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Preparation of Polyvinyl alcohol- Poly-acrylic acid-Cobalt Oxide Nanoparticles Nanocomposites and Study their Optical Properties

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Abstract: ***Nanocomposites of polyvinyl alcohol- poly-acrylic acid- cobalt oxide nanoparticles have been prepared. The polymer matrix consisting of $PVA_{0.85}$ and $PAA_{0.15}$). The cobalt oxide nanoparticles was added to polymers with concentrations are (0, 2, 4 and 6) wt.%. The experimental results show that the absorbance of naoocomposites is increased with the increase of cobalt oxide nanoparticles and optical constants (absorption coefficient, extinction coefficient, refractive index, real and imaginary dielectric constants) of (PVA-PAA-CoO) nanocomposites are increased with the increasing of cobalt oxide nanoparticles concentrations. The energy band gap of nanocomposites is decreased with the increase of cobalt oxide nanoparticles concentrations.***

Keyword: optical constants, poly-acrylic acid, cobalt oxide, nanocomposites.

1. Introduction

Nanotechnology is the engineering science that can change the material properties. Nanoparticles have a ratio between surface area and volume of a larger, this makes the nanoparticles are more reactive. Reactivity of the material is determined by the atoms on the surface, because only these atoms are in direct contact with another material. Application of nanotechnology used in many fields including high-resolution screen, creating an anti-stain clothing, health and automotive areas. Nanoparticles used to prevent fouling on clothing, where the feathers glued surface with nano size so similar to taro leaf surface . Polymer nano sizes ranging from 10 nm to 100 nm is used for exterior wall paint, adhesives, paper coatings, upholstery fabrics, as well as retaining cosmetic UV rays, as well as retaining the light of the sun [1]. In recent years, many efforts have been focused on the inorganic/organic nanocomposite materials with various compositions. By combining organic and inorganic materials, the resulting composites can possess advantages of both organic polymers (e.g. flexibility, ductility, dielectric) and inorganic components (e.g., rigidity, high thermal stability, strength, hardness, high refractive index), thus creating extensive usages in many areas. By incorporating nanoparticles into polymer matrix even with a very little loading, many interesting optical properties including absorption, fluorescence, luminescence, nonlinearity, high reflex index (RI), magnetic properties, and excellent mechanical properties may be obtained [2]. The insulator applications of polymers include printed circuit boards, wire encapsulants, corrosion protective electronic devices, and cable sheathing materials. Polymers have several advantages, such as easy processing, low cost, flexibility, high strength, and good mechanical properties. In the microelectronic fabrication industry, polymers are used in the photolithography process [3]. Polyvinylalcohol (PVA) is an important polymer, because of its unique physical and chemical properties. This polymer can be made in powder, film and fiber forms. It is a semi-crystalline polymer that arises from the role of OH group and the hydrogen bonds. It is also recognized as one of the very few vinyl polymers soluble in water with a high transparency and a good flexibility. It is used industrially for emulsification, sizing and adhesives, in biomedical materials as drug-delivery system and membranes. PVA can also be used in medical applications such as artificial blood vessels, artificial intestines, and contact lenses. It had been noted as a medical material due to its compatibility to the living body [4]. Polymeric composites have high strength and stiffness, light weight, and high corrosion resistance. In the past decade, extensive research work has been carried out on the natural fiber reinforced composite materials in many applications. Natural fibers are available in abundance in nature and can be used to reinforce polymers to obtain light and strong materials [5]. Polymers can be prepared through various techniques such as radical, cationic and anionic polymerization. The mechanical, thermal and structural properties can be studied through different kinds of characterization methods to determination of structure–property relationships. Recently, polymers have been applied in various fields such as automotive, construction, electronic, cosmetic and pharmaceutical industries due to its advantageous material properties. Functional polymers of controlled refractivity , photochromic, electrochromic and optoelectronic functions were developed recently. The use of polymers with tunable refractive properties as optical modulators, optical filters, or electro optic waveguide devices has been reported. The functionalization of bioactive molecules can be carried out due to presence of carboxylic groups in Poly Acrylic Acid. The interactions due to the electrostatic forces, hydrophobic nature, hydrogen bonding, vanderwaals forces or the combination of these interactions leads to the formation of polymer complexes. The formation of complexes may strongly affect the polymer solubility,

rheology, conductivity, and turbidity of polymer solutions, mechanical properties permeability, electrical conductivity of the polymers. This paper aims to study of optical properties of (PVA-PAA-CoO) nanocomposites.

2. Materials and Methods

The nanocomposites have been prepared by dissolved polyvinyl alcohol (85 wt.%), and poly-acrylic acid (15 wt.%)) in distill water by using magnetic stirrer. The cobalt oxide nanoparticles is added to solution with concentrations are (0,2 ,4 and 6) wt.%.

The nanocomposites samples are prepared by using casting technique. The optical properties are measured by using UV/1800/ Shimadzu spectrophotometer in range of wavelength (200-800) nm. The absorption coefficient (α) calculated by the absorbance spectra[7]:

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

Where A: is the absorbance and t: is the thickness of sample.

The energy band gap has bee calculated by following equation [8]:

$$\alpha h\upsilon = B(h\upsilon - E_g)^r \quad \ldots\ldots\ldots(2)$$

Where B is a constant, hυ is the photon energy , E_g is the optical energy band gap and r = 2 for allowed indirect transition and r = 3 for forbidden indirect transition.

The Refractive index (n) has been calculated by using the reflectance spectra [9]:

$$n= (1+R^{1/2})/ (1-R^{1/2}) \quad \ldots\ldots\ldots (3)$$

Where R is the reflectance.

The extinction coefficient (k) calculated by the following equation[9]:

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

The real and imaginary parts of dielectric constant (ε_1 and ε_2) are calculated by using equations[10]:

$$\varepsilon_1=n^2-k^2 \text{ (real part)} \quad \ldots\ldots (5)$$

$$\varepsilon_2=2nk \text{ (imaginary part)} \quad \ldots\ldots (6)$$

3. Results and Discussion

The absorbance spectrum of (PVA-PAA-CoO) nanocomposites is recorded by using UV spectrophotometer with wavelength range (200-800) nm as shown in figure1.

The absorbance of (PVA-PAA-CoO) nanocomposites is increased with the increase of concentrations of cobalt oxide nanoparticles, this behavior attributed to increase the number of carries charges [11].

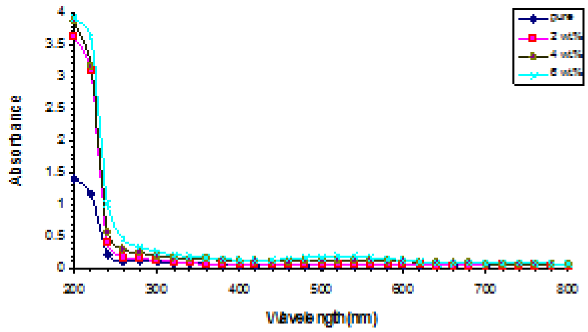

Figure- 1
The variation of optical absorbance for (PVA-PAACoO) nanocomposites with wavelength

The effect of cobalt oxide nanoparticles on absorption coefficient of (PVA-PAA-CoO) nanocomposites is shown in figure 2. The absorption coefficient of (PVA-PAA-CoO) nanocomposites is increased with the increase of cobalt oxide nanoparticles concentrations which attribute to increase the absorbance. We can known the energy band gap from the values of absorption coefficient, which explain that the nanocomposites have indirect energy gap as shown in figures 4 and 5 for allowed indirect and forbidden indirect transition of (PVA-PAA-CoO) nanocompsites respectively. The figures show that the energy band gap of (PVA-PAA-CoO) nanocomposites is decreased with the increase of the cobalt oxide nanoparticles concentrations which due to increase of the localized level in energy gap[12].

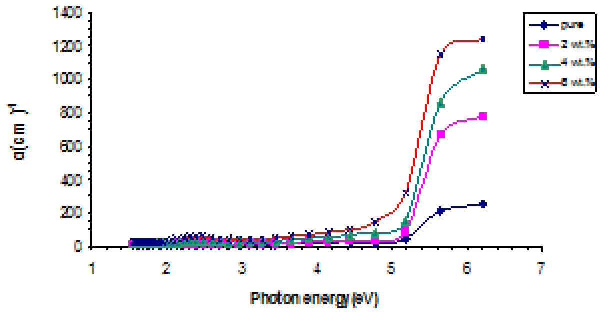

Figure-2
The absorption coefficient for (PVA-PAA-CoO) nanocomposite with various photon energy

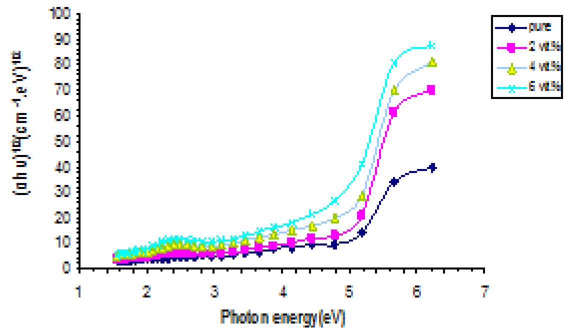

Figure-3
The relationship between $(\alpha h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of (PVA-PAA-CoO) nanocomposites.

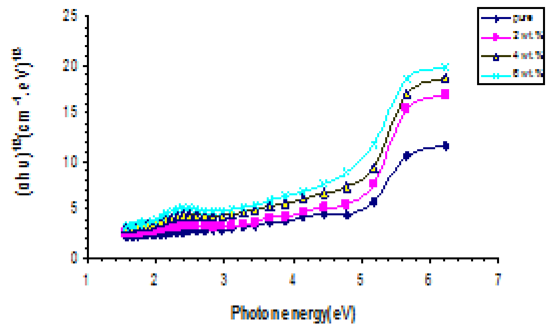

Figure-4
The relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of (PVA-PAA-CoO) nanocomposites.

The variation of extinction coefficient of (PVA- -PAA-CoO) nanocomposites with photon energy is shown in figure 5. The extinction coefficient of nanocomposites increases with the increase of cobalt oxide nanoparticles concentrations which attributed to the increase the absorbance as a result the increase of number of carries charges in (PVA- -PAA-CoO) nanocomposites [13].

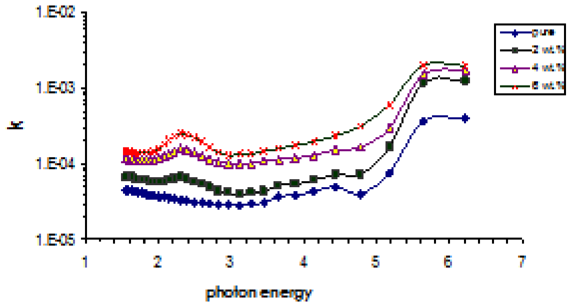

Figure-5
The extinction coefficient for (PVA-PAA-CoO) nanocomposite with various photon energy

The variation of refractive index of (PVA- -PAA-CoO) nanocompsites with photon energy for different concentration of cobalt oxide nanoparticles is shown in figure 6. The increase of cobalt oxide nanoparticles, the refractive index of (PVA- -PAA-CoO) nanocomposites is increased as a result of increase the density of(PVA- -PAA-CoO) nanocomposites [13].

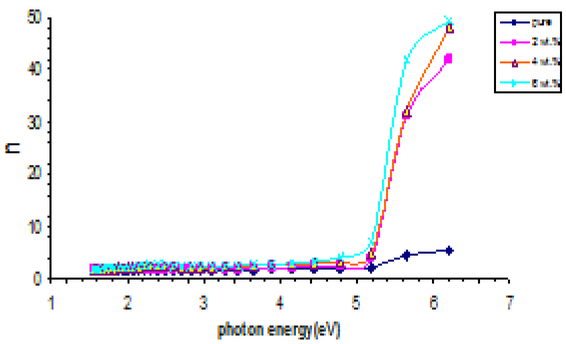

Figure-6
The relationship between refractive index for (PVA-PAA-CoO) nanocomposites with photon energy

The variation of real and imaginary parts of dielectric constants of (PVA- -PAA-CoO) nanocompsites with photon energy for different concentrations of cobalt oxide nanoparticles are shown in figures 7 and 8. The real part of dielectric constant is increased with the increase of cobalt oxide nanoparticles concentrations as a result of increase the scattering. The imaginary part of dielectric constant is increased with the increase of cobalt oxide nanoparticles as a result of absorption coefficient and refractive index [14].

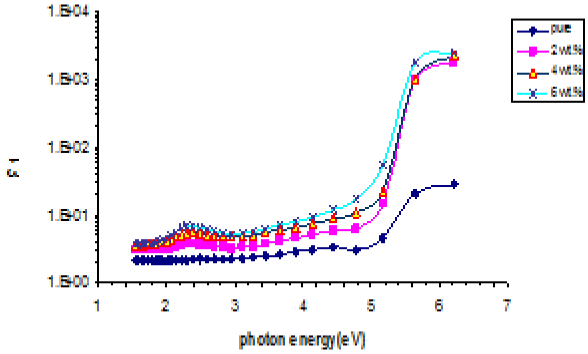

Figure-7
The variation of real part of dielectric constant of (PVA-PAA-CoO) nanocomposites with photon energy

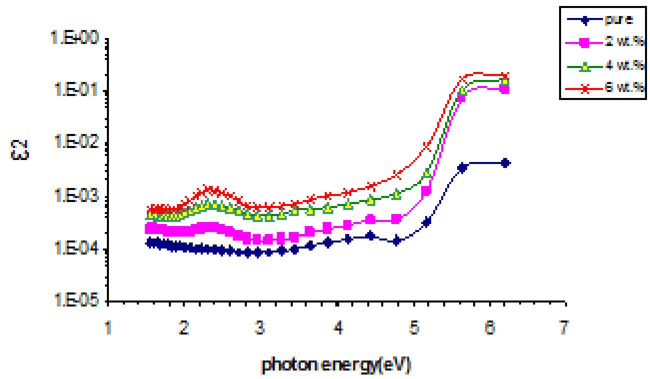

Figure-8
The variation of imaginary part of dielectric constant of (PVA-PAA-CoO) nanocomposites with photon energy

4. Conclusions

1) The absorbance of nanocomposites is increased with the increase of cobalt oxide nanoparticles concentrations.
2) The absorption coefficient, extinction coefficient, refractive index, real and imaginary dielectric constants of (PVA- -PAA-CoO) nanocomposites are increased with the increase of concentrations for cobalt oxide nanoparticles.
3) The energy gap of (PVA- -PAA-CoO) nanocomposites decreases with the increase of cobalt oxide nanoparticles concentrations.

References

[1] Makmur Sirait, Saharman Gea, Motlan, Eddy Marlianto, 2014, "Effect of mixed nanoparticles ZnS and polyvinyl alcohol (PVA) against nanocomposite mechanical properties of PVA / ZnS", American Journal of Physical Chemistry, Vol. 3, No. 1.

[2] Vijaya S. Sangawar and Manisha C. Golchha, 2013, "Evolution of the optical properties of Polystyrene thin films filled with Zinc Oxide nanoparticles", International Journal of Scientific & Engineering Research, Vol. 4, Issue 6.

[3] A. N. Alias, Z. M. Zabidi A.M.M. Ali, M. K. Harun, M.Z.A. Yahya, 2013, "Optical Characterization and Properties of Polymeric Materials for Optoelectronic and Photonic Applications", International Journal of Applied Science and Technology, Vol. 3, No. 5.

[4] EM Abdelrazek, Abdelghany AM and Tarabih AE, 2012, "Characterization and Physical Properties of Silver/PVA nano- composite", Research Journal of Pharmaceutical, Biological and Chemical Sciences,

[5] Ahmed Hashim, Alaa J. Kadham Algidsawi, Hayder Abduljalil, Shaymaa Hadi, 2011, "Mechanical Properties of (PVA-CoNO3, BaSO4.5H2O) Composites", European Journal of Scientific Research, Vol.65, No.2.

[6] V. Vetriselvi and R. Jaya Santhi R, 2014, "Synthesis and Characterization of Poly Acrylic Acid Modified with Dihydroxy Benzene-Redox Polymer", Research Journal of Chemical Sciences, Vol. 4, No.5.

[7] G. Attia and M.F.H. Abd El-kader, 2013, "Structural, Optical and Thermal "Characterization of PVA/2HEC Polyblend Films", Int. J. Electrochem. Sci., Vol. 8 , P. 5672 - 5687.

[8] Zahra Hossein Esfahani, Mahshad Ghanipour, Davoud Dorranian, 2014, "Effect of dye concentration on the optical properties of red-BS dye-doped PVA film", J. Theor. Appl. Phys. , Vol. 8.

[9] Sabah A. Salman, Muhammad H. Abdu-allah, Nabeel A. Bakr, 2014, "Optical Characterization of Red Methyl Doped Poly (Vinyl Alcohol) Films", International Journal of Engineering and Technical Research (IJETR), Vol. 2, Issue.4 .

[10] Adnan KURT, 2010, "Influence of AlCl3 on the optical properties of new synthesized3-armed poly(methyl methacrylate) films", Turk Journal Chem., Vol. 34, pp. 67 – 79.

[11] M.K. El-Mansy, E.M. Sheha, K.R. Patel, G.D. Sharma, 2013, "Characterization of PVA/CuI polymer composites as electron donor for photovoltaic application", Elsevier GmbH. , optics Vol. 124, Issue 13.

[12] Ziad T. Khodair, 2014, "PREPARATION AND STUDY OF OPTICAL PROPERTIES OF PURE AND YELLOW METHYL -DOPED POLYVINYL ALCOHOL (PVA) FILMS", International Journal of Current Research Vol. 6, Issue.5, P.6821-6824,

[13] Bahaa H. Rabee and Ahmed Hashim, 2011, "Synthesis and Characterization of Carbon Nanotubes -Polystyrene Composites", European Journal of Scientific Research, Vol.60 No.2.

[14] Ahmad A.H., Awatif A.M. and Zeid Abdul-Majied N., 2007,“ J. of Eng. &Technology”, Vol.25, No.4, P.558-568.