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Synthesis of New Biomaterial Composite for Thermal Energy Storage and Release

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ABSTRACT

Bio composites have many applications in biomedicine and industrials applications. In this work, polyvinyl alcohol-poly-acrylic acid blend as matrix and extract of pomegranate peel as filler bio composites have been prepared. The optical properties of polyvinyl alcohol-poly-acrylic acid blend- extract of pomegranate peel bio composites were studied in wavelength range (200-800) nm. The experimental results show the optical properties of bio composites were changed with increase of the extract of pomegranate peel concentrations. The bio composites were applied for thermal energy storage and release. The results show that the melting and solidification time for thermal energy storage and release were decreased with increase of extract of pomegranate peel concentrations.

KEY WORDS: bio composite, energy storage, polyvinyl alcohol, optical properties.

1. INTRODUCTION

Forming polymer blends is a traditional method for making new materials with enhanced properties. Traditionally, block and graft copolymers are used to strengthen the interface and stabilize the morphology. However, they are system specific, relatively expensive to engineer, and very difficult to produce for systems with more than two components. In recent years, the search for optical properties has increased because of their applications in integrated optics such as optical information, optical modulation, and optical data storage. The study of optical absorption useful for elucidation of the electronic structure and determine direct and indirect transitions. The advantages of organic polymers are formability, low density and flexibility toughness. In recent years on of the main classes of high performance engineering materials, next to metals and alloys, ceramics and polymer materials are composite materials. The idea of connecting two or more different constituents into on substance gives almost infinite possibilities to create new engineering materials characterized by variety of different properties. Composite materials because of these diverse properties are successfully used in almost all areas of industry and science. Especially popular are composites in automotive, electrical and electronic, aerospace and machine building industries, sport and leisure industry, civil engineering, etc. PVA is the good potential materials which are having high storage capacity, high dielectric strength, and electrical properties. It has good mechanical properties and shows electronic as well as ionic conduction. The lightweight composite materials can offer the impressive mechanical properties such as stiffness, a high specific strength and the relatively good energy absorbing characteristics.

2. MATERIALS AND METHODS

The films of polyvinyl alcohol-poly-acrylic acid blend with different volumetric percentages of extract of pomegranate peel were prepared by using casting technique. The extract of pomegranate peel was added to blend solution (93 wt.% PVA and 7 wt.% PAA) with different volumetric percentages are (0, 4, 8 and 12) Vol.%. The bio composites were casted in the template (petri-dish has diameter 10 cm). The absorbance spectra of bio composites were recorded by UV/1800/ Shimadzu spectrophotometer in range of wavelength (200-800) nm. The water and bio composites solution were used as the heat transfer fluid, whose temperature can be varied to 60°C with stirrer and measuring the temperature of bio composites during the heating and cooling processes by digital device.

The absorption coefficient α(ν) can be determined from the optical absorption spectrum by the following equation:

$$\alpha = 2.303\frac{A}{t} \quad \text{.....(1)}$$

Where, t is the sample thickness and A is absorbance.

The direct and indirect transitions can be defined by:

$$\alpha h\nu = C_0(h\nu - E_g^{opt})^r \quad \text{.....(2)}$$

Where, ν is the frequency, C_0 is a constant, h is Planck's constant, E_g^{opt} is the energy band gap between the valence band and the conduction band and r can take the values 2, 3, 1/2 or 3/2 for transitions designated as indirect allowed, indirect forbidden, direct allowed and direct forbidden, respectively.

3. RESULTS AND DISCUSSION

The absorbance spectra of (PVA-PAA-EPP) bio composites with wavelength as shown in figure.1. The absorbance increases with increase the volumetric percentages of extract of pomegranate peel which attributed to increase the charges carries in bio composite.

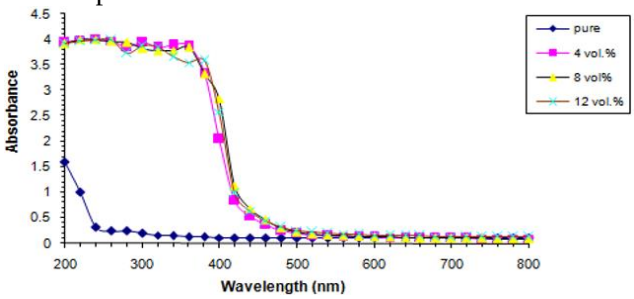

Figure.1. The absorbance spectra of (PVA-PAA-EPP) bio composites with wavelength

Figure.2, shows the variation of $(\alpha h\nu)^{1/2}$ with different photon energy ($h\nu$). The energy band gap of (PVA-PAA-EPP) bio composites decreases with increase the concentrations of extract of pomegranate peel which due to the creation of levels in the energy band gap.

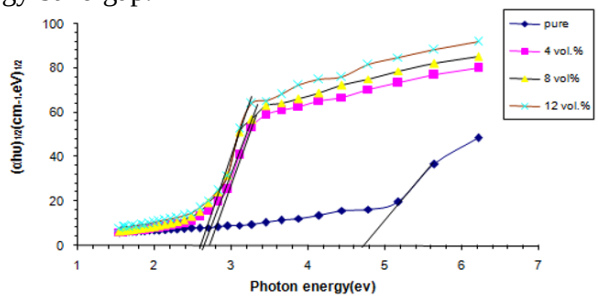

Figure 2. The variation of $(\alpha h\nu)^{1/2}$ with different photon energy ($h\nu$)

Figure.3 and figure.4, show that the melting and solidification curses for (PVA–PAA–biomaterial) bio composites respectively. The melting and solidification time were decreased with increase of biomaterial 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.

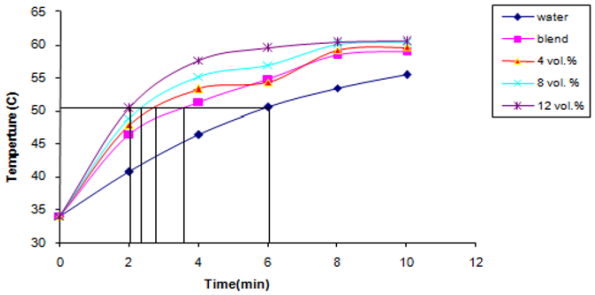

Figure.3. The melting curse for (PVA–PAA–biomaterial) bio composites

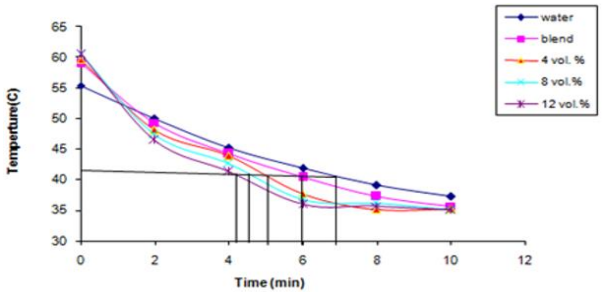

Figure.4. The solidification time for thermal energy storage and release for (PVA–PAA–biomaterial) bio composites

4. CONCLUSIONS

The absorbance of polyvinyl alcohol-poly-acrylic acid blend increases with the increase of the concentrations of extract of pomegranate peel.

The energy band gap of polymer blend decreases with the increase of the extract of pomegranate peel concentrations.

The melting and solidification time for thermal energy storage and release application are decreased with increase of extract of pomegranate peel concentrations.

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