Structural and Morphological Study of Interfacial Polyanilne / FA / Ag Nano composites using by DC Glow Discharge Plasma

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Abstract: ***This paper describes a new approach to improve the analysis of surface modification of free-standing semiconducting polymer films using D.C glow discharge plasma. The conducting polymer polyaniline (PANI) has a wide range of optoelectronic applications. The IPANI+ FA+Agno composites have been synthesized with various composition (5, 10, 15, 20 and 25 wt %) of FA in PANI. Thin film of (IPANI + 5% FA + Agno) was treated by DC glow discharge air plasma. The formation of the compound and structural changes were investigated by Fourier Transform Infrared Spectroscopy (FTIR), X-ray diffraction (XRD). The morphology and composition of flyash particles of different sizes were studied with Scanning Electron Microscopy (SEM) and EDAX. The combination of PANI as a semiconducting polymer with silver as a noble metal may produce hybrid material that behaves a semiconductor at low temperature and as a metal at high temperature.***

Keywords: Interfacial, Polyaniline, Flyash, Glow discharge Plasma, FTIR, XRD, SEM and EDAX composite

1. Introduction

The conducting polymers have emerged as a novel class of materials of current research interest worldwide. They have electrical properties of semiconductors at the same time, the advantages and mechanical properties of polymers. The conducting polymers (PANI) and its derivates have attracted much interest because of their higher environmental, thermal and chemical stability along with high conductivity [1]. Conducting polymer – Inorganic oxide composites are expected to improve or complement the electrical , electromagnetic, chemical and structural properties over their single components, to achieve maximum efficiency required on the different process taking place in specific applications [2-6].

In this work IPANI films were treated with DC glow discharge air plasma under different exposure films with a intension of improving the intrinsic low – surface properties. The formation of the compound and structural changes were investigated by Fourier Transform Infrared Spectroscopy (FTIR), X-ray diffraction (XRD). The morphology and composition of flyash particles of different sizes were studied with Scanning Electron Microscopy (SEM) and EDAX. The combination of PANI as a semiconducting polymer with silver as a noble metal may produce hybrid material that behaves a semiconductor at low temperature and as a metal at high temperature.

2. Experimental

2.1 Synthesis of IPANI/Fly ash/Ag Nano composites:

IPANI/ Fly ash/Ag composites were prepared with the concentrations of 0.3M silver nitrate solution and it was dissolved in 1.0 M HNO_3 than added to the organic phase which contains 0.5g of aniline in 10 ml of $CHCl_3$. 0.1 M ammonium persulphate is dissolved in 1.0 M in double distilled water and the same is slowly added to the above mixture of aqueous and organic phase. After 5 min, dark green layer was formed slowly at interface and then gradually diffused into the aqueous phase. After 24 h the entire aqueous phase was homogenously filled with dark green colour and an organic layer observed shows orange colour due to the formation of aniline oligomers. The dark green precipitate in aqueous phase was collected, and washed with ethanol and water to remove the unreacted monomer. The residue of polymer thus obtained is purified and dried in a vacuum oven at 40.8 C for 36 h.

2.2 Plasma Treatment

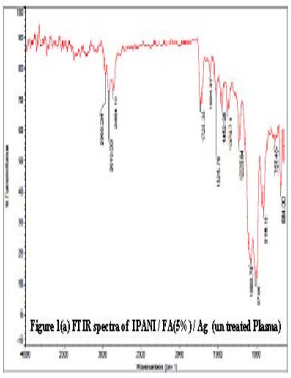
PANI film was cut into 8cm×8cm section for plasma treatment. DC glow discharge plasma of low pressure was generated in a stainless steel chamber of 50cm length and 30 cm internal diameter size. Vacuum of 10^{-3} m bar was maintained inside the chamber using a vacuum pump. Required vacuum was maintained using fine control gas needle. Pirani gauge was used for pressure measurement. Circular shaped electrodes made of aluminium with a diameter of 5cm were fixed inside the chamber. The electrodes were separated by a distance of 3cm. Air was used as the reactive gas. High tension dc power supply of 1.5 kv was used. The IPANI film was placed perpendicular to the discharge axis between the parallel electrodes using a holder. The discharge potential and pressure was 350 V and 0.2 mbar respectively.

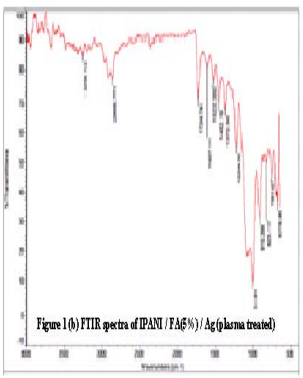
3. Results and Discussion

3.1 FTIR Spectra

The FTIR spectra recorded for IPANI / FA (5%) / Ag nano composites (untreated and treated Plasma) as shown in figure1(a)and (b).The characteristics peaks of pure PANI observed around 2965.342919.00,1725.35, 1525.78,1452.98,1225.84,1080.73,914.18and684.00. The band assignments of the FTIR spectrum of polyaniline are given in Table.1.

IR Frequency (Cm^{-1})		*Bond and Functional Groups*
Untreated	*Treated plasma*	*Untreated plasma and Treated plasma*
2866.71	2864.10	C-H Stretch
3258.12	2965.34	N-H Stretching in Primary amine
1724.74	1725.35	-C=C- Stretch
1522.32	1525.78	N-H bending
1452.19	1452.98	C-C Stretch in Aromatic
1224.50	1225.84	C-N Stretch
1003.91	1080.73	=C-H bending
910.39	914.18	N-H Wag
678.96	684.00	C-H bending





3.2 XRD

The X-ray diffraction data for I PANI+ 5% FA + Ag nanoparticle (Un treated and treated plasma) as shown in figure2(a) and (b). The X-ray scattering pattern exhibits amorphous nature. The shifting in position is due to different crystalline behaviour and structure of PANI. However results reveals the strong crystalline nature of synthesissed of PANI. There are major changes in the shape and position of the diffraction peaks after plasma treatment (Table-2)

Table 2: XRD Spectra of Polyaniline and treated polyaniline

Untreated Plasma		Treated Plasma	
2θ	d- Spacing	2θ	d- Spacing
19.577°	4.5308°	19.256	4.6055
26.925°	3.0876°	35.320	2.5263
36.535°	2.5243°	37.891	2.3725
38.396°	2.3425°	44.007	2.0669

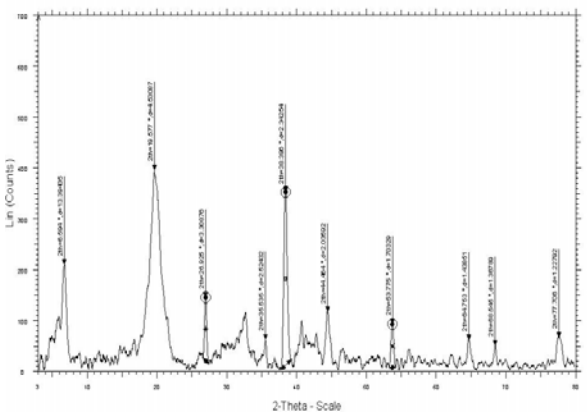


Figure 2: (a) XRD spectra of IPANI+5%FA+Ag (untreated plasma)

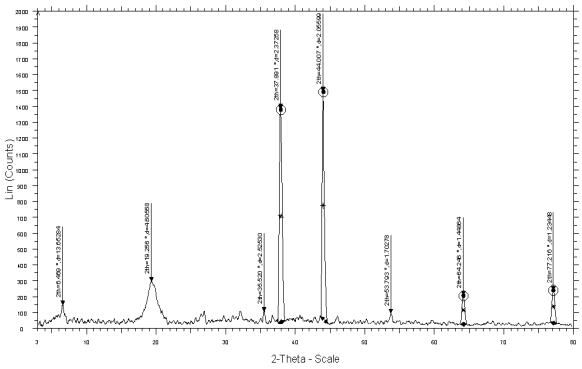


Figure 2: (b) XRD spectra of IPANI+5%FA+Ag (treated plasma)

3.3 SEM

SEM of untreated and treated plasma IPANI/5%FA+Ag nano particle is shown in figure 3(a) and (b). From the figure 3(a) It shows the presence of silver nano rod shaped structure, which are homogenously distributed throughout the composited. The particles size throughout the composites. The particles size of raw FA varies between 191.66 nm and 2.31µm. This is because of the presence of FA/Agno surfaces is likely to give the strong interfacial interaction between the polymer matrix and the Agno in polymer composites. From the figure 3(b) It shows the presence of very high magnification reveals the homogenous distribution of fly ash particles. Hence, a network of flyash and granular polyanilne has been formed in case of composites. The particle size of FA varies between 285.71 nm and 342.86µm. The amount of porosity induced in these composites sample increases at W% of FA in IPANI+5% FA +Agno free standing thin film. By comparing treated and un treated plasma of IPANI+5%FA +Agno, it can be conclude that the gradual increases in granular size and change in morphological helps the transportation of charge particles through the carbon back-bone of polymer chains [16]

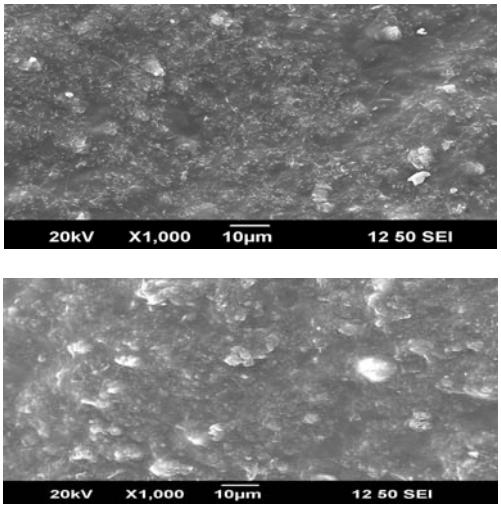


Figure 3: (a) SEM photographs of IPANI+5%FA+Ag (untreated plasma)

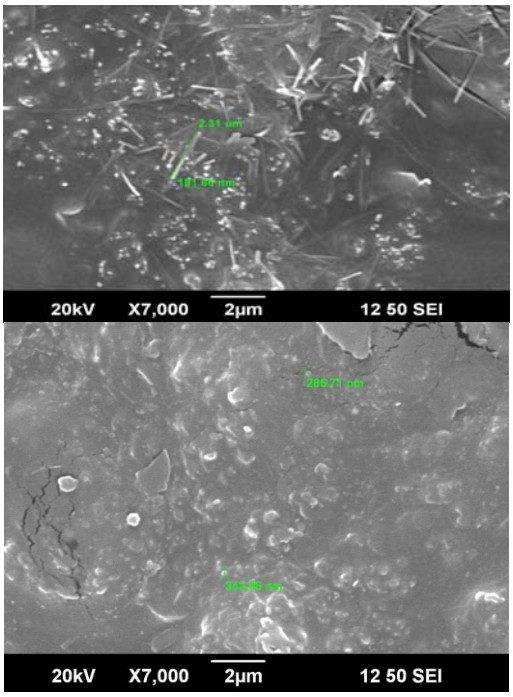


Figure 3 (b): SEM photographs of IPANI+5%FA+Ag (treated plasma)

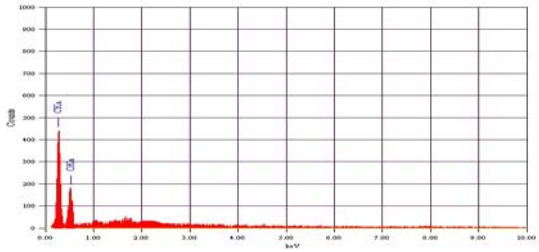


Figure 3(a): EDAX photographs of IPANI+5%FA+Ag (untreated plasma)

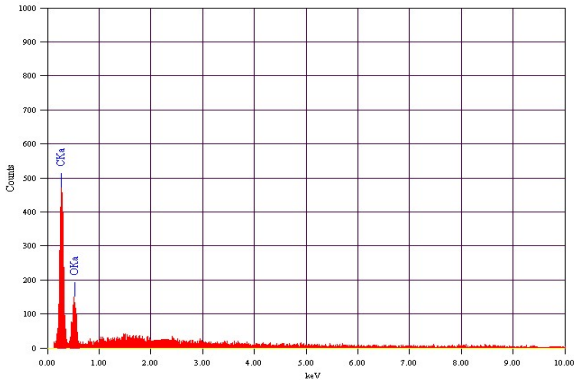


Figure 3(b): EDAX photographs of IPANI+5%FA+Ag (treated plasma)

4. Conclusion

Low pressure DC Low temperature plasma treatment has been used to modify the IPANI / FA (5%) / Ag film surfaces. It was found that the plasma treatment modified the surface both in chemical composition and morphology. FTIR spectra showed the increases in absorption bands due to plasma treatment. XRD spectra of highly ordered structures of composites were confirmed. SEM study reveals that granular shape structure morphology of PNI-Ag nanocomposite

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