Improving the Optical Properties of PVA/PEG Blend Doped with BaTiO$_3$ NPs

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Abstract
In this paper, synthesis in PVA/PEG/BaTiO$_3$ new nanocomposites was investigated to use in various optoelectronics fields. The PVA/PEG/BaTiO$_3$ nanostructures prepared from PVA/PEG blend with various ratios of BaTiO$_3$ NPs. The optical characteristics of synthesized PVA/PEG/BaTiO$_3$ nanostructures have studied. Results indicated that the optical characteristics of PVA/PEG improved as BaTiO$_3$ NPs ratio increase, this behavior makes it may be used in different electronics and photonics fields.

Keywords: nanostructures, BaTiO$_3$, photonics fields, PEG, optical characteristics.

Introduction
In the last few years, examinations of polymer optical properties and electrical have gotten a lot of interest in terms of their applications in electronics (optical, electronic). Optical qualities are intended to be anti-reflective, obtaining polarization characters and better reflection, while the electrical characteristics are intended at knowing transportation of the fee prevalent existence in these compounds. The dopant addition will tailor electrical and the optical properties the polymers based reactivity with the polymer matrix. Furthermore, the benefits polymer fabrics, such as nice moldability, high power, and durability, can be mixed with the outstanding properties inorganic compounds, such as thermal resistance, heat strength, and high strength, during the production of composite materials, high strength and chemical resistance are needed. Nanofillers can be used in a wide variety of applications, including tissue manufacturing, filters, catalysis, scaffolds, wound dressing and sensors, and their electrical, magnetic, mechanical, optical, and thermal properties can be improved by integrating organic and inorganic materials into their structures [1]. In the type of novel materials, polymeric
nanocomposites include grabbed huge attention relate to their improved optical, electrical and magnetic characteristics. These materials enjoy rise modulus and flame resistance and are as well capable to prevent agglomeration and oxidation. These improvement in characteristics are relate to interaction between polymer and nanoparticles. The nanoparticles addition in polymer enhances of nanoparticles life time, modifies the nanoparticles surface by passivation defect levels, give low cost, device fabrication easily and tunable electronic and optical characteristics [2]. The nanocomposites of organic and inorganic are very promising for fields in smart microelectronic, photodiodes, light-emitting diodes, gas sensors, photovoltaic cells. etc. [3].

PVA is a polymer with a hydroxyl groups and the backbone of the carbon chain connecting it. The OH groups can act as a hydrogen bonding source, assisting in the forming of polymer blends. The PVA is nontoxic, which is generally used in the polymeric blends related to its excellent chemical and physical characteristics, good forming of film properties, noncarcinogenic, emulsifying capability, biocompatible and biodegradable characters. These exceptional properties allow it for its in pharmaceutical applications applicability, drug coating agents, cosmetic and industries of surgical structures. Polymeric blend may be more positive because of its easier fabrication technique and its ease to manage the polymer electrolytes characteristics by varying the blended polymer composition [4]. The present work aims to prepare the PVA/PEG/BaTiO$_3$ nanostructures and testing their optical characteristics.

Materials and Methods

The below are the components that were used in this project polymers (polyvinyl alcohol and polyethylene glycol) with ratio 87 wt. % PVA: PEG 13 wt. %. The sample of PVA/PEG was prepare by dissolving (1gm) dissolved in pure water (30 ml). The BaTiO$_3$ NPs have been added to polymeric solution based on proportions (0, 1.4, 2.8, 4.2 and 5.6) wt. %. The casting method has been employed to prepare PVA/PEG/BaTiO$_3$ nanostructures.

Absorption coefficient $\alpha$ was calculated by [5,6]:

$$\alpha = 2.303 \frac{A}{t}$$  \hspace{1cm} (1)

$A$: absorbance and $t$: sample thickness.

The energy gap was calculated by [7,8]:

$$\alpha h\nu = D(h\nu - E_g)^r$$  \hspace{1cm} (2)

Where, $D$: constant, $h\nu$: photon energy, $E_g$: energy gap, $r = 3$ (forbidden indirect transition) and $r = 2$ (allowed indirect transition).

The optical conductivity ($\sigma_{op}$) can be determined by [9]:

$$\sigma_{op} = \frac{\alpha n e}{4\pi}$$  \hspace{1cm} (3)
Results and Discussion

The absorbance and transmittance behavior of PVA/PEG/BaTiO$_3$ nanostructures with wavelength are given in Fig.1 and Fig.2. The absorbance of PVA/PEG blend increases while the transmittance reduces with the rise in BaTiO$_3$ NPs ratios, which have risen as a result of the increase in the number of charges carries in nanocomposites [10-15]. The coefficient of absorption variation the photon's energy is shown in Fig.3. Absorption coefficient of PVA/PEG rises with rising of the BaTiO$_3$ NPs ratios. The $\alpha$ demonstrates the existence of the energy difference. From the $\alpha$ The energy difference is indirect at these values, as seen in Figs. 4 and 5 to allowed and forbidden transitions. The energy gap for transitions (allowed and forbidden) reduces with the rise in BaTiO$_3$ NPs ratios which related to create a levels in the optical band gap that are localized [16-18]. Fig.6 represents the optical conductivity variation of PVA/PEG/BaTiO$_3$ nanostructures with wavelength. As shown in this figure, the optical conductivity of PVA/PEG rises in tandem with the increase in BaTiO$_3$ ratios of NPs that related to ascend in the $\alpha$ values and reduce in energy gap [19-21].

![Absorbance behavior of PVA/PEG/BaTiO$_3$ nanostructures with wavelength.](image)
Fig. 2. Transmittance behavior of PVA/PEG/BaTiO$_3$ nanostructures with wavelength.

Fig. 3. Absorption coefficient variation with energy of photon.
Fig. 4. Energy gap of allowed transition.

Fig. 5. Energy gap of forbidden transition.
Fig.6. Optical conductivity variation of PVA/PEG/BaTiO₃ nanostructures with wavelength.

Conclusions

The optical characteristics and parameters of PVA/PEG blend boosted by the increase in BaTiO₃ ratios of NPs. The high absorption of PVA/PEG/BaTiO₃ nanostructures showed in UV spectra which makes it suitable for different photonic and optic devices.

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