FTIR Study of Chemically Synthesized Conducting Polyaniline by Using Natural Acid

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Abstract:

The conducting polyaniline was synthesized by using natural acid rather than chemical acids such as hydrochloric acid, sulphuric acid etc. extracted from Citrus Limon which is commonly known as Lemon. The citric acid present in lemon juice so called natural acid was taken as electrolyte for the preparation of conducting polyaniline. The polymerization took place after certain conditions and colouration happened. A dark green coloured powder form of conducting polyanline was obtained. This ecofriendly conducting polyaniline was then comparing with chemically synthesised conducting polyaniline. The characterization of this material was done by using FTIR, Nicolet iS5, and Keithley Electrometer. It has been seen that there are new and modified wavelength peaks observed in FTIR Spectra of conducting polynailine. This may be happening due to modification and recombination of bonding between atoms and molecules while polymerization process has been done.

Keywords: Polyaniline, Natural Acid, FTIR, Keithley etc.

Introduction

The field of conducting polymers has been largely dominated by the search for higher conductivities, better stability, and greater processibility. The doped conducting polymers that have been widely investigated are polypyrrole, polythiophene and polyaniline. Polyaniline is unique among the class of electrically conducting polymers in that their electrical properties can reversibly be controlled by changing the oxidation state of main chain and by the protonation of amine nitrogen chain [1].

One of the important areas of research on conducting polymers concerns methods about their processibility. Various acids are used for doping polyaniline such as perchloric acid, sulphuric acid, hydrochloric acid and many others. Doping of strong acids imparts high electrical conductivities but makes the polymers unstable at high humidity conditions. Like most of the conducting polymers, PANI is doped with strong acids, however less attempt has been made to use weak acids [2].

It has been seen that Polyaniline(PANi) was doped with different dopants like camphosulphonic acid (CSA), diphenyl phosphate(DPPH), suiphonic acid(S), and Maleic acid (MAC) by chemical method. The samples were prepared in the form of pellets as well as films [3]. It has been reported that use of maleic acid (Mac), camphosulphonic acid (CSA) and diphenyl phosphate (DPPH) as weak acid dopants in polyaniline and to use them for sensing porpose.[4]

Polyaniline (PANI) is one of the most intensively investigated polymers during the last few decades. The establishment of the scientific principles allowing regulation of its properties, determining the potential application areas (alternative energy sources and transformers, media for erasable optical information storage, non-linear optics, membranes, etc.) is an important scientific problem [5]. Polyaniline is an environmentally stable and technologically important conducting polymer, whose electronic conductivity can be altered reversibly by both oxidation/reduction and acid/base chemistries. Polyaniline can exist as “salts” or “bases” in three isolable oxidation states, leucoemeraldine (LES or LEB), emeraldine (ES or EB), and pernigraniline (PS or PB), among which only emeraldine salt (ES) is electrically conductive [6].

Conducting polymers have elicited much interest among researchers because of their reasonably good conductivity, stability, ease of preparation, affordability and redox properties compared to other organic compounds. In particular, the electronic and electrochemical properties of conducting polymers have made them find applications in photovoltaic cells, organic light emitting diode and sensors. Among the conducting polymers, polyaniline has received much attention and intensive research work has been performed with the polymer in its native state or functionalized form. This is mainly due to the fact that polyaniline and its derivatives or composites or co-polymers with other materials are easy to synthesise chemically or electrochemically by oxidative polymerization [7]. This article reveals about synthesis of conducting polyaniline by using natural acid so called citrus limon and its FTIR characterization study.

Experimental

Synthesis of polyaniline by sulphuric acid

The chemical oxidative polymerization of aniline has been carried out in aqueous solution kept in ice bath by dissolving aniline in a strong acidic solution 0.1M H_2SO_4.The polymerization is invited by drop wise adding of aqueous Potassium persulphate solution. The reaction is highly exothermic.

Solvent + Monomer + Electrolyte Polymerization $\longrightarrow$ Conducting Polymer.

Distilled Water + 0.1 M Distilled Aniline + Acid Polymerization $\longrightarrow$ Conducting Polymer.

Synthesis of Polyaniline by Natural Acid

Conducting polyaniline was synthesized by chemical method. For the execution of reaction, we used distilled aniline, ammonium persulphate (APS) and natural acid as citric acid which was extracted from fresh lemons.

0.1M ammonium persulphate was completely dissolved in 200 ml distilled water at room temperature. The color of solution changed from white color to transparent color. 0.1M aniline and 50 ml citric acid was taken in another beaker and then kept in ice bath for stirring with magnetic stirrer for 450 RPM (Rotation per minute). While stirring this solution, we added APS solution drop wise frequently. After two hours the color was changed from dark brown color to bottle green color. After that process we filtered this solution by using watt-man paper. We got a residue of that solution on a watt-man paper. Obtained residue was washed by acetone. We dry that residue for 30 minutes under the IR lamp.

Results and Discussion

The FTIR of chemically synthesized polyaniline was recorded with the help of Nicolet iS5 Infrared Spectrometer.Wave number of the peak 3650.45 cm^{-1}, 3676.36 cm^{-1} having wave length range 2.72-2.79 are groups of alcohol, phenol, free OH and type of stretching was O-H stretching. That of 3436.51 cm^{-1} having wave length range 2.89-2.91 was secondary amides free NH (trans) group and type of stretching was N-H bending. 1559.98 cm^{-1} indicates C-O stretching type. Wave number 1476.87 cm^{-1} with their wave length range 6.74-6.92 have group of alkanes (-CH-) and type of vibration was C-H stretching. 1302.30 cm^{-1} has group of alkane and type of vibration was C-H bending. 1242.92 cm^{-1} show skeletal stretching with 7.97-8.33 wave length range and its intensity was strong double and multiple bonds. Wave number 1121.59 cm^{-1} corresponds to C-O-H stretching. 800.81cm^{-1} shows benzene ring with three adjacent H atom and type of deformation was C-H stretching. 624.66 cm^{-1} indicates C-H stretching type of deformation.

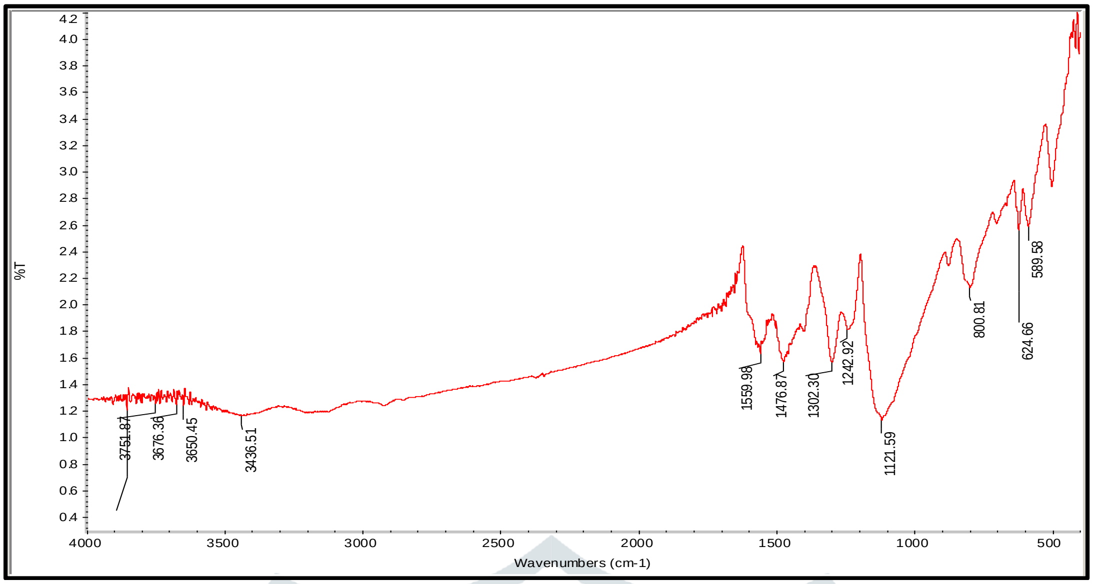

Fig. 1 FTIR of PANi H_2SO_4

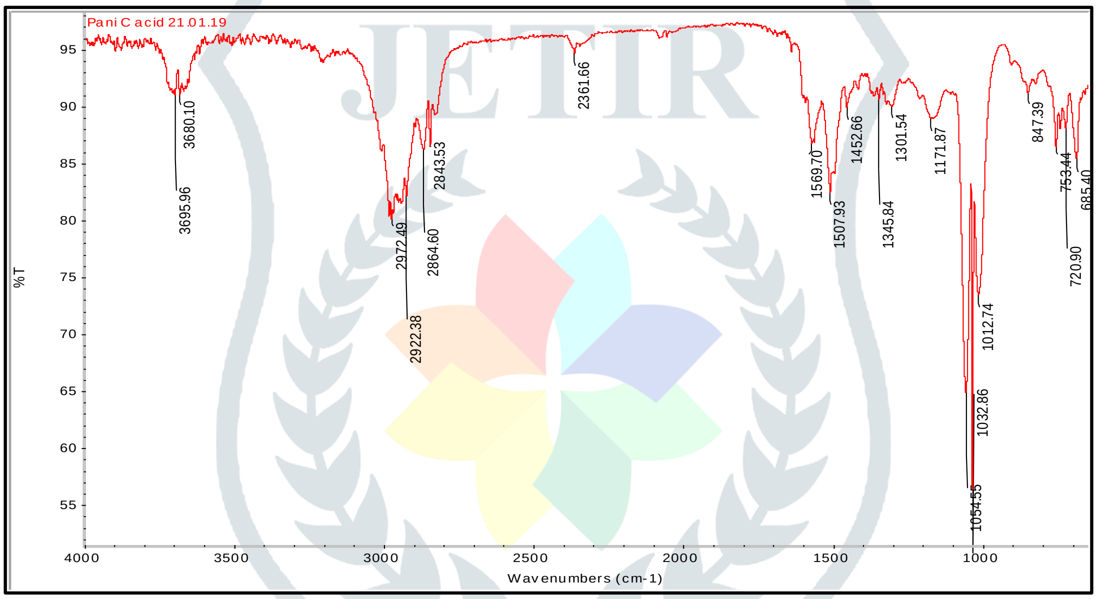

Fig. 2 FTIR of PANi Natural Acid

The figure 2 represents FTIR spectra of PANi natural acid was obtained by using Nicolet iS5 at room temperature in the range of 400 cm^{-1} to 4000 cm^{-1} .The material shows IR peaks at 3680.10 cm^{-1} and 3635.96 cm^{-1} indicates N-H stretching. The stretching bands which are characteristics of aromatic amine are observed at 1345.84 cm^{-1} and 1301.54 cm^{-1} . A Strong peak at 1452.66 cm^{-1} was assigned to CH2 bending mode arrived due to doping of citric acid. Peaks at 1569.70 cm^{-1} and 1507.93 cm^{-1} are assigned to the asymmetric C6 ring stretching modes. The higher frequency vibration at 1569.70 cm^{-1} has a major contribution from quinoid ring while the lower frequency mode at 1507.93 indicates the presence of benzenoid ring. This indicates that polymer is composed of amine and imine units and presence of different oxidation states of the polymer.

Conclusion

The comparison of chemically synthesized polyaniline by using sulphuric acid and natural acid as citric acid shows variations in the IR peaks. This may be happening due to modification and recombination of bonding between atoms and molecules while polymerization process has been done.

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