Effect of Doping different Percentages of Lithium Fluoride on Some Optical Characteristics of Poly-Methyl Methacrylate Polymer

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Abstract

This study implements the optical characteristics of Poly-Methyl methacrylate (PMMA) polymer before and after doping different percentages of Lithium Fluoride (LiF). Where the specimens were formulated as disk shape with diameter of (2.5 cm) and thickness of (0.148 cm) using Thermal pressing technology. The absorbance and reflectivity spectra were recorded in addition to their coefficients at range (300-1100) nm. Also, the study has included the determination of refraction and real and imaginary part of dielectric constant coefficients.

Key Words: Poly-Methyl Methacrylate (PMMA) Polymer, Lithium Fluoride (LiF), Refractive Index, Real and Imaginary Parts of Dielectric Constant.

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Introduction

Poly-Methyl methacrylate polymer It is considered an important species due to its chemical and physical properties. Such polymer has good resistance to different diluted acids and alkalis, and it dissolves in some organic solvents such as gasoline and chloroform.

(PMMA) has higher elasticity properties when subjected to higher temperature. such advantage makes the polymer easy to form. The glass transition property for PMMA is about (102^{o}C), and has optical characteristics enable the polymer to be transparence Especially when exposed to visible light at wave length range of (100-360 nm). The previous advantages made the polymer to be utilized as an alternative to the traditional house windows glass and airplanes, as lens and prismatic in some complex optical technologies, and in the manufacture of liquid crystals (Aden, 2010).

Lithium Fluoride is non-organic composition consists of lithium and fluorine of chemical formula (LiF). it is a solid colorless material, converted to a white with lower crystal size. additionally, it is odorless, slightly soluble in water, having melting point of about (848.2^{o}C), and boiling at (1676^{o}C). further, Lithium Fluoride has an optical property which enables it to be transparence when subjected to a wide range of electromagnetic ray. Therefore, it can be used in the manufacture of organic light emitting diode (OLED) (Ahmed et al, 2007).

Experimental Work

It worth to be mentioned that both Poly-Methyl methacrylate polymer and Lithium Fluoride that used to prepare the specimens in this study have been supplied form Dentaurum, the German company.

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The preparation method can be summarized as follows; 10% and 20% of Lithium Fluoride have been added to a (1.5 g) of PMMA in (3 cm) mold diameter, then subjected to the thermal press for 10 minutes at temperature and pressure of about (145^0C) and (100 bar), respectively. After that, the prepared specimens were left to be cool down to get finally specimens with (3 cm) diameter, and thickness of (1.48 mm).
The optical characteristics of the prepared specimens were studied using UV-Visible Spectrophotometer device, that manufactured by SHIMADZU (a Japanese company). All measurements of reflectivity, refraction coefficient, real and imaginary dielectric constant were recorded at room temperature and at wave length range of (300-1100 nm).

Results

Figure (1) clarifies the relation between reflectivity and wave length for the pure and doped polymer, it can be observed that reflectivity increases with higher doping percentages, and this agree with (El-Bashir et al, 2019).

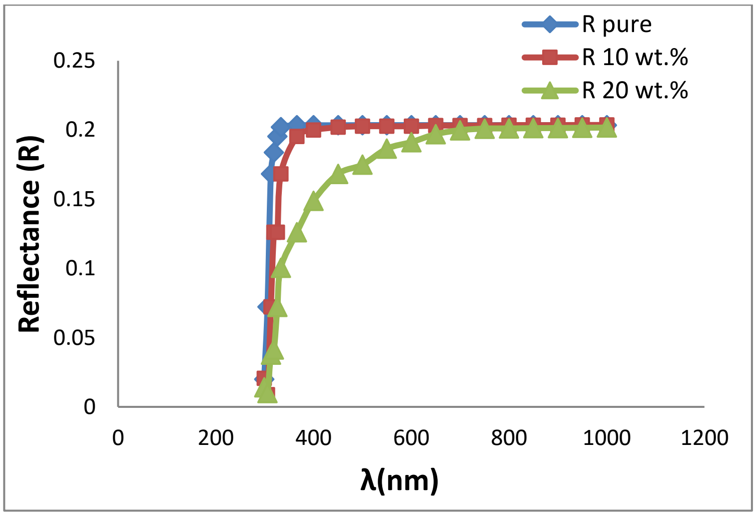

Figure 1. Explains the relationship between reflectivity and wave length for PMMA polymer before and after doping different percentages of Lithium Fluoride

Figure (2) clarifies the relation between absorption and the wavelength of samples prepared before and after the doping process. From the previous figure, It can be noticed that that absorbance property behaving oppositely to the reflection curve, and this agree with (Farah, 2016).

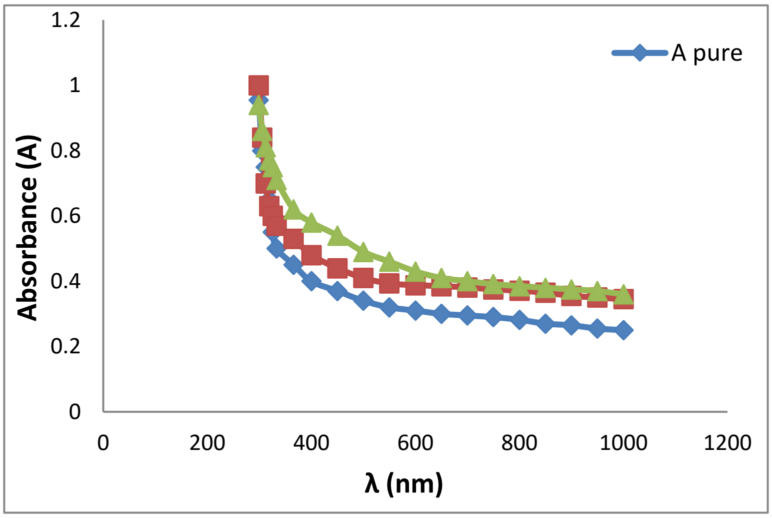

Figure 2. Explains the relationship between Absorbance and wave length for PMMA polymer before and after doping different percentages of Lithium Fluoride

Fig. (3) explains the relationship between refractive index (n) and wave length for samples before and after doping with LiF at different concentration. The refractive index has been calculated from the following relationship (Ghaidaa, 2019):

$$n = \frac{1+\sqrt{R}}{1-\sqrt{R}} \quad \text{.......... (1)}$$

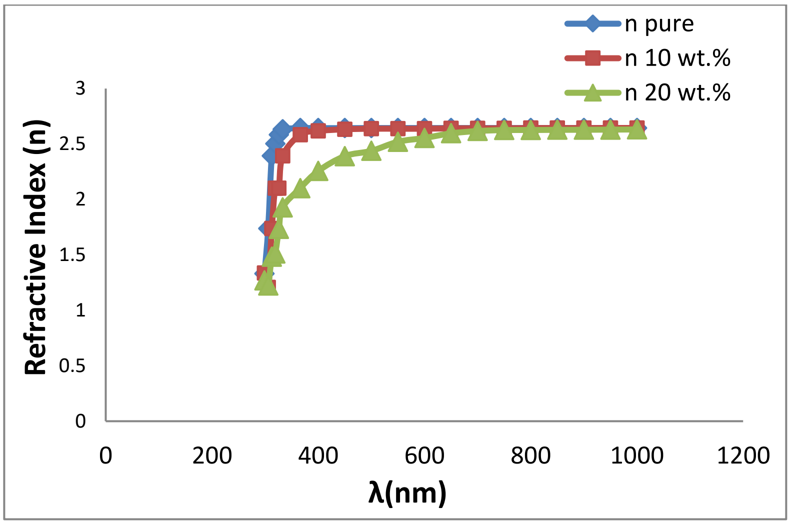

Figure 3. Explains the relationship between the Refractive Index and wave length for samples before and after doping

From the fig. (3) we can see that the refractive index increases by increasing the wave length of the falling beam and the values of the refractive index after doping are less than their values before doping, and These results are in agreement with the results of the reference (Ghaidaa, 2021).

The real and imaginary dielectric constant (ε_r, ε_i) was calculated from the following equations (Hamed et al, 2012):

$$\varepsilon = \varepsilon_r - i\varepsilon_i \qquad (2)$$

$$\varepsilon_r = n^2 - K^2 \qquad (3)$$

$$\varepsilon_i = 2nK \qquad (4)$$

Figures (4,5) shows the relationship between the real and imaginary dielectric constant with wave length of samples before and after doping with LiF at different concentration.

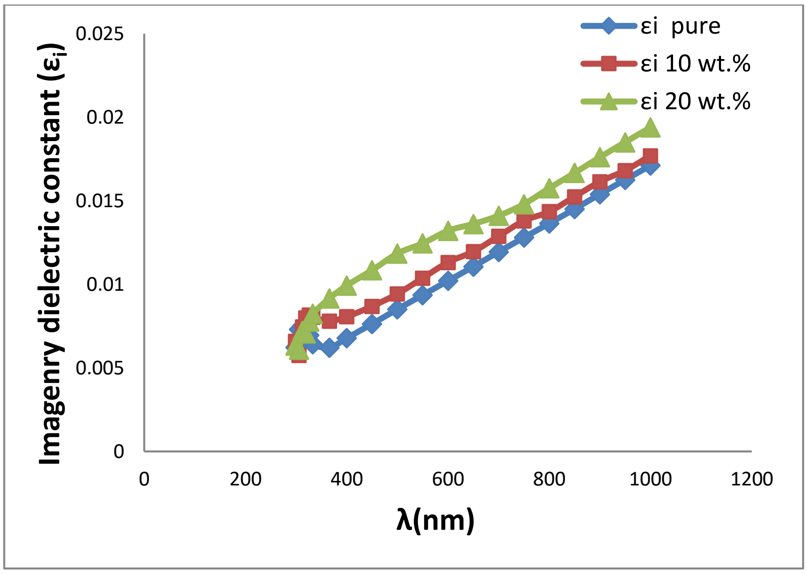

Figure 4. Explains the relationship between the real dielectric constant and wave length for samples before and after doping

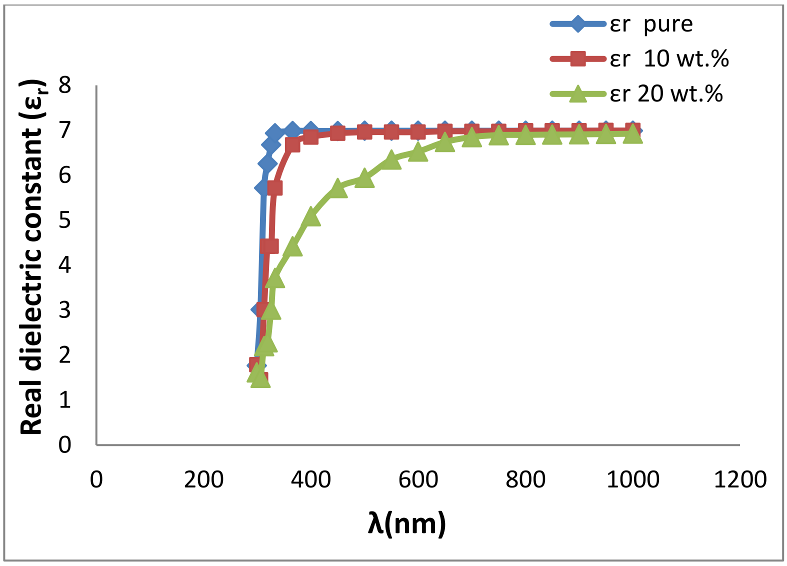

Figure 5. Explains the relationship between the imaginary dielectric constant and wave length for samples before and after doping.

We observe from the fig. (4) that it (ε_r) behaves similarly to the refractive index (n). either in fig. (5) we find that (ε_i) it exhibits almost similar behavior to the extinction coefficient, and These results are in agreement with the results of the reference (Heath et al, 1986; Nahida et al, 2011).

Conclusions

1. From the Figures (1,3, and 4), it can be observed that both reflection, refraction, and real dielectric properties reduces with higher percentages of Lithium Fluoride. Such advantage may be useful for some optical devices.
2. From the Figures (2 and 5), it can be noticed that Doping process with Lithium Fluoride have reduced the values of both absorbance and imaginary dielectric constant properties of the tested specimens.

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