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Structural characterization of Polypyrrole and its composites containing TiO_2

Monika, Raman Swamy[1], Gita Rani [2]

[12]*Department of Chemistry, Chaudhary Devi Lal University, Sirsa, Haryana, (India*)

ABSTRACT

Polypyrrole and its composites doped with Titanium dioxide were synthesized by chemical oxidation polymerization method in the presence of ammonium persulphate as oxidizing agent. The reaction was conducted at 5^oC temperature. The morphology and structure were studied by Fourier transform infrared spectroscopy (FTIR) and Scanning electron microscopy (SEM) techniques. The FTIR spectra ascertained the chemical interlinking of Polypyrole with metal oxides. The micrograph of Polypyrrole showed presence of globular particles. This paper gives the information about effect of doping in Polypyrrole and comparison of pure Polypyrrole with Titanium oxide doped Polypyrrole of different concentratios.

Keywords: *Composites, Dopant, FTIR, Polypyrrole,.*

I. INTRODUCTION

In recent years, synthesis and characterization of electrically conducting polymers have become important areas of research in polymer science and engineering owing to their excellent electro-active behavior. Among the conducting polymers, Polypyrrole (PPy) has been regarded as one of the most promising functional materials; many scientists have extensively investigated its synthesis and applications [1–3]. The common feature in the structure of conducting polymers is poly-conjugation of the π system of their backbone. The physical properties of conducting polymers strongly depend on the type of dopants and the doping levels. The doping levels can be easily changed by chemical reactions at room temperatures. PPy and its derivatives are of particular interest because of their high electrical conductivity and stability in the doped state. Conducting polymers have various applications in the field of science like such as thin film transistors [4], polymer light emitting diodes (LEDs) [5], corrosion resistance [6]. This article focuses on chemically synthesis of Polypyrrole and TiO_2 doped Polypyrrole of different concentration and characterization study of these composites.

II. EXPERIMENTAL

2.1 Chemicals

Pyrrole (Double distilled), Ammonium persulphate as oxidant, Titanium dioxide as dopant, Tetrahydro furan as solvent.

2.2 Synthesis Of Polypyrrole And Polypyrrole Composites

Polypyrrole was synthesized chemically by using of ammonium persulphate as oxidant and pyrrole as monomer. Pyrrole was dissolved in 1M solution of Hydrochloric acid and then pre-cooled 1M ammonium persulphate was added drop wise. Then stir these mixtures for about 90 minutes. The reaction was conducted at 5±0^{o}C and stirring was continued for 2 hours. A dark colored Polypyrrole was formed, which was filtered and washed with distilled water many times to remove excess acid. The synthesized Polypyrrole was stirred with NH_4OH for 1 hour, filtered and dried. Titanium oxide doped Polypyrrole of different concentration like 5%, 10%,15% ,20% was made by addition of titanium dioxide in Polypyrrole. The tetrahydrofuran (THF) solvent was used for this doping. The stirring was continued for 3 hours for doping. The titanium dioxide doped Polypyrrole was filtered, washed with distilled water and dried in oven at 70^{o}C.

III. CHARACTERIZATION TECHNIQUES

3.1 Ftir Analysis

The IR spectra of Polypyrrole, titanium oxide doped Polypyrrole of different concentration were recorded by using Fourier transform infrared spectrophotometer in the region of 400–4000 cm^{-1}.

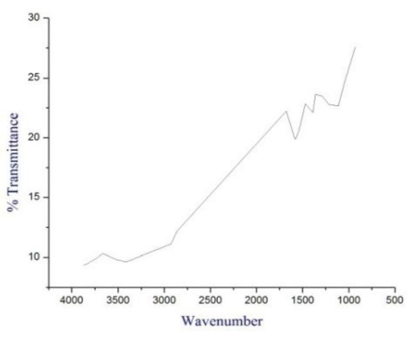
3.2 Sem Analysis

The surface morphology of Polypyrrole, titanium oxide doped Polypyrrole of different concentration was analyzed by using Sigma (Model 0323) instrument.

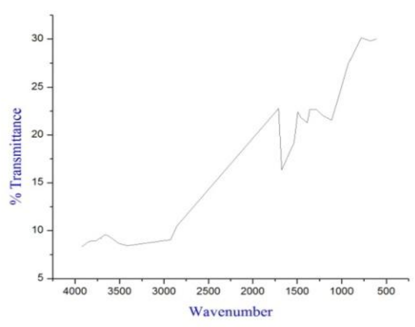
IV. RESULTS AND DISCUSSION

4.1 Ftir Characterization

Fig. 1 shows the FTIR spectra of Polypyrrole and Polypyrrole-TiO_2 composites. The peaks at 1551 and 1468 cm^{-1} could be attributed to C-N and C-C asymmetric and symmetric ring-stretching, respectively. The NH and CH stretching vibration of Polypyrrole appeared at 3429 and 2928 cm^{-1} respectively. The IR peaks obtained at 1045 and 925 cm^{-1} are due to the =CH out of plane vibrations indicating the polymerization of Pyrrole. The peak around 670 cm^{-1} in Polypyrrole TiO_2 composites is due strong interaction of Ti-O stretching is observed. The peak at 670 cm^{-1} is absent in pure Polypyrrole (a).



(a)



(b)

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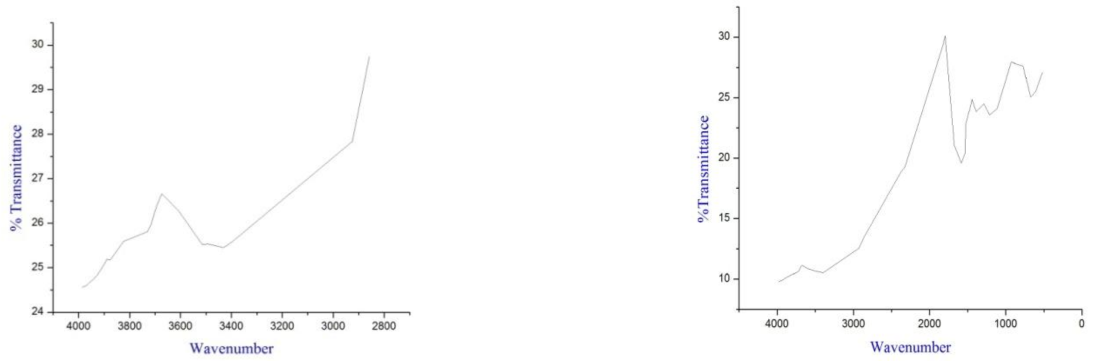
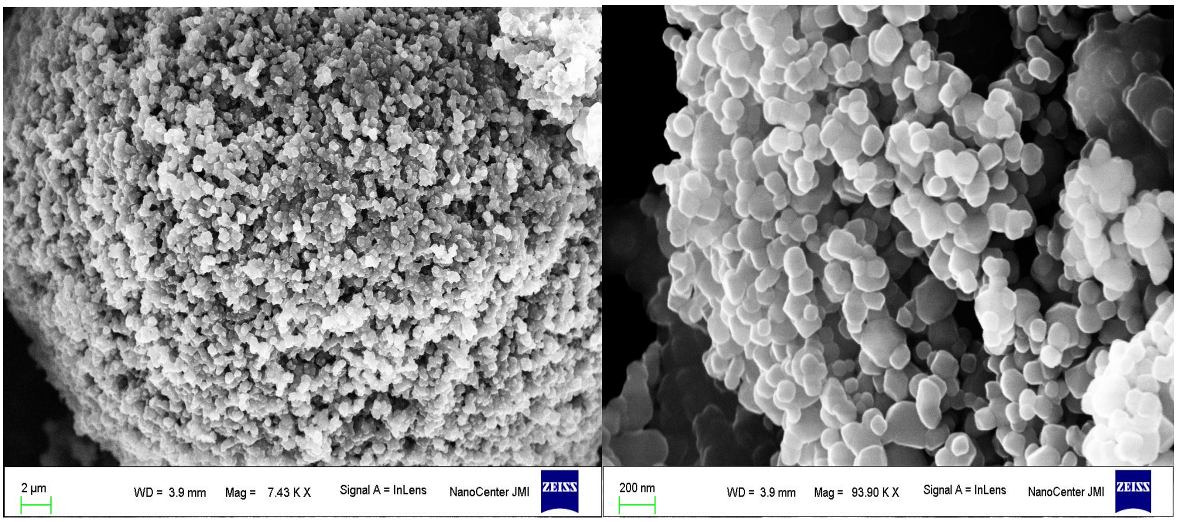


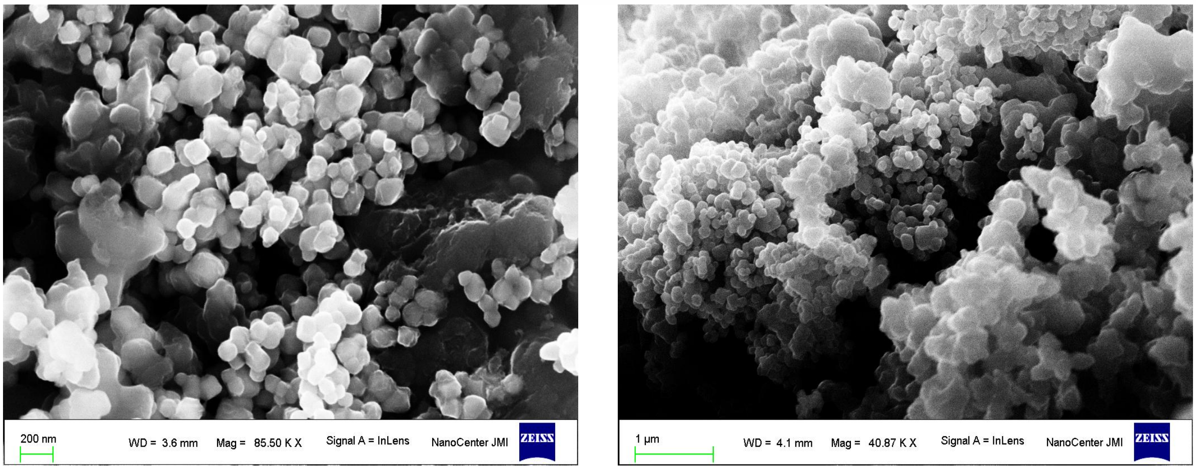
Fig 1. FTIR Spectra of (a) Polypyrrole (b) 5% TiO_2 doped Polypyrrole (c)10% TiO_2 doped Polypyrrole (d) 15% TiO_2 doped Polypyrrole

4.2 Sem Analysis

Fig. 2 (a-d) show the scanning electron micrographs of pure Polypyrrole and TiO_2 doped Polypyrrole of 5%, 10%,15% concentration respectively. Fig. 2(a) shows the presence of globular particles. The particles formed are irregular in Fig. 2(b-d) represents the morphology of the PPy –TiO_2 composite, indicates structures with spherical shape with very good uniformity. This is due to the coordination interaction between orbital of Ti atoms in TiO_2 and the lone-pair electrons of nitrogen atoms of PPy molecules.



(a) (b)



(c) (d)

Fig 2. SEM image of (a) Polypyrrole (b) 5% TiO_2 doped Polypyrrole (c)10% TiO_2 doped Polypyrrole (d) 15%TiO_2 doped Polypyrrole

V. CONCLUSION

Polypyrrole and TiO_2 doped Polypyrrole composites were synthesized by chemical oxidation method. FTIR analysis showed the characterization peak of C-C and N-H in Polpyrrole and doped polyprrole. The peak arround 670 cm^{-1} is due to Ti-O interaction in doped Polypyrrole which is absent in pure Polypyrrole. The SEM analysis showed the globular shape of Polypyrrole and afer doping shape converted to spherical shape.

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