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Fabrication of Polymer Composites and their Application for Energy Storage

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ABSTRACT

Energy storage and release are very important for many applications. The effect of addition the vegetarian lotion of orange on D.C and A.C electrical properties of (PVA –PEG) blend has been studied for thermal energy storage and release. The VLO was added to blend with different volumetric percentages. The results show that the volume electrical conductivity of bio composites is increasing with the increase of the VLO concentrations at room temperature. The dielectric constant and dielectric loss of bio composites increase with the increase of the VLO concentrations and they decrease as frequency increased. The A.C electrical conductivity increases with the increase of the VLO concentrations and frequency. The results of application for bio composites show that the melting and solidification time for thermal energy storage and release decreased with adding VLO concentrations.

KEY WORDS: Bio Composites, Vegetarian Lotion, Energy Storage, Energy Release.

1. INTRODUCTION

Every year in the worldwide about 140 million tons of industry polymers are produced. For several reasons as they are low cost, light weight polymers extremely stable. But, Environmental pollution by synthetic polymers, such as waste plastics and water soluble synthetic polymers in waste water has been recognized as a major problem. So, the lotion vegetarian has been used due to it is fri-environment, cheap price and can be degradable as well as the possibility of recycling. Whereas plastics and some polymers as thermoset are stability and resistance to degradation, they are accumulated in the environment, and difficult to remove it. It can be defining biopolymers as polymers made up under natural conditions during the growth cycles of all organisms. These days various synthetic polymers are being prepared combined with various reinforcing fillers in order to improve the mechanical properties and obtain the characteristics demanded in actual application. Polymeric based composite materials are being used in many applications, such as automotive, sporting goods, marine, electrical, industrial, construction, household appliances, etc. Polymeric composites have high strength and stiffness, light weight, and high corrosion resistance. The resultant composites are used in a range of industries including aerospace, leisure, sporting, automotive, and construction. In the recent years there has been numerous attempts made on the development of an electrical properties of polymer composites for several applications such as fuel cell, battery electrolyte and organic electronics domain. PVA is the good potential materials which are having high storage capacity, high dielectric strength, and electrical properties it has a carbon chain backbone with hydroxyl group attached to methane carbons. These O-H groups can be source of hydrogen bonding and therefore, assists the formation of polymer complex .It has good mechanical properties and shows electronic as well as ionic conduction.

2. EXPERIMENTAL PART

Bio composites of (PVA-PEG-VLO) films were prepared by using casting method. The VLO was added to poly vinyl alcohol and poly ethylene glycol polymer blend with different volumetric concentrations are (0, 4, 8 and 12) Vol%. The D.C electrical properties of bio composites have been measured by determining the D.C electrical resistance for 35C temperature by using the Keithley electrometer type 2400 source mater. The A.C electrical properties (dielectric constant; dielectric loss and A.C. electrical conductivity) of bio composites have been measured for different frequencies range (100-10^6)Hz by using LCR meter type (HIOKI 3532-50 LCR HI TESTER). The thermal energy storage and release include analyzing the melting and solidification characteristics of bio composites during heating and cooling processes. The solutions of bio composites are prepared by dissolving 0.5 gm of polymers (89 wt% PVA, 11 wt% PEG) in 30 ml of distilled water by using magnetic stirrer to mix the polymers to obtain more homogeneous solution. The vegetarian lotion of orange was added to polymers mixture with different concentrations are (2, 4, 8 and 12) Vol%. The water and bio composites solution were used as the heat transfer fluid, whose temperature can be varied from 28ºC to 60°C with stirrer and measuring the temperature of bio composites during the heating and cooling processes by digital device.

The volumetric electrical conductivity σ_V can be calculated for a regular body with a section has along the length (L), a constant area (A) and electrical resistance (R) using the relation:

$$\sigma_V = \frac{l}{RA} \quad \text{.....(1)}$$

The dielectric constant Ɛ can be calculated by using following equation:

$\varepsilon = \frac{C_p}{C_\circ}$……(2)

Where C_p is parallel capacitance and C_o is vacuum capacitor which be calculated by:

$C_\circ = \varepsilon_\circ \frac{a}{t}$……(3)

Where ε_o is vacuum permittivity. a: is the area of capacitance plate. t: is the distance between two plates. Dielectric loss ε'' can written by following equation:

$\varepsilon'' = \varepsilon D$ ……....(4)

D: is dispersion factor.

The alternating conductivity is given by:

$\sigma_{A.C} = w\, \varepsilon''\, \varepsilon_0$ ……..(5)

Where w is the angular frequency.

3. RESULTS AND DISCUSSION

Fig.1, shows the variation of D.C electrical conductivity of bio composites with different volumetric percentages of VLO at 35C. The figure shows that D.C electrical conductivity of blend increases with the increasing of the (VLO) concentrations which was attributed to increase the (VLO) volumetric percentages lead to increases the number of free charge carriers.

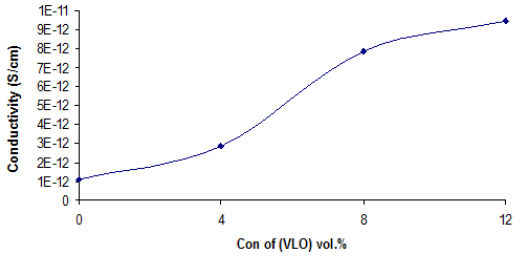

Figure.1. Effect of (VLO) concentrations on D>C electrical conductivity for (PVA-PEG) blend at 35C

Fig.2, shows the variation of dielectric constant of bio composites with different values of frequency. With increasing frequency, the dielectric constant decreases very fast due to control of the atomic and electronic influence in the polymer blend and space charge reduces gradually.

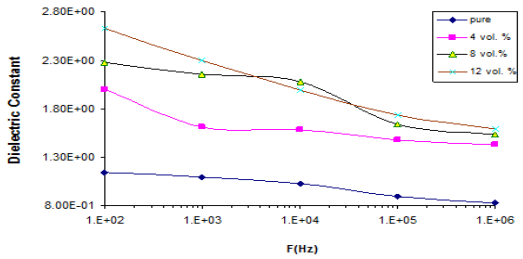

Figure.2. Variation of dielectric constant for (PVA-VLO) bio composites with frequency at room temperature

Fig.3, shows the variation of dielectric loss of bio composites with different values of frequency. For all samples of bio composites the dielectric loss decreases with the increasing of the frequency of applied electric field, this attributed to the decreases of the space charge polarization contribution and associated to the inability of dipoles to rotate quickly leading to a gap between frequency of oscillating dipole and that of the applied field.

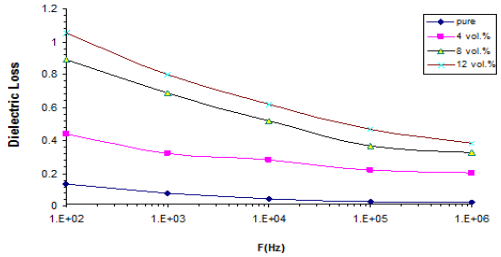

Figure.3. Variation dielectric loss for (PVA-VLO) bio composites with frequency at room temperature

Fig.4, shows the variation of A.C electrical conductivity of (PVA-PEG-VLO) bio composites with different values of frequency at room temperature. The A.C electrical conductivity increases with increasing of the frequency of electric field for all samples of bio composites, this behavior attributed to the mobility of charge carriers and the hopping of ions from the cluster.

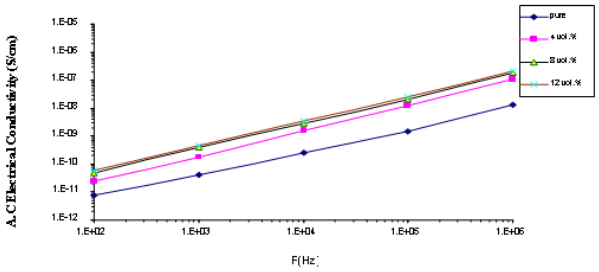

Figure.4. Variation of A.C electrical conductivity for (PVA-PEG-VLO) bio composites with frequency at room temperature

Figs.5, and 6, show the melting and solidification curses for bio composites. As is shown in figures, the melting and solidification time decrease with adding VLO concentrations, this is a useful method to improve the whole thermal conductivity of organic materials. Furthermore, faster rates of melting and solidification of bio composites would be evident to the thermal conductivity enhancement of base material.

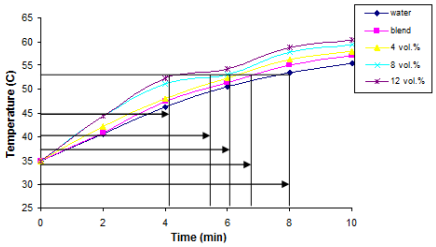

Figure.5. Melting curves of (PVA-PEG-VLO) bio composites

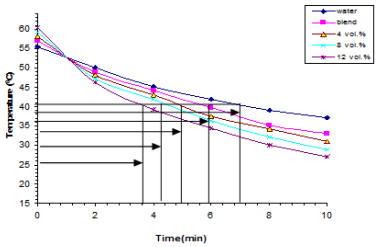

Figure.6. Solidification curves of (PVA-PEG-VLO) bio composites

4. CONCLUSIONS

- The volumetric electrical conductivity of bio composites increases with the increase of the concentrations of VLO.
- The dielectric constant and dielectric loss are increases with increase concentrations of VLO and they decrease with increased frequency.
- The A.C electrical conductivity increases with the increase of the concentrations of the vegetarian lotion of orange and frequency.
- The melting and solidification time for thermal energy storage and release application are decreased with adding vegetarian lotion of orange concentrations.

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