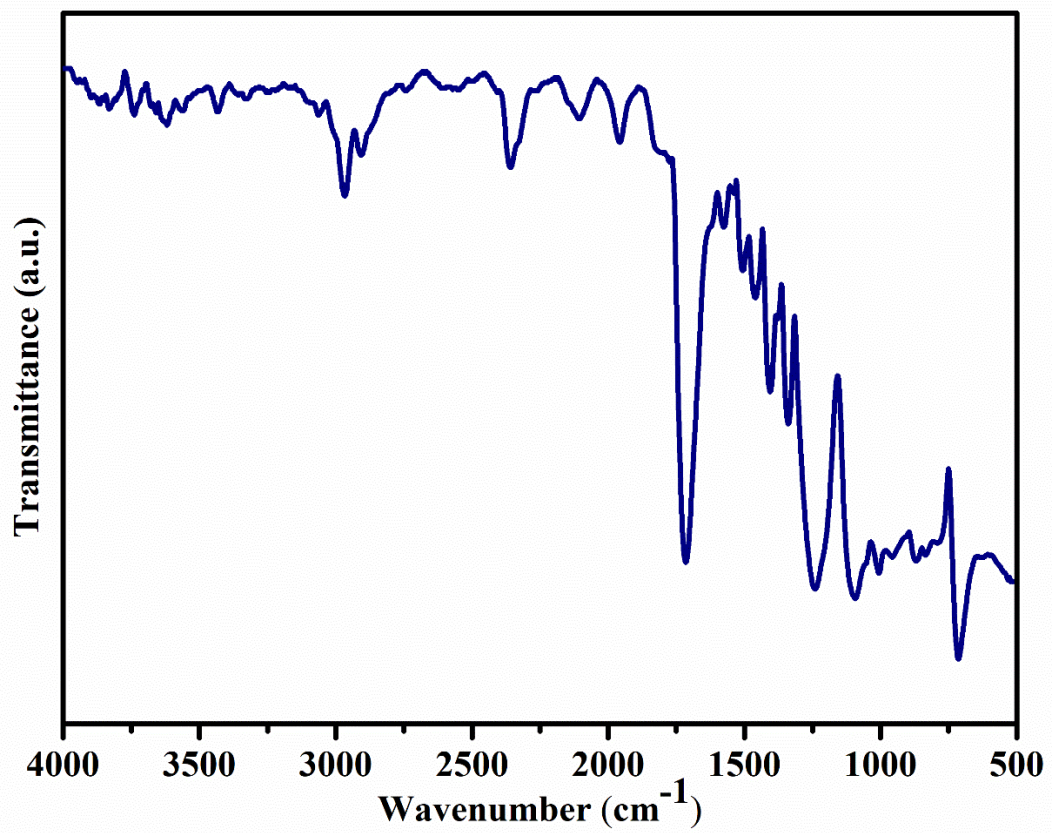

Fig. 3 FTIR spectrum of sulphuric acid doped polyaniline

4. CONCLUSION:

The present report successfully prepared the sulphuric acid doped polyaniline and studied the structural and optical properties. The chemical oxidative technique was reveled its compatibility to successful formation of sulphuric acid doped polyaniline. The XRD study shows the amorphous properties of the developed sulphuric acid doped polyaniline and exhibited the developed materials is highly useful for various applications. The optical study shows the two absorption peaks at 284 and 432 nm which confirmed the very small optical bandgap as like semiconductor. The FTIR study confirmed the proper formation of sulphuric acid doped polyaniline material by showing all corresponding peaks related to it.

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