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Synthesis and Characterization of conjugated Copolymers of PPy-PTh for Photovoltaic (PV) Applications

S. R. Takpire[1], R. V. Barde[2], S. A. Waghuley[3]*

[1]Department of Physics, Dr. B. N. college of Engg. and Tech., Yavatmal-Maharastra, India
[2]Department of Physics, Indira Gandhi Kala Mahavidyalaya, Ralegaon- Maharastra, India
*[3]Department of Physics, Sant Gadge Baba Amravati University, Amravati- Maharastra, India

ABSTRACT

All through the last decade the field of polymers photovoltaic have seen a remarkable development in in cooperation device efficiency and considerate of the essential optical properties. A class of new conjugated polymers containing a donor polythiophene (PTh) and polypyrrol (PPy) was synthesized via Chemical polymerization by using $TiCl_4$ as a oxidizing agent. The resulting copolymer was characterized by UV-vis, XRD, FE-SEM analysis. We fabricated organic photovoltaic cell device by using as-prepared composite. Copolymer photovoltaic cell of a bulk heterojunction was fabricated on ITO glass plates with the structure of ITO/copolymer/ITO. The photovoltaic parameter such as open-circuit voltage (Voc), fill factor (FF), short-circuit current (Isc), were measured. The conversion efficiency for as fabricated photovoltaic cell was found to be 0.34%.

Keywords: Copolymer, Isc, Voc, Fill Factor.

I. INTRODUCTION

Light energy sources has aggravated industrial and logical research come near towards the expansion of most efficient, lightweight and low-cost photovoltaic devices[1]. The organic Photovoltaic cell fabrication methods, bulk-hetoro-junction the photoactive layer has been extensively studied [2]. Organic photovoltaics (OPV) solar cells are at this time the most investigate architectures, allowing the preparation of large area devices using simple and effective techniques, i.e. roll-to-roll [3], screen painting[4] and doctor blading technique[5], leading to current certified efficiencies up to 15%. quite a few cpolymers of polythiophene with different conjugated materials have been synthesized for the fabrication of PVCs showed Promising photovoltaic application. UV–vis absorption has been enhance with dopant concentration increases at low temperature. PTh, PPy and its copolymer In polymer/metal oxide composites have been high the light-absorption, electron-transporting and PV efficiency of Organic PV [6,7,8]. . PTh, PPy composites have a potential candidate for elementary study of modern device applications such as PV cells, transparent electrodes, super capacitors, gas and humidity sensing, and light emitting diodes [1,2].

II. Experimental Section

2.1 Materials and Synthesis

The thiophene, pyrrol monomer and titanium chloride ($TiCl_4$) and other AR grade chemicals and reagents were purchased from commercial sources

SD fine, India and used without any further purification. The 50 wt % of thiophene and Pyrrol monomers were added in beaker, After the rigorous stirring of solution of thiophene and Pyrrol monomers added 50 % $TiCl_4$ in that solution. In the copolymerization reaction of mixture of monomers, it was observed that as soon as the $TiCl_4$ was added to the monomer solution, the colour changed almost instantaneously and the solution became dark brown/black. The copolymer and mixture of PTh/PPy so obtained was soft powder, dried in a desiccator's overnight and again dried in an oven at 50°C. The prepared sample then washed with double distilled water at least three times for removing unreacted chorine in the reaction. PVCs were fabricated on ITO glass plates in the sandwich structure with ITO electrode and a metal (Al) electrode. The doctor blade technique was used for coating of composite active layer on ITO substrates in the architecture of ITO/Ti-PTh-PPy/Al.

3. Results and discussion

3.1 UV-Vis analysis

Figure 1 shows the UV–vis spectra of the as-prepared PTh-co-PPy-Ti composite of in the range 190 nm to 2000 nm. PTh-co-PPy-Ti composite was establish intensive and broad absorption bands in the UV region, that indicating π– π * polymer backbone [7]. The absorption spectrums show a broad absorption over the wavelength ranging from 190-280 nm. Beyond 310 nm, absorption decreases slickly up to 520 nm. However, the absorption at 340 nm increases gradually with an increase in Ti and content present in polymer matrix

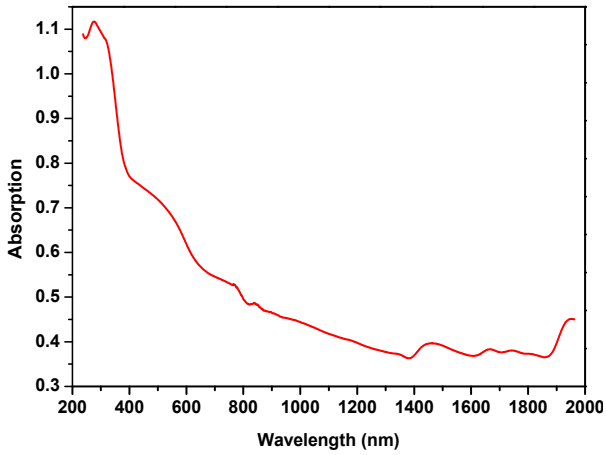

Figure 1. UV visible spectra of PTh-co-PPy-Ti composites

3.2 XRD analysis

Figure 2 shows the typical X-ray diffraction (XRD) pattern of the Ti-PTh-PPy composite. In this pattern observed the some sharp and prominent peak at specific position 21°,40°, so it reflects that it is crystalline nature but other position weak and noisy peak so its reflect amorphous in nature. This simultaneous amorphous and crystalline nature in same material confirms the semicrystallization of as prepared samples

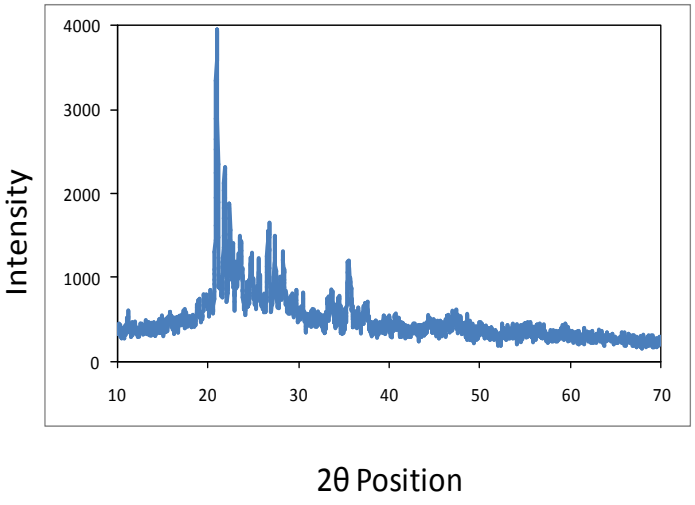

Figure 2. XRD patterns Ti doped PTh-PPy copolymer composites with 50:50:50 wt% ratio of thiophene Pyrrol and $TiCl_4$

3.3 FE SEM analysis

To confirms the structural characteristics of the Ti-PTh-PPy composites, figure 3 shows the FE-SEM image. FE-SEM was applied to study its surface

morphology. It was unveiled that Ti-PPy-PTh composite consists of mesh and porous networks formed by Ti- PTh composites.

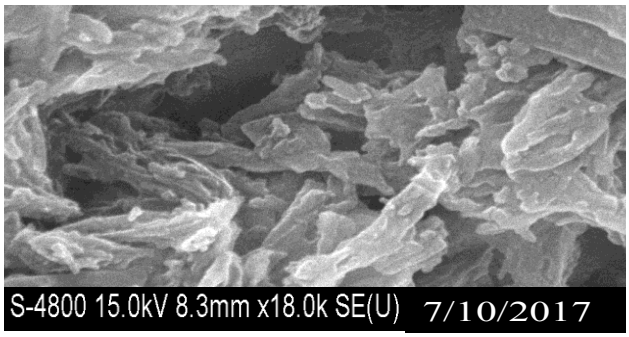

Figure 3. FE-SEM image Ti doped PTh-PPy copolymer composites with 50:50:50 wt% ratio of thiophene, Pyrrol and $TiCl_4$

I-V characteristic

The photovoltaic performances of the hybrid PVC were determined by measuring photocurrent-photovoltage (I–V) characteristic both in the under irradiation. The I-V curve has several characteristic points. The short circuit current (Isc) is obtained when the voltage is zero and the electrodes are connected externally. The open circuit voltage (Voc) is obtained when the current is zero. At both points the cell does not produce power, since VI = 0. Another indicator for the parameters the fill factor (FF) and Power conversion efficiency was find out from equation 1 and 2 resp.

$$FF = V_{max} \times I_{max} / V_{oc} \times I_{sc} \quad (1)$$

$$\eta = (V_{oc} \times I_{sc}) \times F.F./ P_{in} \ [10] \quad (2)$$

Corresponding to an overall conversion efficiency (η) of 0.34% and other photovoltaic parameter is short circuit current(Isc) 0.019 mA, open circuit voltage (Voc) 0.56 V, Imax 0.014, Vmax 0.45 V.

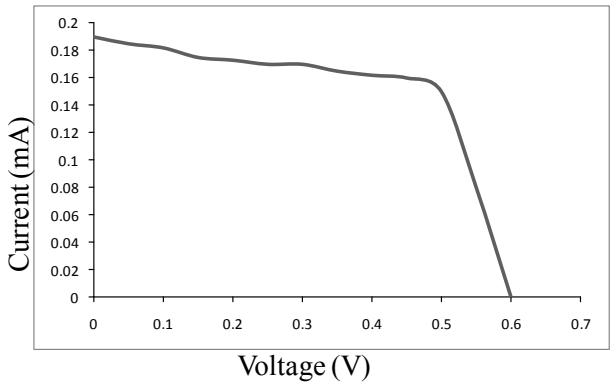

Figure 4. I-V characteristics Ti doped PTh-PPy copolymer composites with ratio 50:50:50 of thiophene Pyrrol and $TiCl_4$

III. Conclusions

In summary, we have successfully fabricated and studied the PVC on ITO coated glass substrate with the architecture of ITO/Ti-PTh-PPy/Al for PV applications. Characterizations of Ti-PTh-PPy copolymer were done through UV-Vis, XRD, FE-SEM analysis. The optimum value of power conversion efficiency was found to be 0.34 % for 50:50 wt %.and other parameter of PVC was found to be Voc = 0.56, Isc =0.19mA, FF = 0.56.

IV. REFERENCES

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