Impedance and Structural Studies of Bio Plastic Based on Banana Starch

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Abstract- *Plastics play a vital role in our daily life due to their relatively low cost. However, plastics are hardly degraded and they are creating lots of environmental problems. In order to eliminate this problems Bio plastics have been developed to replace the conventional plastics since they are easily degraded and also eco –friendly in nature. In the present work, PVA/Banana starch bio plastics have been prepared with molar ratio 70:30 by using Solution Casting Technique. The prepared bio plastic is subjected to FTIR, AC Impedance studies and swelling test studies.*

Keywords- Bio plastic, FTIR, AC impedance studies

I. INTRODUCTION

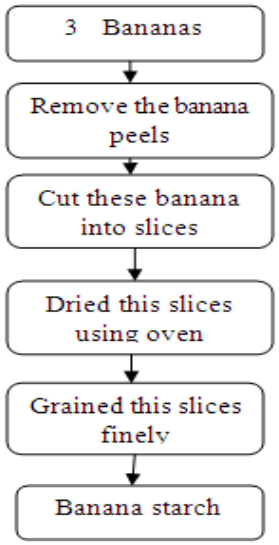
The production of Plastics has been rapidly growing since the beginning of 20th century. Plastics are very useful for our daily life. It becomes an integral part of human life. It has many applications due to its versatile practical use, lightness and convenience. But it creates an accumulated environmental problem since plastics have been hardly degraded in the nature. Biodegradable plastics are classified into two types. The materials which will be decomposed in natural aerobic (composting) process is one type of plastic materials while another is decomposed in anaerobic (landfill) environments. Starch is one of the most popular, renewable, biodegradable polymer, rich variety and abundances in nature. Poly (vinyl alcohol) has advantages over other polymers like PMMA, PAN, PEO, PVP etc., like excellent film forming ability, good mechanical strength, dopant dependent electrical and optical properties [1]. The structure of PVA shows many hydroxyl groups which can form from hydrogen bonds. These hydrogen bonds are the cause of excellent properties of PVA. Hence PVA has been chosen as the host polymer for the present study.

Polymer additives play a significant role in the modern plastics industry. Banana peel is low cost byproduct of food industry. The plastics synthesized using Banana peel has excellent properties like pliability, user friendliness and degradation tractable **[2]**. Banana starch is used as polymer additives in the present study.

II. EXPERIMENTAL PROCEDURE

A. Preparation of banana starch

In present study, the preparation of banana starch is shown below



B. Sample Preparation

PVA-Banana starch bio plastics have been prepared by solution casting technique using PVA and Banana starch. 0.44g of PVA is dissolved in 20 ml of acetic acid solution using magnetic stirrer at 100 ^{o}C for 1 hour. 0.55 g of banana starch is dissolved in 20 ml of acetic acid solution using magnetic stirrer at 50^{o}C for 2 hours. Then these solutions are mixed together and stirred well by using magnetic stirrer in order to obtain a homogeneous mixture. The obtained mixture is casted into petri dish and is subjected to vacuum dried at 40 ^{o}C for 1 day. After the complete evaporation of the solvent, the films are carefully removed from the petri dish and sealed in an air tight cover. The prepared sample is subjected to FTIR and AC impedance studies.

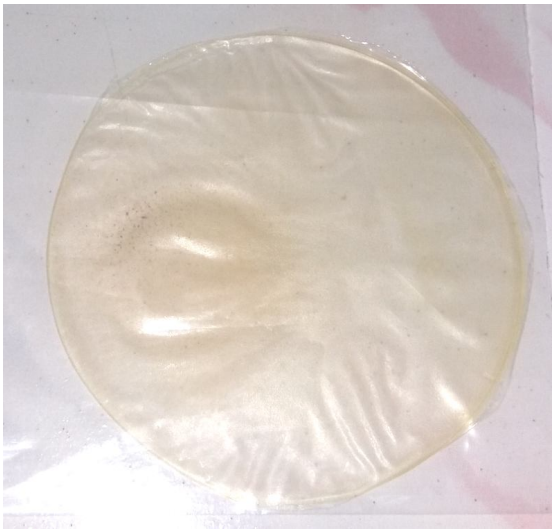


Figure 1 Photograph of 70 PVA :30 Banana starch bio plastic

III. RESULTS AND DISCUSSION

A. Fourier Transform infrared analysis

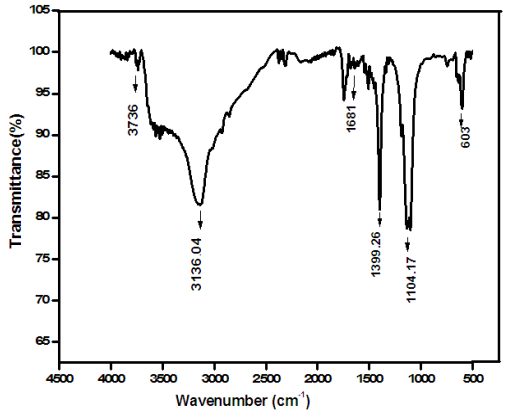


Figure 2 : FTIR Spectrum of 70PVA:30 Banana starch bio plastic

FTIR is used to determine the chemical properties of a compound in a qualitative manner. Figure 2 shows the vibrational peaks at 3235 cm^{-1} and 3136 cm^{-1} corresponds to stretching vibration of OH group present in PVA. The band at 1746cm^{-1}, 1681 cm^{-1} and 1510 cm^{-1} assigned to C=O stretching vibration of banana starch respectively [3]. The peaks at 1137 cm^{-1} and 1104 cm^{-1} are assigned to C-O stretching vibration of Banana starch. The peaks at 1399 cm^{-1} and 603 cm^{-1} assigned to C – H stretching deformation and C –H wagging vibration of Banana starch and PVA respectively [4]. The prepared sample confirms the complex formation among PVA and Banana starch.

TABLE I

Vibrational peaks and attributions of prepared PVA: Banana starch bio plastic

Vibrational peaks (cm^{-1})	Attributions
3736	O – H (s)
3136	O – H (s)
1746	C = O (s)
1681	
1510	
1399	C – H (s)
1137	C – O (s)
1104	
603	C – H (w)

B. Conductance Spectra Analysis

AC Impedance spectroscopy is a powerful experimental tool for characterization of the electrical properties of materials. The conductance spectra analysis has been used to find the dc conductivity of the mobile ion. Figure 3 shows that the conduction spectra of the prepared sample at different temperatures. This graph is a plot between log ω and log σ of the prepared sample at different temperatures.

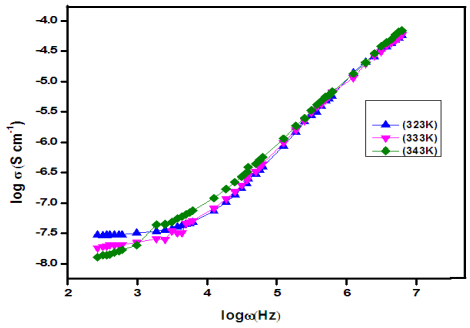


Figure 3 Conductance spectra of 70PVA: 30Banana starch bio plastics at different temperatures

TABLE II

Conductivity data of the prepared 70PVA: 30Banana starchbio plastic

Solvents	Initial weight of the sample	Final weight of the sample	Percentage of swelling
Distilled water	0.110	Completely dissolved	100%
Acetic acid	0.105	Completely dissolved	100%
Glycerol	0.111	0.145	30%

The conductance spectrum has two well defined regions. There is a constant plateau region at low frequencies. It is followed by dispersion in the high frequency region. The

low frequency plateau region corresponds to the dc conductivity of the bulk material while the high frequency region corresponds to the ac conductivity. The extrapolation of the constant region in the low frequency region to the log σ axis gives the conductivity of the sample [5]. From the table II, it has been observed that PVA: Banana starch has very low ionic conductivity in the order of 10^{-8} Scm^{-1} at all temperatures. It indicates that the prepared sample is bio plastic.

C. *Swelling Test Analysis*

The swelling capacity of a polymer is determined by the amount of liquid material that can be absorbed. This case can done by two methods.

1. Beaker test method
2. Tea bag test method

In this present study swelling test is carried out using Beaker test method.

Swelling test formula [6]

$$\textbf{Swelling Percentage} = \frac{Ws-Wd}{Wd} * 100$$

Where

Wd= weight of polymer

Ws=weight of swollen polymer

The solubility studies of sample are carried out to check the degradable properties of prepared bio plastic materials. The sample is cut into small pieces of 2 X 2 cm and is inserted into a test tube containing different solvents for 3 hours.

TABLE IIII

SWELLING TEST DATA OF 70PVA: 30BANANA STARCH BIO PLASTIC USING VARIOUS SOLVENT

Temperature (K)	Ionic Conductivity (X 10^{-5} Scm^{-1})
323	2.9369
333	1.9787
343	1.3329

From the table III, it has been observed that the prepared Bio plastic is completely dissolved in distilled water and acetic acid solutions respectively and it is partially dissolved in glycerol. It confirms that the prepared Bio plastic is degradable.

IV. CONCLUSIONS

The bio plastic using PVA and Banana starch has been prepared by Solution Casting Technique. The FTIR analysis confirms the complex formation between PVA and Banana starch. The ac conductivity for prepared bio plastic has been evaluated using conductance spectra at different temperatures. The ionic conductivity PVA: banana starch has no much variation with rise in temperature. The low ionic conductivity of the prepared sample indicates that the sample is Bio plastic.

REFERENCES

[1] K.P. Radha, S. Selvasekarapandian, M. Hema, "Characterization Of Composite Proton Conducting Polymer Electrolyte based On Poly (vinyl alcohol)" International Journal Of Electro Active Materials, vol.2, pp 28-33, 2014.

[2] Patricia Bataglini Franco, Leiliance Aparecida de Almeida, Rodrigo Fernando Costa Marques, Mariana Altenhofen da Silva, Maria Gabriela Nogueira Campos, "Chitosan Associated With The Extract Of Unripe Banana Peel For Potential Wound Dressing Application", International Journal Of Polymer Science, vol. 2017, Article ID 9761047, pp 1-8

[3] Jayachantra Yaradoddi, Vinay Patil, Sharanabasava Ganachari, Nagaraj Banapurmath, Anand Hunashyal, Ashok Shettar, "Biodegradable Plastic Production From Fruit Waste Material And Its Sustainable Use For Green Applications" International Journal Of Pharmaceutical Research And Allied Sciences, vol.5, no.4, pp 56-66, 2016.

[4] Jia Pu-you, Bo Cai – ying, Hu Li – hong, Zhou Yong – hong, "Properties of Poly (vinyl alcohol) Plasticized by Glycerin" Journal Of Forest Products & Industries, vol.3, no.3 , pp 151-153,2014. ISSN 2325 – 453X

[5] K.P. Radha, S. Selvasekarapandian, S. Karthikeyan, M. Hema, C. Sanjeeviraja, "Synthesis And Impedance Analysis Of Proton Conducting Polymer Electrolyte PVA: NH_4F", Ionics, vol.19, no.10, pp 1437-1447,2013.

[6] Sapei I, Padmawijaya K.S, Sijayanti O, Wardhana P.J, "Study of the influence of ZnO addition on the properties of chitosan – banana starch bioplastics" Innovation in Polymer Science and Technology 2016 doi:10.1088/1757-899X/2231/012044