# Preparation of (PVA-PEG-VLW) Bio composites for Energy Storage and Release

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**ABSTRACT**

Energy storage and release are very important for several applications. So, poly vinyl alcohol (PVA) and poly ethylene glycol (PEG) have been prepared by using casting method with different percentages of the vegetarian lotion of willow (VLW). The effect of (VLW) filler on D.C and A.C electrical properties of (PVA –PEG) blend has been studied. The samples have been prepared by adding vegetarian lotion of willow with different volume percentages. The results show that the volumetric electrical conductivity of (PVA-PEG- vegetarian lotion of willow) bio composites was increased with the increasing of the vegetarian lotion of willow concentrations at $35^0$C. The dielectric constant and dielectric loss (PVA-PEG-vegetarian lotion of willow) bio composites were increased with the increase of the vegetarian lotion of willow concentrations and they are decreased as frequency increased. The A.C electrical conductivity for (PVA-PEG- vegetarian lotion of willow) bio composites are variety with the increase of the vegetarian lotion of willow concentrations and frequency. The results of applications for (PVA-PEG-VLW) bio composites show that the melting and solidification time for thermal energy storage and release decreased with adding vegetarian lotion of willow concentrations.

**KEY WORDS:** bio composites, vegetarian lotion, energy storage, energy release, willow.

## 1. INTRODUCTION

Biopolymers are usually mean as polymers can be produced in a natural way by living species. Molecules of these polymers are composed of repeating units of amino acids saccharides or nucleic acids. They also produced from bio monomers by using conventional chemical processes as poly lactic acid, genetically modified organisms, as poly hydroxyl alkanoates or directly in microorganisms. Biopolymers are used as single-use packaging in food, or for making clothing and furniture or electronics industries. The composites materials are produced by the combination of polymers and inorganic/organic fillers. The interaction between polymer or blend and fillers leads to form a bridge in the polymer matrix or blend hence to the enhancement of the electrical, optical or mechanical properties of composites.

## 2. EXPERIMENTAL PART

PVA and PEG solution were prepared by dissolving it in water by using magnetic stirrer in mixing process to get homogeneous. Bio composites of (PVA-PEG-VLW) films are prepared by using casting method. The vegetarian lotion of willow is added to poly vinyl alcohol and poly ethylene glycol with different concentrations are (0, 4, 8 and 12) vol.% and mixed to get more homogenous solution. The D.C electrical properties of (PVA-PEG-VLW) bio composites have been measured by determining the D.C electrical resistance for 35C by using the Keithley electrometer type 2400 source mater. The A.C electrical properties of (PVA-PEG-VLW) bio composites have been measured by determining the dielectric constant; dielectric loss and A.C. electrical conductivity for different frequencies range ($100-10^6$) Hz by using LCR meter type (HIOKI 3532-50 LCR HI TESTER). The solutions of (PVA-PEG-VLW) bio composites are prepared by dissolving the polymers (89 vol.% PVA, 11vol.% PEG) in 30ml of distilled water by using magnetic stirrer to mix the polymers to obtain more homogeneous solution. The vegetarian lotion of willow is added to polymers mixture with different concentrations are (2, 4, 8 and 12) vol. %. The thermal energy storage and release include analyzing the melting and solidification characteristics of bio composites during heating and cooling processes. 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 $\sigma_V$ 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 gotten by using eq. (2)

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

Where $C_p$ is parallel capacitance and $C_o$ is vacuum capacitor which can be calculated by eq. (3)

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

Where $\varepsilon_o$ is vacuum permittivity, a is the area of capacitance plate, t is the distance between two plates.

Dielectric loss $\varepsilon''$ can be computed as follow:

$$\varepsilon''=\varepsilon D \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(4)$$

D: is dispersion factor.

The alternating conductivity is given by:

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

Where w is the angular frequency.

## 3. RESULTS AND DISCUSSION

Fig.1, shows the variation of D.C electrical conductivity of (PVA-PEG-VLW) bio composites with different percentages of vegetarian lotion of willow at 35$^0$C. The D.C volumetric electrical conductivity of (PVA-PEG) blend increases with the increasing of the (VLW) concentrations. The rise the (VLW) percentage leads to increase the number of free charge carriers.

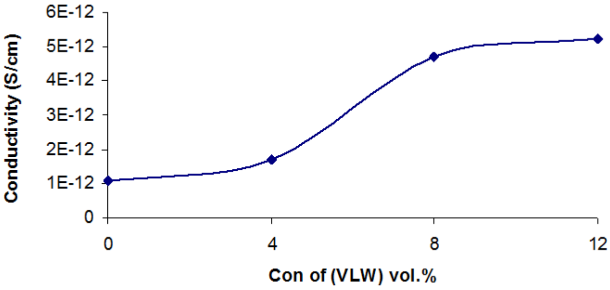


**Fig.1. Effect of (VLW) concentrations on D.C electrical conductivity of (PVA-PEG) blend at 35$^0$C**

Fig.2, shows the variation of dielectric constant of (PVA-PEG-VLW) bio composites with different values of frequency. By increasing frequency, the dielectric constant of (PVA-PEG-VLW) bio composites decreases very fast due to control of the atomic and electronic influence in the (PVA-PEG) blend and space charge reduces gradually but increasing the concentrations of (VLW) the dielectric constant will be increases.

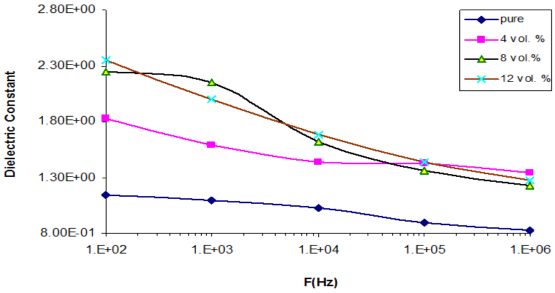


**Fig.2. Variation of dielectric constant for (PVA-PEG-VLW) bio composites with frequency at room temperature**

Fig.3, shows the variation of dielectric loss of (PVA-PEG-VLW) 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 is attributed to the decrease 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.

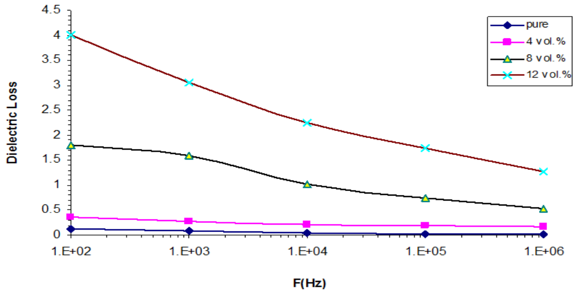


**Fig.3. Variation dielectric loss for (PVA-PEG-VLW) bio composites with frequency at room temperature**

Fig.4, shows the variation of A.C electrical conductivity of (PVA-PEG-VLW) 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.

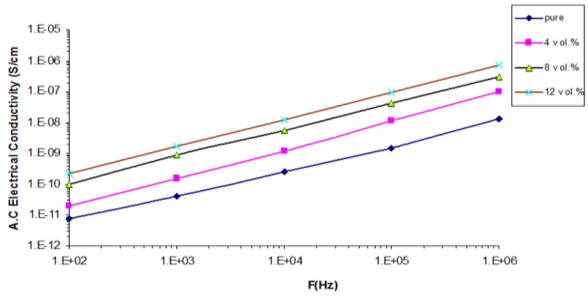


**Fig.4. Variation of A.C electrical conductivity for (PVA-PEG-VLW) bio composites with frequency at room temperature**

Figures.5 and 6, shows the melting and solidification curses for (PVA-PEG-VLW) bio composites. As shown in figures, the melting and solidification time decrease with adding vegetarian lotion of willow concentrations, this is a useful method to improve the whole thermal conductivity of organic materials. The decrease of melting time of the (PVA-PEG) blend for concentration (8 vol.%) of vegetarian lotion of willow is 32.4 % with adding vegetarian lotion of willow. The decrease of melting time of the water for concentration (8 vol.%) of vegetarian lotion of willow is 47.5 % with adding vegetarian lotion of willow. The decreases of solidification time of the (PVA-PEG) blend for concentration (8 vol.%) of vegetarian lotion is 25.49 % with adding orange. The decrease of melting time of the water for concentration (8 vol.%) of vegetarian lotion is 46.47 % with adding vegetarian lotion of willow, Furthermore, faster rates of melting and solidification of bio composites would be evident to the thermal conductivity enhancement of base material.

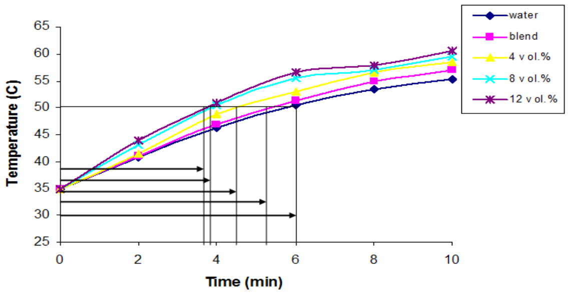


**Fig.5. Melting curves of (PVA-PEG-VLW) bio composites**

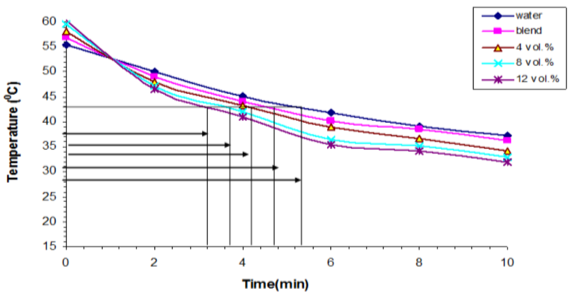


**Fig.6. Solidification curves of (PVA-PEG-VLW) bio composites**

## 4. CONCLUSIONS

The volumetric electrical conductivity of (PVA-PEG-vegetarian lotion of willow) bio composites increases with the increasing of the concentrations of vegetarian lotion of willow.

The dielectric constant and dielectric loss are increased with increasing concentrations of vegetarian lotion of willow and they decrease with increased frequency.

The A.C electrical conductivity of (PVA-PEG- vegetarian lotion of willow) bio composites increases with the increasing of the concentrations of the vegetarian lotion of willow and frequency.

The melting and solidification time for thermal energy storage and release application are decreased with adding vegetarian lotion of willow concentrations.

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