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Preparation of PS-PMMA Copolymer and Study the Effect of Sodium Fluoride on its Optical Properties

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Abstract: Composites materials are used in many applications: Solar cells, Light Emitting Diodes (LED), optoelectronic device, industrial applications in aircraft, military and car industry for their low cost, light weight, electrical properties, mechanical and optical properties. In this research, preparation of PS-PMMA copolymer have been investigated. The sodium fluoride was add to PS-PMMA copolymer with concentrations are 0-3 wt.%. The samples were prepared casting technique. The optical properties of composites was measured in the range of the wavelength 200-800 nm. The results showed that the absorption coefficient, extinction coefficient, refractive index real and imaginary dielectric constants of PS-PMMA copolymer are increasing with increase the sodium fluoride concentration.

Key words: Composite, copolymer, absorbance, dielectric constants, Iraq

INTRODUCTION

Water-soluble polymers that respond to external stimuli, such as pH, temperature, electrolytes, illumination, electric and magnetic field are called as smart, stimuli-responsive, intelligent or environmentally sensitive polymers. Recent interest in intelligent polymeric systems has focused on aqueous solutions, interfaces, nanogels and hydrogels due to their promising applications in targeted drug delivery systems, immobilization of enzymes, cell encapsulation, ordered porous materials and chemical sensors, etc. (Roshan Deen, 2012). In recent years, there has been increasing concern about land filling non-degradable materials, such as plastics. The main reasons for the continue increase in the demand of the commodity plastics are as follows:

- Plastics are low density solids which makes it possible to produce lightweight objects
- Plastics have low thermal and electric conductivities since they are widely used for insulation purposes
- Plastics are easily moulded into desired shapes
- Plastics usually exhibit high corrosion resistance and low degradation rates and are highly durable materials
- Plastics are low cost materials

All these advantages make the plastic materials to be used in almost all fields of the every day life. The great majority of the plastic materials are derived from petroleum which is a finite source the most optimistic evaluations are foreseeing that the depletion of petroleum reserves will happen in about 50 years from now on (Salagean *et al*., 2009).

Composites have good potential for various industrial fields because of their excellent properties, such as high hardness, high melting point, low density, low coefficient of thermal expansion, high thermal conductivity, good chemical stability and improved mechanical properties, such as higher specific strength, better wear resistance and specific modulus. Composites are used in making solar cells, optoelectronic device elements, laser diodes and Light Emitting Diodes (LED), industrial applications in aircraft, military and car industry (Canbay and Aydogdu, 2009). Rabee and Hashim (2011) studied the optical constants of polystyrene-carbon nanotubes in the wavelength range 200-900 nm. They found that the optical constants change with increasing carbon nanotubes concentrations. The aim of this study is effect of sodium fluoride concentration on the optical properties of PS-PMMA-NaF composite.

MATERIALS AND METHODS

Experimental part: The materials used in this study are polystyrene and sodium fluoride. Different weight percentages of PS-PMMA and NaF are dissolved completely in chloroform (weight of each sample 1 g and the concentrations of sodium fluoride are 0-3 wt.% was add to equal mixture of PS and PMMA) distilled under

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constant stirring for 1 h. The samples were prepared casting technique thickness ranged between 355-645 μm. The transmission and absorption spectra of composites have been recording in the wavelength range 200-800 nm using double-beam spectrophotometer (UV-210°A shimedza).

The absorption coefficient (α) is calculated by using the Eq. 1:

$$\alpha = 2.303A/t \quad (1)$$

Where:
A = Absorption
t = The thickness of film

The refractive index is calculated by using Eq. 2 (Ahmad *et al*., 2007):

$$n = [4R/(R-1)^2-(R+1/R-1)]^{1/2} \quad (2)$$

The extinction coefficient is obtained by the relation (Rabee and Hashim, 2011):

$$K = \alpha\lambda/4\pi \quad (3)$$

Real and imaginary dielectric constant is calculated from the Eq. 4 and 5 (Ahmad *et al*., 2007):

$$\varepsilon_1 = n^2-k^2 \quad (4)$$

$$\varepsilon_2 = 2nk \quad (5)$$

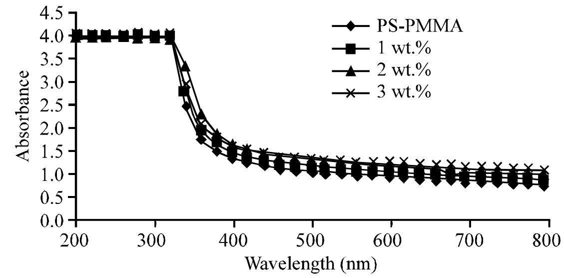

Fig. 1: The variation of optical absorbance for composite with wavelength

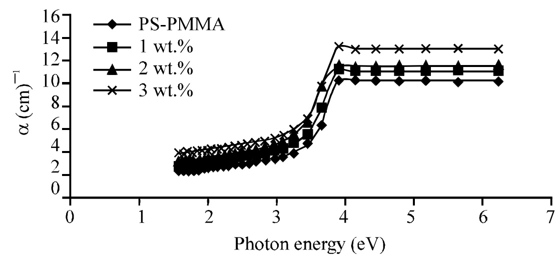

Fig. 2: The absorption coefficient for PS-PMMA-NaF composite with various photon energy

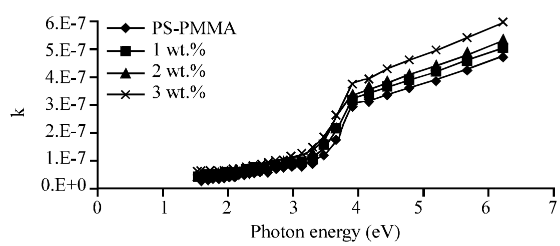

Fig. 3: The extinction coefficient for PS-PMMA-NaF composite with various photon energy

RESULTS AND DISCUSSION

The variation of absorbance of PS-PMMA-NaF composite of different weight percentages of sodium fluoride is shown in Fig. 1. Figure 1 shows the absorbance of composite increases with increase concentration of sodium fluoride this related to absorb the incident light by the free charge carriers (Ahmad *et al*., 2007).

Figure 2 shows the effect of photon energy on absorption coefficient of composites of different concentrations of sodium fluoride, Fig. 2 obvious the change of the absorption is small at low energies but at high energies, the absorption coefficient is increased of different concentrations and increases with increasing of sodium fluoride weight percentages (Ahmad *et al*., 2007). Figure 3 shows the variation of extinction coefficient of (PS-PMMA-NaF) composites and wavelength from Fig. 3, the value of extinction coefficient increases with increasing of sodium fluoride concentration, this behavior is due to increase absorption coefficient of composites with increase the sodium fluoride weight percentages.

Figure 4 shows the relationship between refractive index and photon energy for PS-PMMA-NaF composites. Figure 4 shows that the refractive index increases with increasing of the sodium fluoride concentration, this is due to increase the intensity of composite with increase sodium fluoride weight percentages (Tintu *et al*., 2012).

Figure 5 and 6 show the variation of real and imaginary dielectric constant (ε_1, ε_2) as a function of photon energy of different concentration of sodium fluoride. The real dielectric constant (ε_1) is considerably depends on (n^2) due to low value of (k^2). The imaginary dielectric constant (ε_2) is dependent on k and n values.

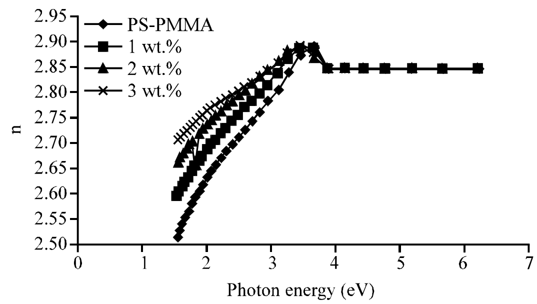

Fig. 4: The relationship between refractive index for PS-PMMA-NaF composite with photon energy

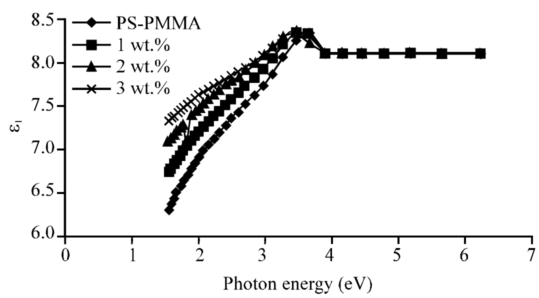

Fig. 5: The variation of real part of dielectric constant PS-PMMA-NaF composite with photon energy

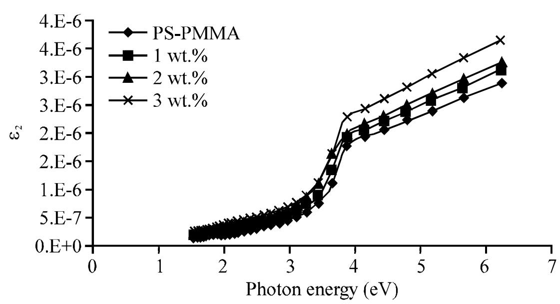

Fig. 6: The variation of imaginary part of dielectric constant PS-PMMA-NaF composite with photon energy

The increase of real and imaginary dielectric constants with increasing of sodium fluoride concentration related to increase the density of free charge carriers (Ahmad *et al*., 2007).

CONCLUSION

The results showed that the absorbance of PS-PMMA copolymer increases with increasing the sodium fluoride concentration. The absorption coefficient, extinction coefficient, refractive index, real and imaginary dielectric constants are increasing with increase the weight percentages of sodium fluoride.

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