



RESEARCH ARTICLE - physics

Some Polyaniline Blends Films Physical Characteristics

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Article Info.	Abstract
<p><i>Article history:</i></p> <p>Received 24 September 2023</p> <p>Accepted 13 April 2024</p> <p>Publishing 30 June 2024</p>	<p>The casting technique has been successfully used to prepare films with polyaniline (PAni) blends. Films made from the (PMMA ,PAni), PS, and POE at consistent concentrations have a thickness of 50 micro meters. By using XRD and FTIR spectroscopy, the PAni Blends films are identified. Using this method, the presence of the films' distinctive bonds was discovered. Electrical characteristics showed that, the conductivity of PAni blend sheets measured at room temperature is as follows: for PAni blends made with PMMA, PS, and PEO, respectively: (5.18, 9.23 and 0.12) 10^{-9} S.cm⁻¹. The tensile stress and hardness numbers of the numerous PAni blend films can differ from one another depending on the mechanical characteristics. The results also indicated that the polymers can be used with a very thin layer in photovoltaic cell applications.</p>
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1. Introduction

Polymer blends can be made by combining two or more different types of polymers in order to produce a novel substance with a wide range of different physical properties [1]. Polyaniline is a significant intrinsically conducting polymer because of the one kind electrochemical characteristic it possesses as well as its resistance to the effects of the environment [2]. There are many different kinds of polyaniline, each of which has its own set of distinct molecular and physical properties. Conductivity of the most common green protonated emeraldine is on the order of 100 S cm^{-1} , which is significantly greater than the conductivity of the typical polymer, which is 10^{-9} S (1/cm) , but it is lower than the conductivity of typical metals, which is $>10^4 \text{ S cm}^{-1}$. In other words, the conductivity of the most common green protonated emeraldine is lower than the conductivity of typical metals. Protonated PAni (such as P hydrochloride) undergoes a transformation into a non-conducting blue emeraldine base when it is subjected to the action of ammonium hydroxide [3]. Significant features that appear to be promising for a variety of practical applications are included in the PAni. These features include rechargeable power sources), sensors, magnetic shielding etc. and light-emitting diode technology [4]. The PAni has significant features that appear to be promising for a variety of practical applications. Access to the PAni has been limited because of the inadequate technical qualities it possesses [5]. This property is going to be combined with those of more conventional polymers in order to improve it. Conventional polymers such as PMMA, PS, and POE are renowned for their superior mechanical properties and share characteristics such as high light transparency and an amorphous structure. Another name for these three types of polymers is the "big three." The extensive use of polymers in design applications that call for bending and stress attenuation [6] makes it necessary to emphasize the significance of the material's mechanical properties, which in turn makes it necessary to emphasize the material's mechanical properties. The vast majority of mixtures have been created with the intention of improving particular mechanical characteristic combinations [7]. We investigated the electrical conductivity, structure, and mechanical properties of PAni while blending it with different types of polymers (PMMA, PS, and POE) at constant concentrations in order to determine which conventional polymer is the best candidate for use in the fabrication of PAni films. Our goal was to identify the conventional polymer that, when combined with PAni, produces the best films.

2. Details Experimental

PAni blends films are cast using this technique. PAni.ES powder weighing 50 mg was dissolved in 5 ml of chloroform to create the PAni blends solution films. The mixture was stirred continuously for 2 hours to create a homogeneous solution before adding 200 mg of PMMA, 0.2 g of PS, and 0.07 g of PEO to the (PAni.PEO) preparation solution. The process was repeated for the other polymeric solutions as well. These solutions were added to flat glass plate plates, where they were allowed to air dry for four days. The infrared study of wave numbers between 400 and 4000 (1/cm) is performed using a SIDCO England series FT-IR spectrometer. Using Philips X-ray diffraction diffract meters, the structure of the prepared samples which deposited on glass and silicon substrates is examined. Use the JIANQIAO TESTING EQUIPMENT type tensile tester for tensile tests, and the TH200 model hardness tester for hardness tests. The prepared polymeric compounds with an amount of not more than 10 microliters were used to coat the porous silicon prepared by an electrochemical method of the positive type by drop casting method and use it as a window and to protect the silicon and reduce the reflectivity as shown in fig. 1.

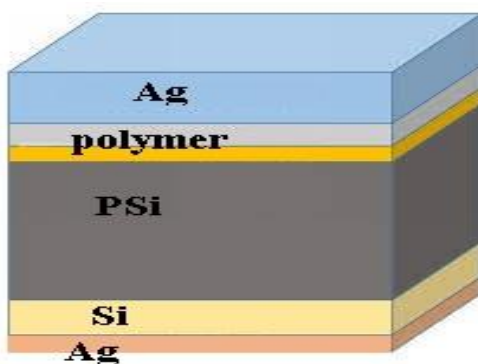


Fig.1. Scheme of the prepared heter-ojunction.

3. Results and Discussion

At room temperature, the differences in the electrical conductivity of PAni films produced with different blends are displayed in Table 1. It has been determined that PAni can have a maximum permeability. When compared to the other two blends, the conductivity of the PEO mixture was approximately $1.22 \times 10^{-8} \text{ S.cm}^{-1}$, which is greater than the average for (PAni.PEO). May be due to the structural condition of the films, but it is important to note that the findings from this study are very similar to those described in the literature [7]. This is something that needs to be taken into consideration.

Table 1. PAni blends electrical and structure parameters

Samples	$\sigma \text{ S.cm}^{-1} \times 10^{-9}$	C.S A°	Hardness	Tensile MPa
Pani.PMMA	5.181	10.10	104.0	6.940
Pani.PS	9.233	11.34	102.8	5.880
Pani.PEO	0.122	10.20	105.0	2.338

Fig. 2 displays the correlations between blends of (PAni.PMMA), (PAni.PS) and (PAni.PEO) and the three spectra that were analyzed using X-ray diffraction. The numerous peaks in the X-ray spectra served as evidence that all of the film combinations had a polycrystalline structure. This conclusion was reached after the films were analyzed. Fig. 1 demonstrates that the (PAni.PS) blend has a minimal polycrystalline structure in contrast to the (PAni.PEO) and (PAni.PMMA) blends, both of which have more peaks than the (PAni.PS) blend. The Scherrer formula [8], which demonstrates the difference in average grain size at blends, is utilized in the process of calculating the average crystalline size of the material.

The results of the XRD examination reveal a marginal difference in crystalline size, as can be seen in Table 1.

$$C_s = \frac{M \lambda}{FWHM \cdot \cos \theta} \tag{1}$$

Where A is the shape factor, commonly assume M =1 and FWHM is the half maximum of full width.

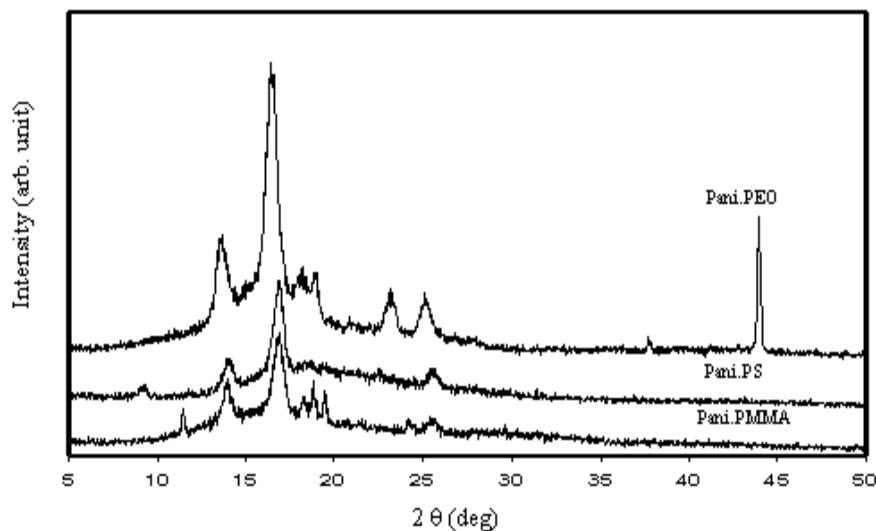


Fig. 2. The XRD spectra of PAni Blends

The XRD peak that can be seen when the diffraction angle is set to. The (PAni.PS) blend has been discovered to have the maximum typical grain size. (PAni. PMMA), (PAni.PS) and PAni. Spectra were all taken using FTIR. PEO blends are illustrated in Fig. 3, 4, and 5, which provides information regarding the specific functional groups that are contained within these blends.

In Fig. 3, the FTIR spectra of PAni. PMMA sheet can be seen. According to these findings, it is abundantly clear that the peaks corresponding to PMMA that are seen in the blended polyaniline [9] are present. It has been observed that there is a peak that appears at 1730 (1/cm), which refers to C=O unsaturated) [10]. As a direct consequence of the transfer of hydrogen by the NH group, these modifications can be attributed to the formation of hydrogen bonds between the aforementioned groups. The development of an interpenetrating network of polyaniline and the matrix chain is developed as a result of the H-bonding, which provides harmonization between polyaniline and the carbonyl group in PMMA. The FTIR spectrum of PAni. Fig. 4 demonstrates using the PS blends the characteristic peaks that are produced by the PAni. At

1740 (1/cm) for the stretching vibration (C=C) of the Quindío ring, 1493 (1/cm) for the stretching vibration (C=C) of the benzenoid ring, 1263 (1/cm) for the C-N stretching vibration, 1103 (1/cm) for the C-H in-plane deformation, and 806 (1/cm) for the C-H out-of-plane deformation, PS blends were demonstrated for polyaniline. In addition to this, polystyrene is connected to a unique absorption band located at 2968 (1/cm) (methylene C-H stretching) [11], which is a part of the PANi FTIR bands. The PEO blend is illustrated in fig. 5. The results presented here make it abundantly clear that the blended polyaniline has peaks that are equivalent to PEO. The blend formation, also known as the PANi spectra, can be seen immediately in peaks as well as changes in existing levels. It was discovered that PEO samples have an IR absorbance peak at a wavenumber of 2893 (1/cm) [12], which is evidence that OH bonding is present. This was found out as a consequence of hydrogen bonding taking place in the NH section that exists between PEO and PANi.

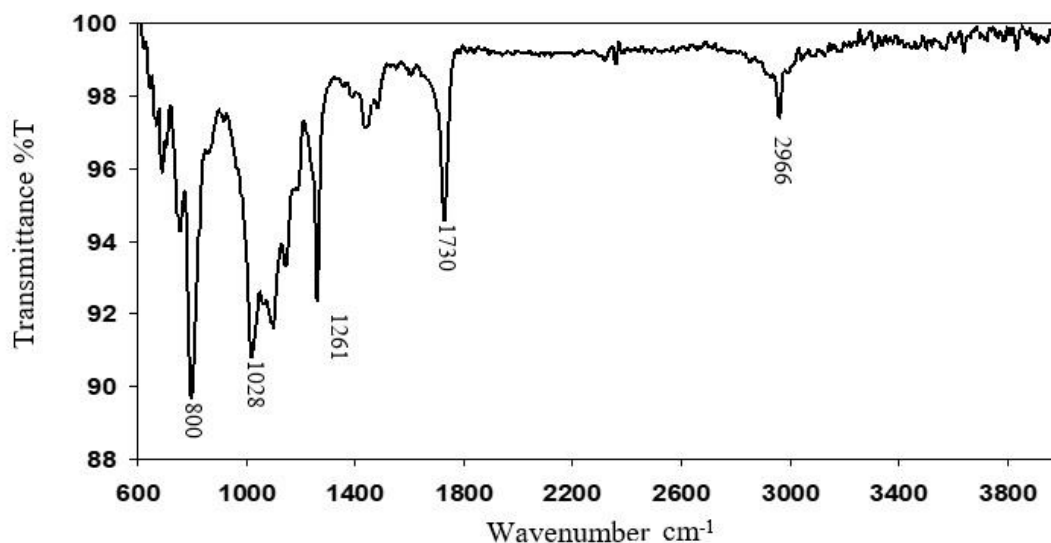


Fig. 3. Pani.PMMA FT-IR spectra

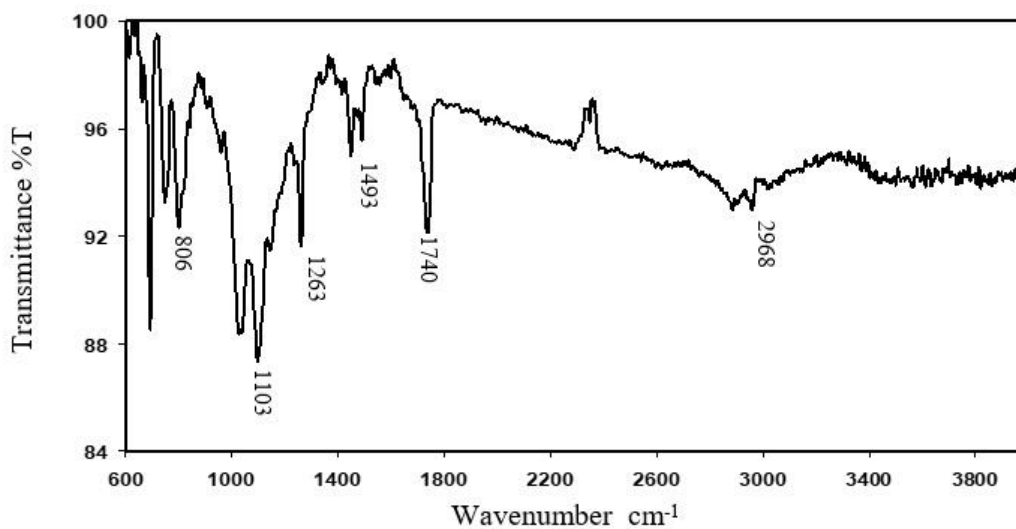


Fig. 4. Pani.PS. FT-IR spectra.

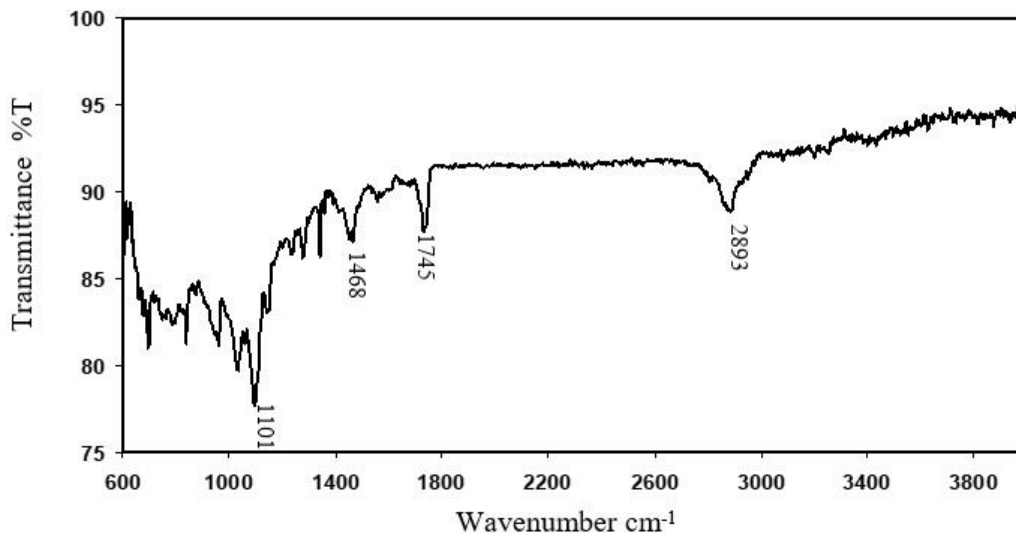


Fig. 5. Pani. PEO .FT-IR spectra.

The degree to which a substance is able to withstand the application of concentrated plastic deformation is what's meant when people talk about a material's toughness. Because they are uncomplicated, inexpensive, and non-destructive, hardness tests are carried out more frequently than other kinds of mechanical examinations. In addition, the findings of hardness tests can frequently be used to deduce the values of other types of mechanical characteristics, such as tensile strength. This is because hardness is a measure of the resistance of a material to being bent or stretched. In order to calculate the hardness of the PANi mixes and the results of the testing, it is necessary to perform tests on the hardness of the it as well as the impact of additives (PMMA, PS, and PEO polymer) on the outcomes of the tests. Table 1 outlines the various hardness ratings that each of the different combinations of (PANi. PMMA), (PANi.PS) and (PANi. PEO).In terms of its level of abrasiveness, the (PANi. PEO) mixture achieves a maximum value of approximately 10^5 , as is evident from the preceding statement. It is conceivable that this is the results of adding high-strength reinforcements to the mixture of PANi and PEO. These reinforcements have the effect of making the material more rigid. The (PANi. PEO) blend has a minimal value for tensile strength, as shown in Table 1. However, it is plausible that the (PANi. PMMA) blend has a maximum value for tensile strength of approximately 6.94 Mica pa. This is because the (PANi. PMMA) blend has a higher percentage of PMMA. The reason for this is that the (PANi. PMMA) mixture has a higher proportion of (PANi. PEO) than (PANi. PMMA).

4. Dark and light Current-Voltage Measurements

Fig. 6 shows the I-V dark characteristics in forward and reverse direction of Ag/ PANi. PMMA /PSi/n-Si/Ag and of Ag/ PANi. PEO /PSi/n-Si/Ag heter-ojunctions. When the voltage is less than 1 volt, the forward current of any and all heter-ojunctions is extremely low. This type of current is referred to as recombination current, and it only takes place at low frequencies. It is produced whenever an excited electron forms a valence band in an effort to restore the energy equilibrium. The second region, which is represented by high voltage, is either the diffusion or bending region, depending on the series resistance. The bias voltage is able to transport electrons with sufficient energy to break through the barrier that separates the two sides of the junction when they are in this region. Optoelectronic characteristics are of the utmost importance for heter-ojunction, as it is through these characteristics that it is possible to ascertain how the photocurrent is generated from the incident light power. Fig. 6 also demonstrates that the reversed current-voltage characteristics of the device were recorded in the dark and under different light intensities to determine the

photocurrent when it was illuminated by a tungsten lamp with a power output of 10 milliwatts per square meter. It has been demonstrated that the value of the reverse current at a given voltage for Ag/ PANi, PMMA /PSi/n-Si/Ag, and Ag/ PANi can be determined. When exposed to light, the PEO/PSi/n-Si/Ag heterojunction has a higher energy level than when it is in the dark. It increases as the amount of light in the environment increases.

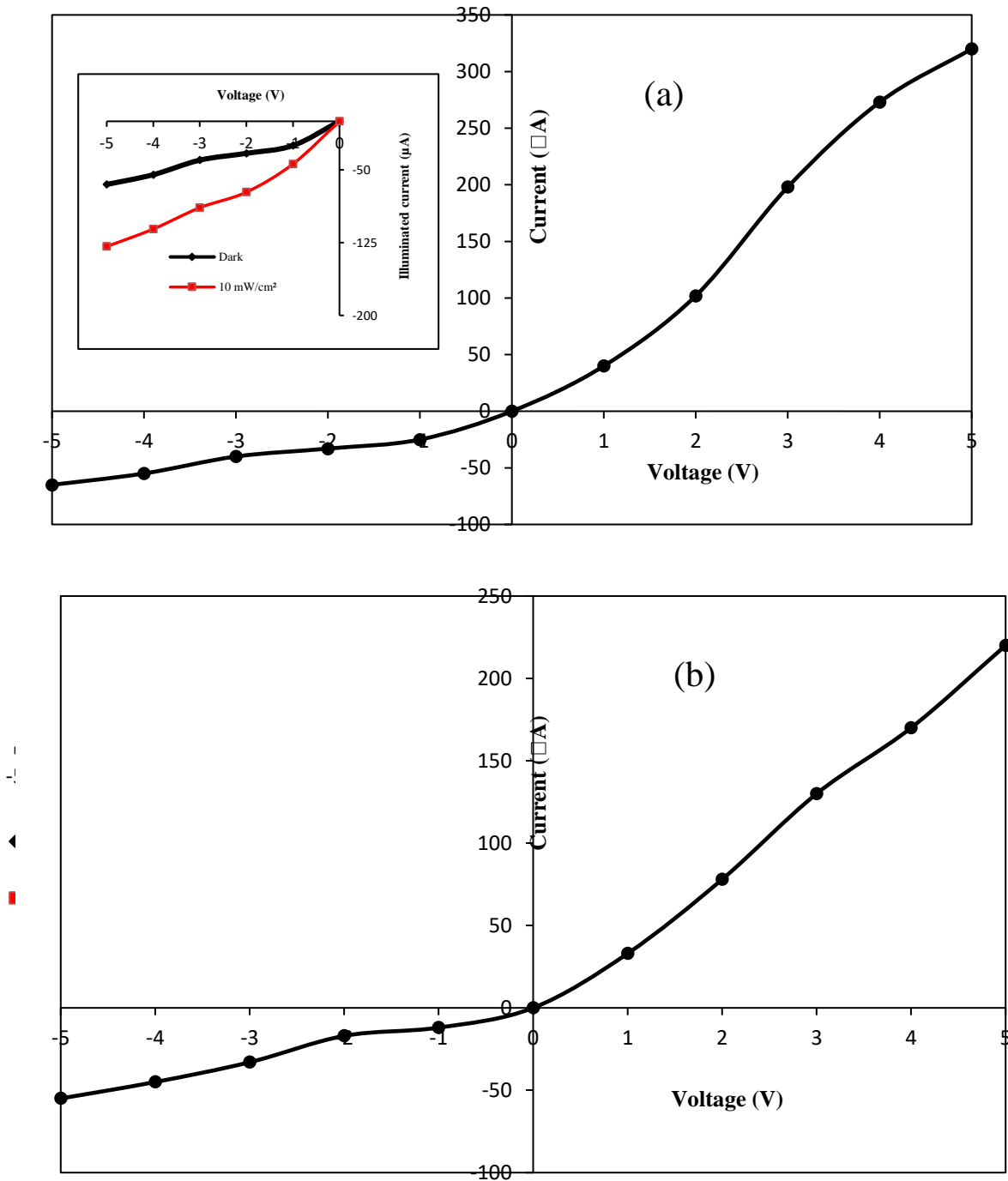


Fig. 6. I-V characteristic under forward reverse bias of the a) Ag/ PANi, PMMA /PSi/n-Si/Ag and b) Ag/ PANi, PEO /PSi/n-Si/Ag heterojunction

Conclusions

Casting has been used to great effect in the production of the PANi Blends films, which have been successful in producing the different PANi blends with (PMMA, PS, and PEO). Structure, mechanical conductivity, and electrical conductivity were all the subject matter of an in-depth investigation. The XRD analysis revealed that each of the samples possessed a polycrystalline structure, and the FTIR analysis revealed that PANi blend had been incorporated into the material. According to the results of the D.C. measurements, we found that the (PANi .PEO) has the greatest conductivity, while the (PANi .PMMA) has the highest number for the strength of tensile. As a result, we are of the opinion that PANi blend films might have a potential application in the future, specifically in bendable electronic devices. The results also indicated that the polymers can be used with a very thin layer in photovoltaic cell applications.

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