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Synthesis of PPy-AA Film for Sensor Development

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ABSTRACT
Conducting polymers have been used extensively for sensor development. In the present study, PPY-AA thin film was synthesized at room temperature using chemical polymerization technique. PPy-AA thin film was deposited on PMMA substrate by oxidation of pyrrole (doped with Acrylic Acid) at room temperature by optimized process parameters. Synthesized film was characterized by FTIR, UV-Vis. Spectroscopy. Scanning electron microscopy shows suitable morphology for sensor application. Sensing behavior of the film for ammonia gas was studied by indigenously developed gas sensing chamber in the laboratory. The PPy-AA film shows good response to 10-20 ppm of ammonia gas at room temperature.
Keywords: Conducting Polymer, Polypyrrole, Acrylic Acid, Ammonia, Sensor

I. INTRODUCTION

Recently, conducting polymer, Polypyrrole (PPy) have been used as sensitive material for the development of gas sensors [1-9]. Chemical polymerization is the simple method to synthesize the PPy film [10-15] It is easy technique and can be controlled by suitable process parameters. The synthesized thin film found to be porous, stable, sensitive, and gives significant change in resistivity when exposed to ammonia gas [16-18]. Monomer Pyrrole (Py), dopant Acrylic Acid (AA) and oxidant ferric chloride ($FeCl_3$) have been used for chemical polymerization of PPy at room temperature and optimized the process parameters [19,20] These synthesized PPy-AA films on PMMA substrate were characterized by FTIR, scanning electron microscopy (SEM), ultraviolet-visible (UV-vis) spectroscopy. The sensitivity of the film to ammonia gas was studied by indigenously developed sensing chamber (Figure 1) in the laboratory [21-23].

II. EXPERIMENTAL

Py, AA and $FeCl_3$ were of analytical reagent grade were used to synthesized the thin film at room temperature ($29^0c \pm 0.5$) in 12 minutes. Monomer and oxidant solutions (with AA) were prepared separately with different concentrations (optimized parameters) in de-ionized water. After mixing the solutions slowly, polymerization takes place and PPy-AA thin film deposited on the PMMA slide rinsed with de-ionized water and dried in air. It was further exposed to ammonia gas and change in resistivity was measured using four probe instrument. (Figure 1) [24-29].

Figure1. Computer controlled gas sensing chamber

III. RESULTS AND DISCUSSION

In the present study, we have synthesized the PPy-AA films on PMMA substrate using optimized process parameters. Its physical and chemical properties along with surface morphology was studied using different characterisation techniques.

3.1. UV-visible spectroscopy

The UV-vis. spectrum recorded (by Chemito-UV-2100 spectrophotometer) in the range 350-800 nm for PPy-AA film in figure 2. It shows the absorption between 350 to 460 nm and absorption around 650 nm indicates the formation of PPy and its conducting nature.

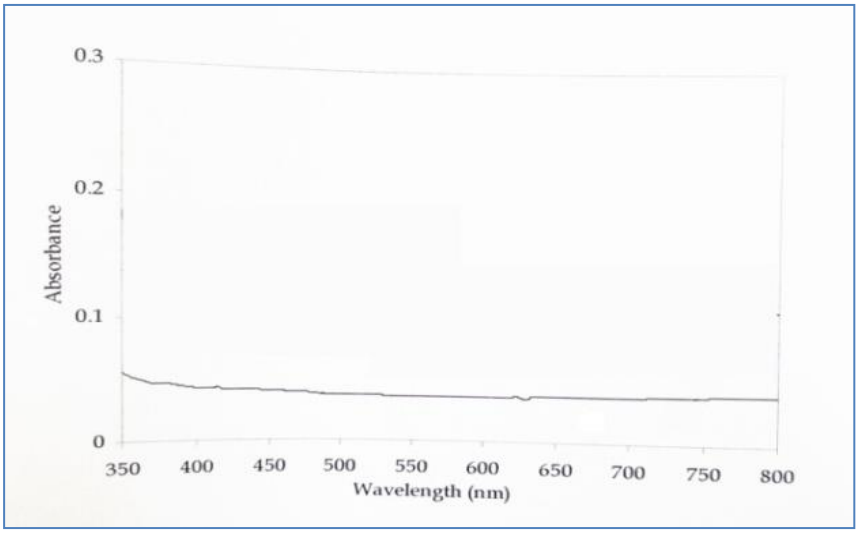

Figure 2. UV-Vis. Spectrum of PPy-AA film

3.2. FTIR Analysis

Infrared spectroscopy recorded in the range 500-4000/cm (Figure 3) shows the absorption or transmittance of the PPy as a function of wave number. Functional groups in PPy is indicated by absorption at different Frequencies. The broad peaks around 3732/cm shows N-H stretching. PPy ring stretch was observed around 1527/cm to 1546/cm. The peaks at 3180/cm and 2960/cm assigned to $–H_3$ and $–CH_2$. All these characteristic bonds represents the formation of PPy in the thin film.

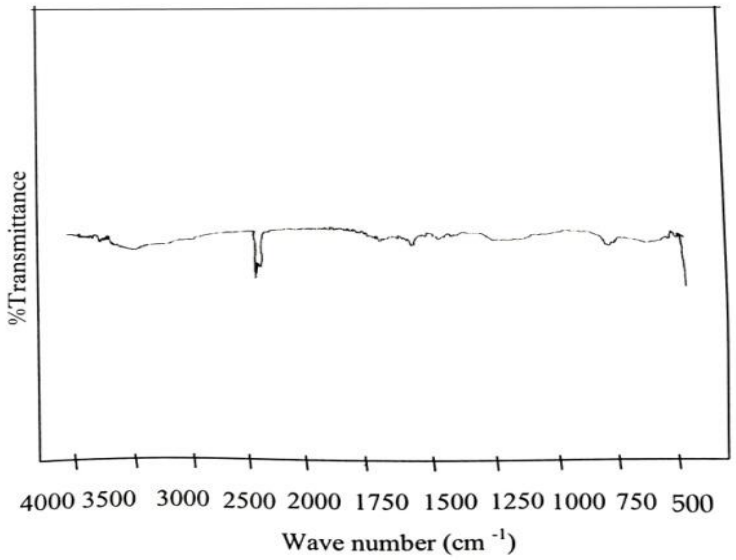

Figure 3.FT-IR Spectrum of PPy-AA film

3.3. SEM Analysis

Scanning Electron Microscopy of the synthesized PPy film was studied by using JEOL-JSM-6360A machine (Figure 4). The PPy-AA film observed to be uniform and adhesive. The micrographs show granular and porous surface morphology, suitable for gas sensing applications.

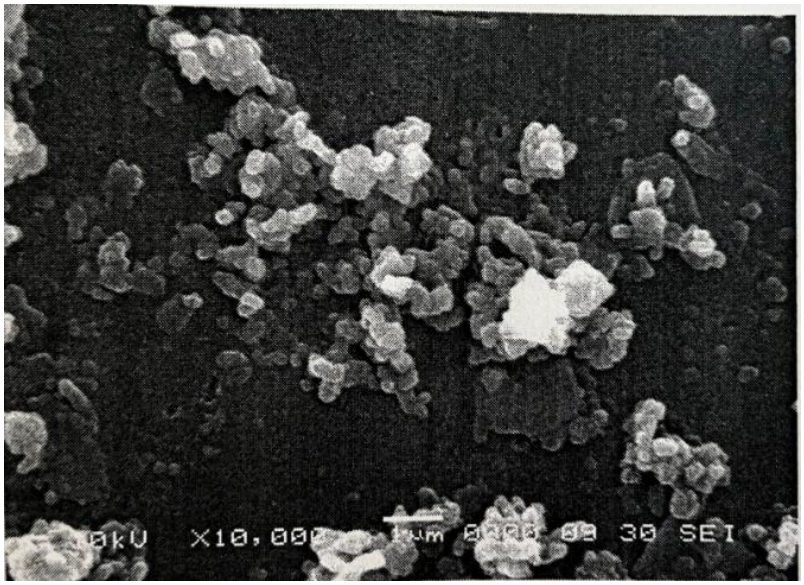

Figure4. SEM image of PPy-AA thin film

3.4. Sensing characteristics of Ammonia

Sensing Chamber with Four Probe instrument was used to study the sensing characteristics of Ammonia (Figure 4). An ammonia-air mixture with different concentrations was taken from the bottle containing ammonia solution and injected in the chamber. Interaction of ammonia with PPy-AA film increases the resistivity. The sensing behaviour in terms of change in resistance when exposed to ammonia gas (5-20 ppm) is shown in figure 5. It shows good response to 10-20 ppm of ammonia.

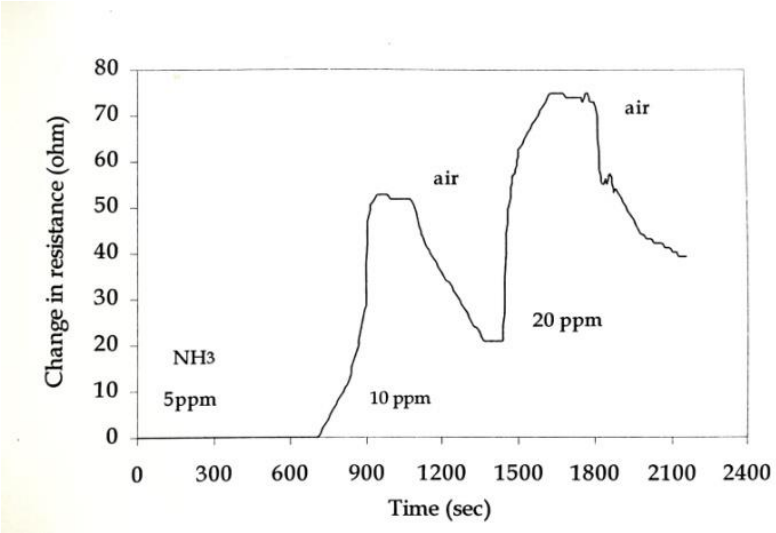

Figure 5. Sensing reponse curve of PPy-AA thin film to 10 -20 ppm of ammonia

IV. CONCLUSION

In this proposed research work, the PPy-AA film has been successfully synthesized on PMMA substrate by oxidative chemical polymerization at room temperature 29^0c+0.5. UV-vis., FTIR analysis confirms the formation of conducting PPy. SEM shows the uniform, adhesive and porous surface morphology. It was observed that the film shows good response to 10 to 20 ppm of ammonia. This supports the functioning of the proposed mechanism as sensor.

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