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RESEARCH PAPER

Effect of Adding Silver Nanoparticles on Structural and Microscopic Properties of PAAm-PEG Polymer Blend

Ahed Ali Kadhim Zbala [1], Abdulazeez O. Mousa Al-Ogaili [1], Khalid Haneen Abass [2]*

[1] *Department of Physics, College of Science, University of Babylon, Iraq*

[2] *Department of Physics, College of Education for Pure Sciences, University of Babylon, Iraq*

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ABSTRACT

Silver nanoparticles (Ag) are of interest because of the unique properties (e.g., size and shape depending optical, electrical, and magnetic properties) which can be incorporated into antimicrobial applications, biosensor materials, composite fibers, cryogenic superconducting materials, cosmetic products, and electronic components. Silver nanoparticles are extensively used for biomedical applications due to the antibacterial and antiviral properties. Polymer blend films were prepared by mixing of polyacrylamide (PAAm) and polyethylene glycol (PEG 4000), with different contents of Ag nanoparticles by casting method. The diffusions of Ag nanoparticles within the mixture were examined using optical microscopy. The optical microscopic images showed that good` diffusions of nanoparticles with some agglomerations. Analysis of the structural properties is the focus of this research for polymer nanoparticles (PAAm-PEG-Ag) films and the study of the effect of the nanomaterial and its diffusion on the mixture.

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INTRODUCTION

Polymer composites have unrivaled properties like high flexibility, light weight, and possibility to be produced at low temperature and low cost [1]. Several factors are affecting preparation and fabricated polymer-based nanocomposites, such as strong interfacial interaction, good homogeneity and fine dispersion in the matrix [2-4]. Silver particles have drawn tremendous academic and industrial interests. Besides of the benefits of their biomedical applications, when the size of silver particles decreases to nanoscale [5]. The polyacrylamide (PAAm) is also water soluble polymer, with a wide range of applications in industrial [6]. PAAm has a great ability to interact with water and produce gel like makes it a good candidate for forming gel polymer electrolyte [7]. PAAm use in industrial areas, used also in water treatment, mining and extraction of oil in the polymers sclerotic industry thermally, it is also used medically in the field of soft tissue industry, and in cosmetic surgery, the industry artificial corneas of the eye, and manufacturing of contact lenses and in the special cover burns the tissue industry, as well as many other medical uses and enters in the paper industry, and made into the plastic, toys, water tanks, and is often used for agricultural land benefactor of the soil and erosion control, as well as it is used as an antioxidants [8]. Polyethylene glycols (PEG) have been employed for this purpose. The homopolymer PEG 4000 (PEG) used was selected due to its easy processing

* *Corresponding Author Email: ahad.zballa.scihigh80@student.uobabylon.edu.iq*

Table 1. The proportions of materials used to manufacture the nanocomposite (PAAm-PEG-Ag).

PAAm (g)	PEG (g)	Ag (g)
0.75	0.250	0
0.735	0.245	0.02
0.720	0.240	0.04
0.705	0.235	0.06

and appropriate structure that also has excellent properties, including good solubility in water and organic solvents, lack of toxicity [9,10]. (PEG) has a very low melting point [11,12]. In this study, the structural and optical properties of PAAm-PEG-Ag nanocomposites were investigated for their candidacy for the fabrication of optical devices.

MATERIALS AND METHODS

Materials

Two polymers were mixed as a bases material; PAAm and PEG. PAAm was purchased from British Drug Houses (BDH) with purity of (99.99%) and (5×10^6 g/mol) molecular weight. PEG was purchased from EMPROVE ESSENTAL Ph Eur with molecular weight =4000 and assay purity= 99%. The doped material was Ag purchased from US Research Nanomaterials, Inc.

Synthesis of nanocomposites

0.75 g PAAm was dissolved in 60 mL of distilled water, stirred at 80 °C, and 0.25 g of PEG was added to the solution with stirring at 70 °C. Then, Ag was added to the solution with different content (0.02, 0.04 and 0.06)g as shown in table (1) with the same particle size to form the samples. The mixture was mixed for 15 minutes after the nanoparticles additive to obtain a homogeneous mixture and then left for 24 hours before pouring. The solution is placed in a petri dish and allowed to dry at room temperature for 10 days, homogeneity, and distribution of Ag nanoparticles in (PAAm-PEG-Ag) films were studied using an optical microscope, scanning electron microscopy and fourier transforms infrared. The resulting samples were prepared with a thickness range (120) µm. Thickness was measured with a digital micrometer.

RESULTS AND DISCUSSION

Fig. 1. at a magnification of 100X, the optical images of PAAm-PEG and PAAm-PEG-Ag nanocomposites with varying Ag concentrations are shown. These images demonstrated the matrix's

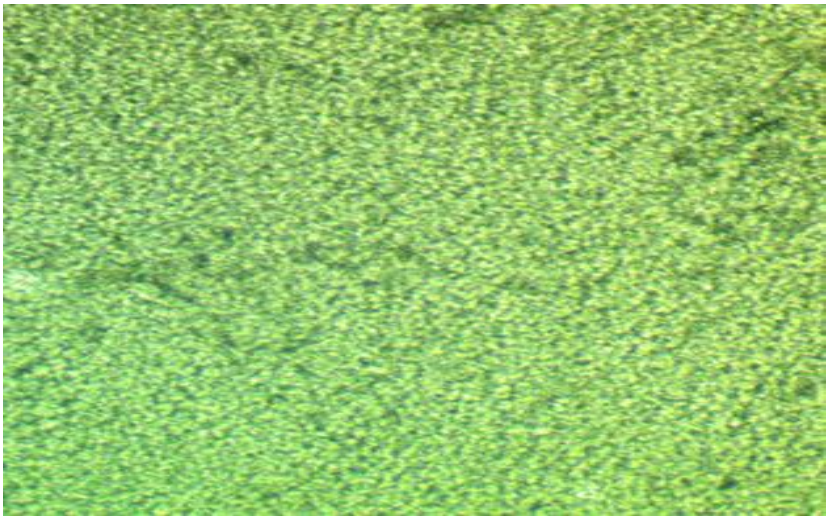

Fig. 1. Photomicrographs (100X) of blend (PAAm-PEG).

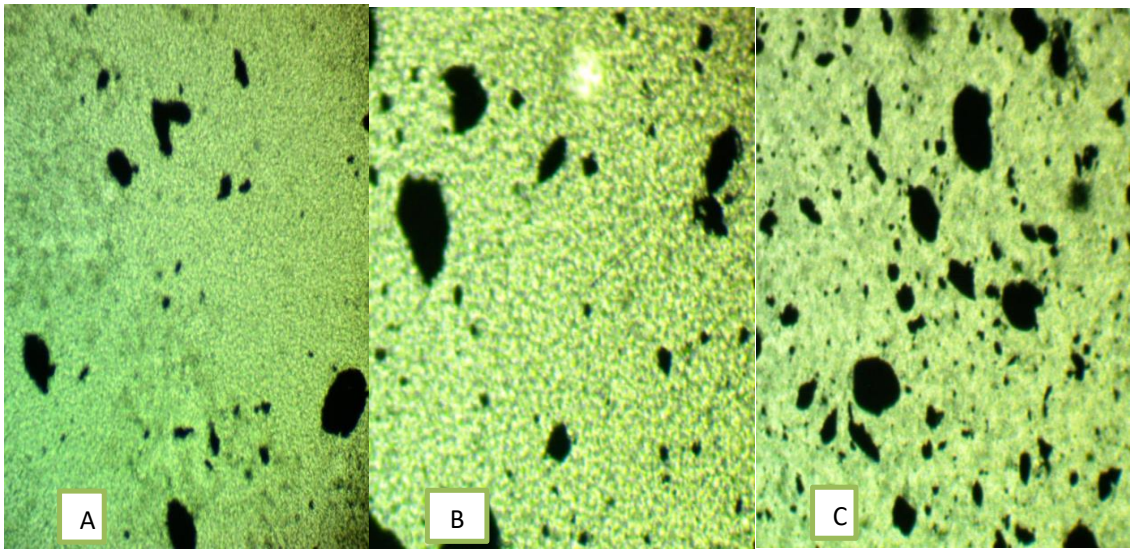

Fig. 2. Photomicrographs (100X) of nanocomposites a) PAAm-PEG :0.02wt.% Ag, b) PAAm-PEG:0.04wt.%Ag, and c) PAAm-PEG:0.06wt.%Ag.

fine homogeneity with a favorable distribution of Ag into the polymer composite blends. The optical microscopy (OM) pictures demonstrated that the PAAm-PEG-Ag nanocomposites were successfully prepared using the casting method.

These images showed the homogeneousness between the blended polymer, these images demonstrated the successful preparation of nanocomposites films with little assembly of nanomaterials.

Fig. 2. shows the images of nanocomposite membranes (PAAm-PEG-Ag), taken from samples with different concentrations at a magnification of 100X. (A, B, C), these images illustrated fine homogeneity of the matrix with a good distribution of (Ag) into the blend-polymer composites. Where the additions are in different ratios (0.02, 0.04 and 0.06) the nanoparticles form a continuous network inside the polymers.

Fig. 3. shows typical SEM images of PAAm-PEG films without nanomaterial concentrations where the polymers are softer, more homogeneous and

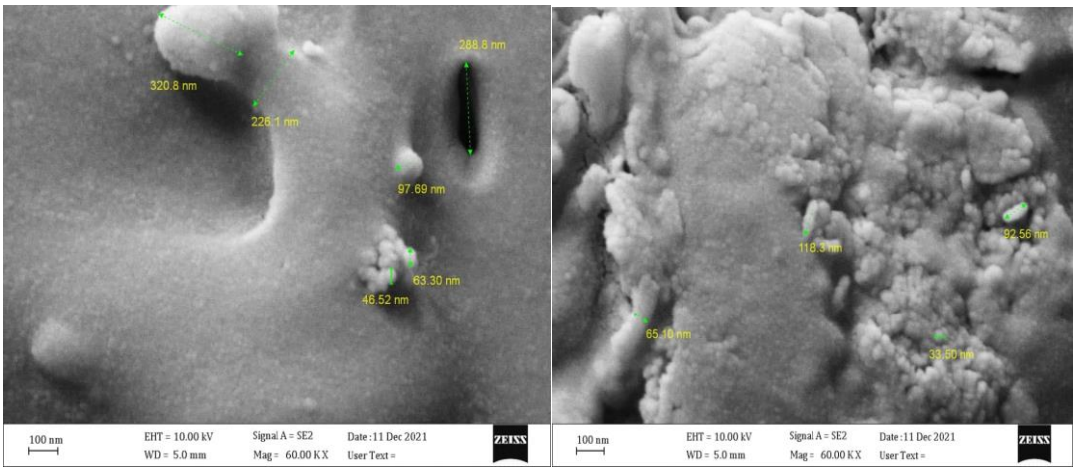

Fig. 3. SEM images of (PAAm-PEG) blend.

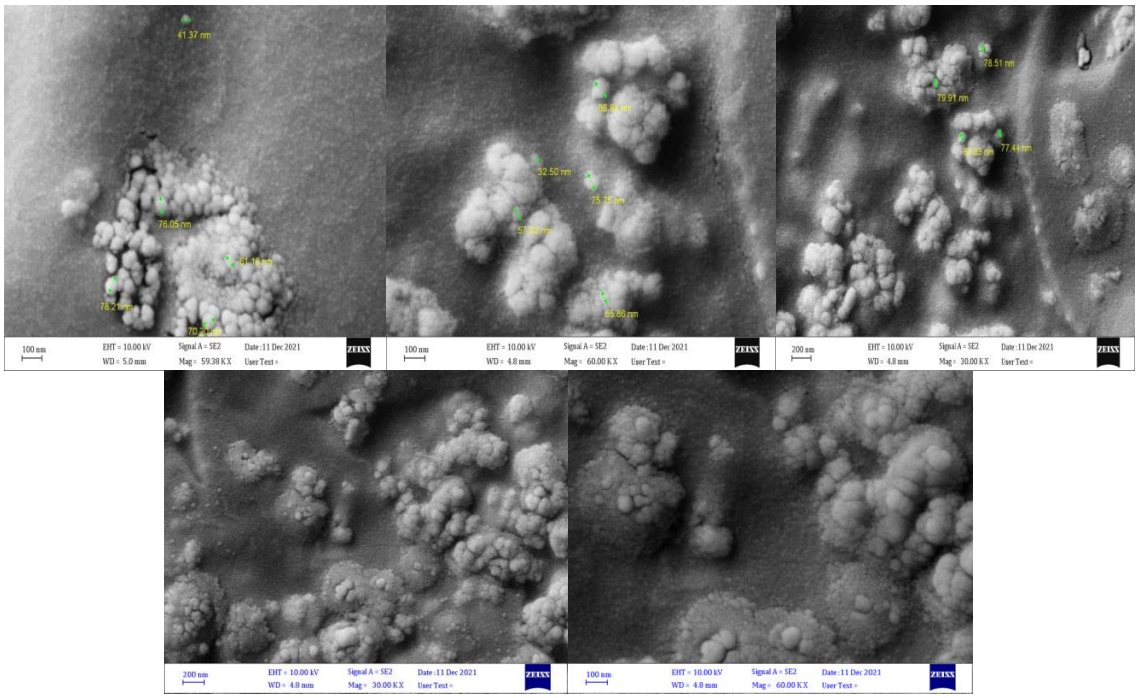

Fig. 4. SEM images of PAAm-PEG-Ag nanocompesite.

cohesive.

Fig. 4 show typical SEM images of films of (PAAm-PEG-Ag) nanocomposites with different concentrations of (Ag) nanocomposites content. It is evident that the addition of nanoparticles in the nanocomposites (PAAm-PEG-Ag) shows changes in the surface morphology of this system. It can be seen from the images that the grains accumulate as the percentage of nanoparticles increases. The surface morphology of the nanocomposites (PAAm-PEG-Ag) films shows many randomly distributed aggregates or pieces on the upper surface. The results show an increase in the number of white dots on the surface with increasing concentration of nanoparticles (Ag). The films display a uniform density of grain distribution in the surface morphology. The results indicate that nanoparticles tend to form well-dispersed aggregates in PAAm-PEG composite films. From Fig. 4. it is understood that (Ag) nanoparticles are randomly distributed in (PAAm-PEG) membranes and it is concluded that small agglomerates are formed in these membranes [13,14].

The main function of using FTIR is to evaluate the type of chemical bonding between different phases that are present, examine if there is a chemical reaction occurs or it is merely physical blending and qualitatively analyze the materials, which are in the bulk of films. All spectra exhibit the characteristic absorption bands of pure (PAAm-PEG) composite, which are (2886, 1648, 1455, 1341, 1108,962, 842) cm^{-1}. It can be noticed that these treatment cause some observable changes in the spectral features of the samples a part from new absorption bands and slight changes in the intensities of some absorption bands. The new bands may be correlated likewise to defects induced by the charge transfer reaction between the polymer chains. The vibrational peaks at (2886, 1648, 1455, 1341, 1108,962, 842) cm^{-1} are assigned to O-H stretching, C-H stretching, C= O stretching, C= C stretching, and C-O-C rocking of (PAAm-PEG) composite respectively as shown in Fig. 5.

The experimental data given the after addition of (Ag) nanoparticles with different percentages (0.02, 0.04, 0.06), some polymer chains have been broken and some other chains have been formed instead.

We notice through (FTIR), if an (Ag) nanoparticle is present in films (PAAm-PEG-Ag) nanocomposites it leads to restriction of molecular vibrational

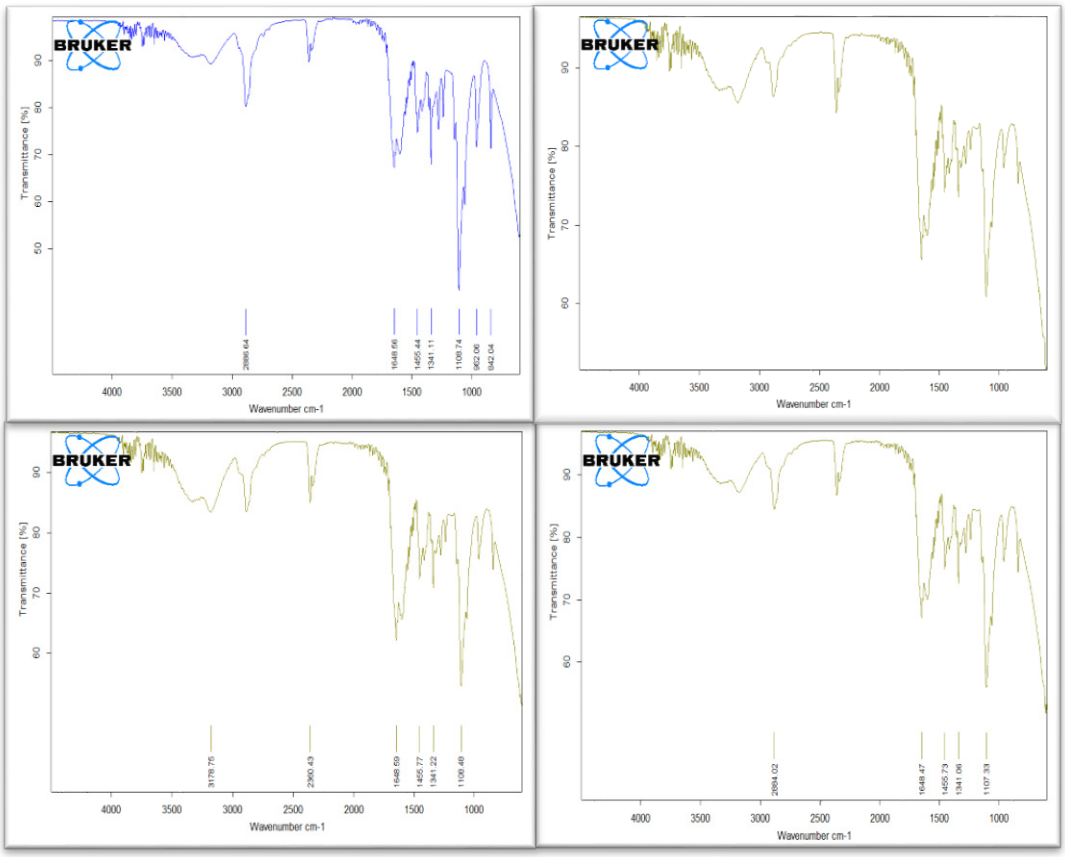

Fig. 5. FTIR of samples after and before doping.

Table 2. FTIR transmittance bands positions and their assignments for (PAAm-PEG-Ag) films with different ratio of Ag nanocomposites.

Band assignment	2 wt. %Ag	4 wt. %Ag	6 wt. %Ag
O–H stretching	2884	3178	3200
C–H stretching vibration	1648	2360	2900
C=C stretching	1455	1648	2405
C=O stretching	1341	1455	1600
C–H bending	1107	1341	1350
C-O stretching		1108	1110

motion, and special vibrational motion at three dimensions for (PAAm-PEG) composite and will most probably be affected by IR energy. This restricted of molecular polymers move reason occurrence apparent distortion for some the parts functional for polymers (functional groups)

therefore, that films nanocomposites has characteristic nano approximately being restricted [15]. The Fourier transforms infrared spectroscopy (FTIR) spectra of pure (PAAm-PEG) and doped (Ag) nanoparticles films are in agreement with [16].

CONCLUSION

The PAAm–PEG mixture was successfully prepared by casting method, as the method succeeded in synthesizing new nanocomposites with homogeneous and fine dispersion as shown by optical micrographs which provided improvements in good morphology properties. The FTIR test showed the difference between the functional group of each component with the same backbone. It also shows how the polymer and Ag nanoparticles have a good interfacial interaction. Both nanocomposites showed a significant improvement in the properties thanks to Ag. SEM showed the homogeneous and wide diffusion of the nanomaterial with the polymer with some agglomeration as the silver is not completely soluble in the solvent.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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