Effect of Nanosilver Particles on the Mechanical Properties of (PVA-PVP) Films

Raheem G.Kadhim

Collage of science, Babylon University

Tel: 07801305881 E-mail: Raheemnano@yahoo.com

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Abstract

In this work,we study the effect of nanosilver particles on mechanical properties of polymer matrix consisting of polyvinyl alcohol and polyvinyl- pyrrolidone. The samples of (PVA-PVP-Ag) nanocomposites were prepared by using casting method. The weight percentages of nanosilver are (0, 4, 8 , 12 and 16) wt.%. , the mechanical properties such as ultrasonic velocity had been measured by ultrasonic waves system at frequency 25 KHz, other mechanical properties had been calculated such as absorption coefficient of ultrasonic waves, relaxation amplitude, specific acoustic impedance, compressibility and bulk modules. The results show that the density , absorption coefficient and the relaxation amplitude are increasing with the increasing of concentrations of the (Ag) nanoparticles ,and the sound wave velocity , specific acoustic impedance , compressibility and bulk modules are decreasing with the increasing of concentrations of the (Ag) nanoparticles .

Keywords: China insurance industry, Foreign fund, Challenge

1. Introduction

Polymer nanocomposites (PNs) consist of a polymeric material (e.g., thermoplastics, thermosets, or elastomers) and a reinforcing nanoscale material (nanoparticle). The nanoparticle has at least one dimension in nanometer scale. Polymer nanocomposites show major improvements in mechanical properties, gas barrier properties, thermal stability, fire retardancy, and other areas. [1]. Particularly, polymermetal hybrid such as polymer-Ag-nanoparticles composites is promising functional materials in several fields such as optical, electrical, thermal, mechanical, and antimicrobial properties [2,3–7]. Many reports in the literature show attempts for synthesis of metal nanoparticles based polymer nanocomposites, with the possibility of variation in their optical and electrical properties for their application in high performance capacitors, conductive inks, and other electronic components [8, 9, 10]. For their application in optoelectronic, electrical, and optical devices, biomedical science, sensors, and so forth, main key points are selection of polymer-metal nanoparticles combination, controlling the particles size, their concentration, and distribution within the polymer matrix [8, 11–13]. Special worthy has been reached to optical properties of the nanoparticles doped in polymer film, depending on the surrounding medium [14–16] and on their size, shape, and concentration [17–20]. Silver nanoparticles have received considerable attention due to their attractive physical and chemical properties ,and it has been protected by polymers such as PVA, PVP, and PMMA [2].

1.1 .Experimental work

The materials used in this paper are polyvinyl pyrrolidone (PVP) and polyvinyl alcohol as a matrix and nanosilver particle as filler. The polyvinyl pyrrolidone and polyvinyl alcohol (70 wt.% polyvinyl alcohol ,30wt.% polyvinyl pyrrolidone) were dissolved in distill water. The nanosilver was add to the polymer matrix by different weight percentages are (0,4,12,16) wt.% .The casting technique was used to preparation the nanocompsites and the density of the samples were measured by the weight method..

The sound wave measurements were made at fixed frequency (f =25 KHz) using technique of sender-receiver type (SV-DH-7A/SVX-7 velocity of sound instrument).

1.1.1 **Theoretical calculation**

The absorption coefficient (α) was calculated from Lambert – Beer law[21]:

$$A/A_0 = e^{(-\alpha x)} \qquad \ldots\ldots\ldots\ldots(1)$$

Where (A_0) is the initially amplitude of the ultrasonic waves,(A) is the wave amplitude after absorption and (x) is the thickness of the sample.

The ultrasonic wave velocity (V) was calculated using the following equation[22]:

$$V = x / t \qquad \ldots\ldots\ldots\ldots(2)$$

Where (t) is time that the waves need to cross the samples (digital obtained from the instrument).

Attenuation is generally proportional to the square of sound frequency so the relaxation amplitude (D) was calculated from the following equation[23] where (f) is the ultrasonic frequency:

$$D = \alpha / f2 \qquad \ldots\ldots\ldots\ldots (3)$$

The acoustic impedance of a medium (Z), it was calculated by equation[24]:

$$Z = PV \qquad \ldots\ldots\ldots\ldots (4)$$

Bulk modulus (K) is the substance's resistance to uniform compression, it is defined as the pressure increase needed to decrease the volume; it was calculated by Laplace equation[25] :

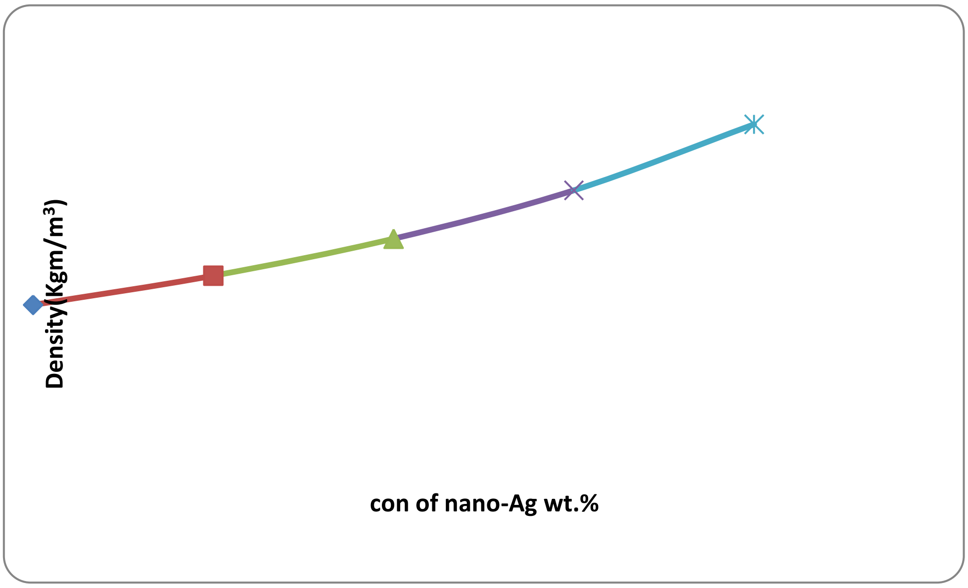
$$K = pV^2 \qquad \ldots\ldots\ldots\ldots(5)$$

Compressibility (B) is a measure of the relative volume change of a fluid or solid as a response to a pressure (or mean stress) change, it was calculated by the following equation[26]:

$$B = (PV^2)^{-1} \qquad \ldots\ldots\ldots\ldots(6)$$

1.1.2 **Result and discussions**

The Density of (PVA-PVP- Ag) nanocomposites films is shown in Figure (1), it is increasing when adding (Ag) nanoparticles. These results are similar to the results reached by the researchers[27,28].

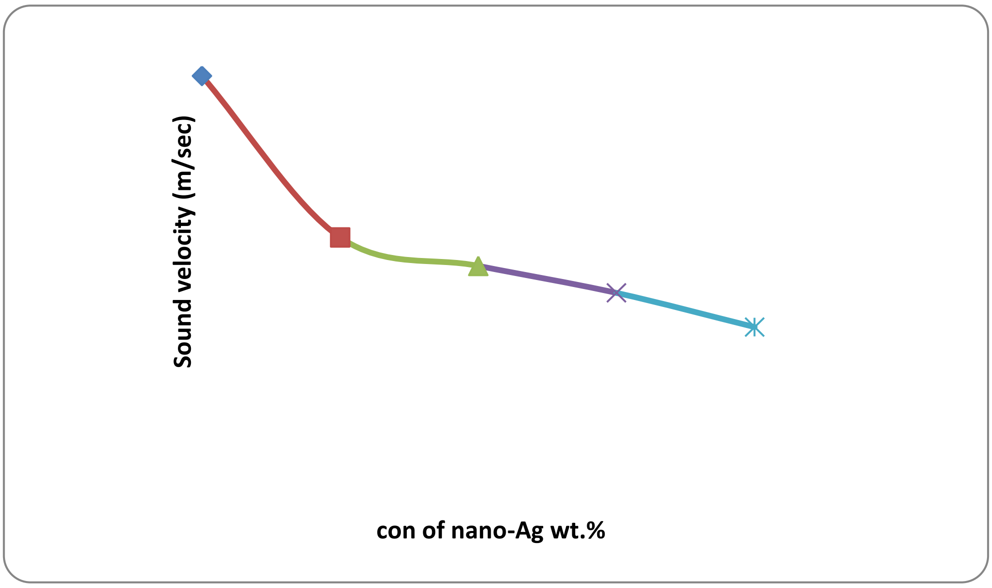


Figure(1):Variation Density with the

Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites

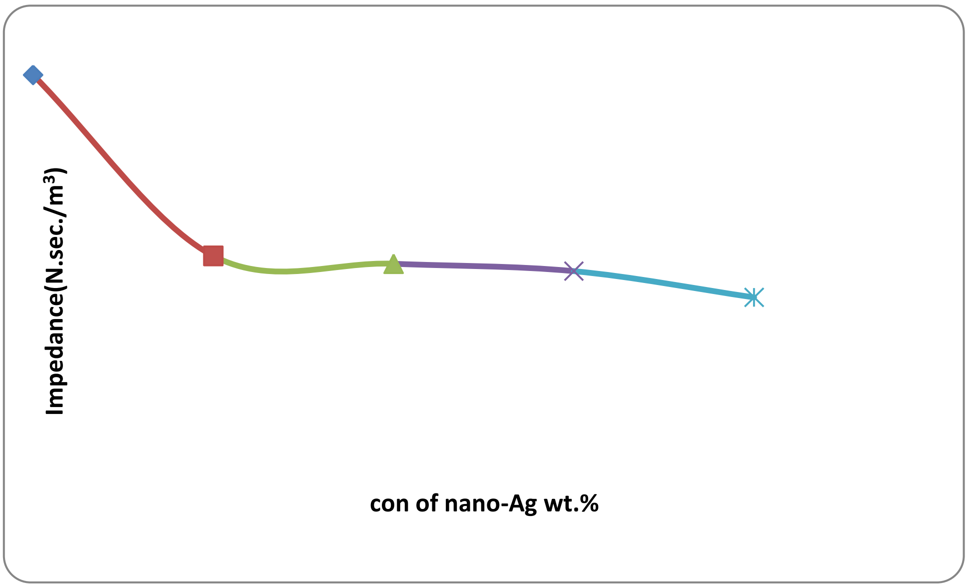
The sound wave velocity results shown in figure (2) that it is decreasing with concentration because when wave are propagated thought it the resultant periodical changes of wave pressure causes molecules to flow into vacancies in the lattice during

compression phase and to return to their original positions in the lattice during rarefaction, so when concentration increases the velocity decreases [29,30]. These results are similar to the results reached by the researchers[28,31].



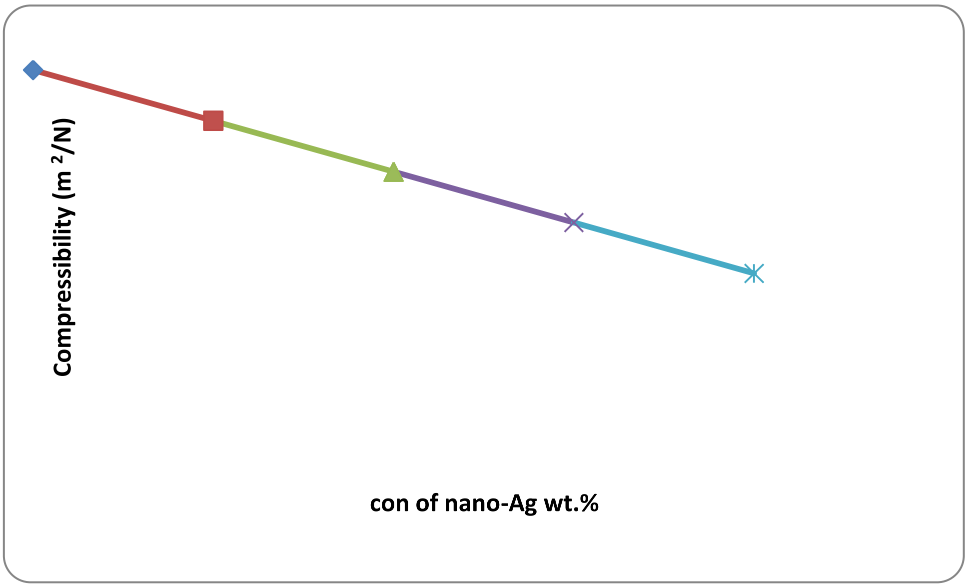
Figure(2):Variation velocity with the Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites

The specific acoustic impedance is decreasing with increase of concentration as shown in figure (3),it seem that added (Ag) nanoparticles to (PVA-PVP) has higher specific acoustic impedance since there is more degradation. These results are similar to the results reached by the researchers[28].

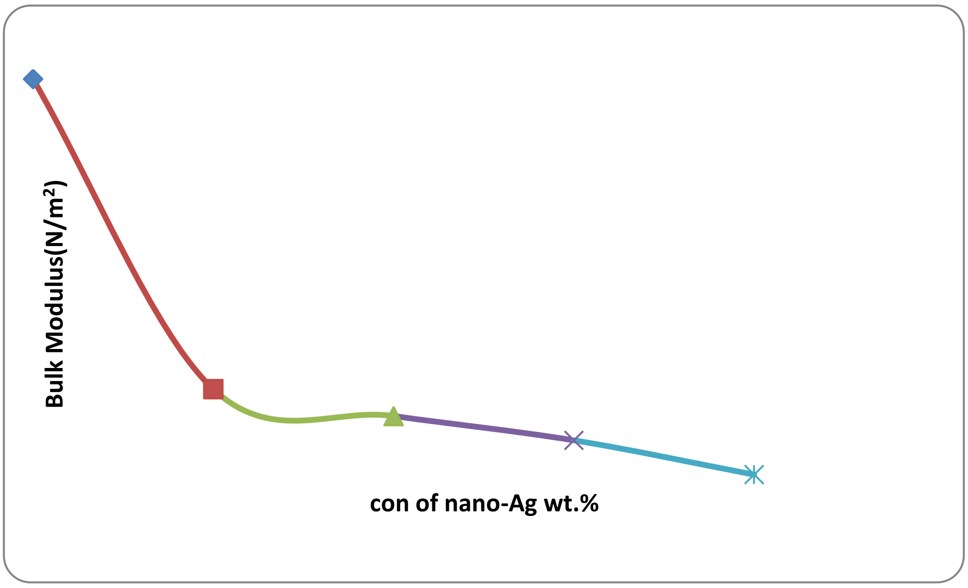


Figure(3):Variation impedance with the Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites

The compressibility of samples was calculated using Laplace equation, the results in figure (4) Shows that the compressibility are decreasing with increasing concentration this could be attributed that the waves propagation made polymer chains that randomly coiled to be each close together, this change confirmation and configuration of these molecules, so there are more compression happen of these molecules through sound wave propagation [32,33], this compression fills the vacancies between polymer molecules and restricted the movement of these molecules this lead to reduce the elasticity of the composite with adding(Ag) nanoparticles as shown in figure (5) . These results are similar to the results reached by the researchers[27,34].

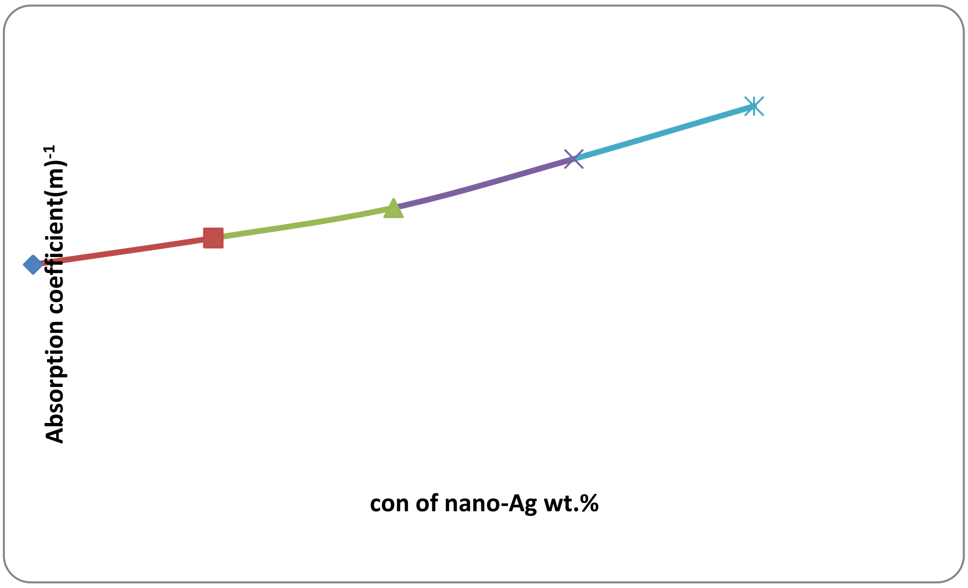


Figure(4):Variation compressibility with the Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites



Figure(5):Variation Bulk Modulus with the Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites

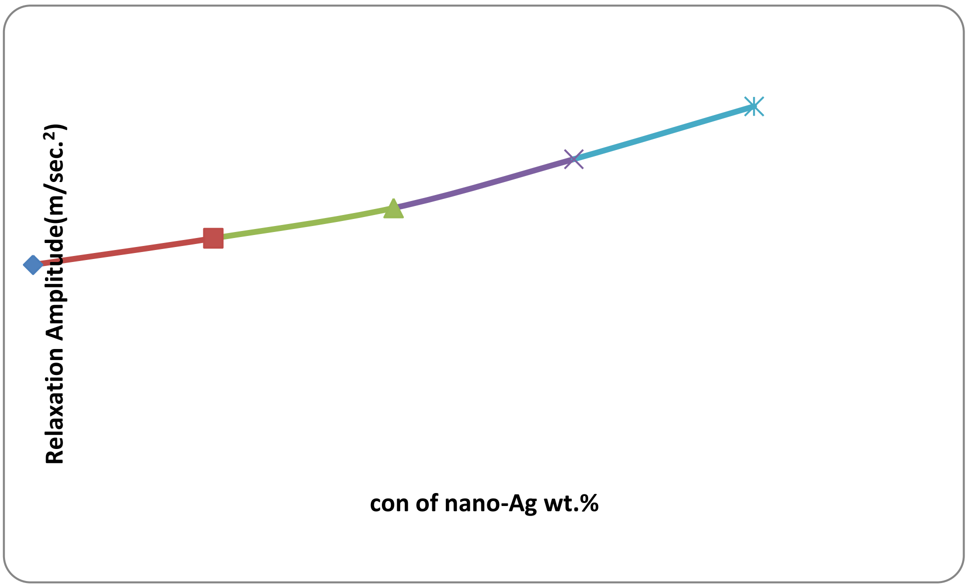
Figure (6) shows that absorption coefficient is increasing with concentration this attributed to the fact that when polymer concentration increase there will be more molecules this lead to more attenuation against wave propagation, the attenuation can be attributed to the friction and heat exchange between the particles and the surrounding medium as well as to the decay of the acoustic wave in the forward direction due to scattering by the Particles [35]. These results are similar to the results reached by the researchers[27,28 ,34].



Figure(6):Variation absorption coefficient with the

Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites

The relaxation amplitude is increasing with increasing concentration as shown in figure (7) this attributed that the displacement of excited molecules became small because moment of inertia for polymer macro molecules reduce[36]. These results are similar to the results reached by the researchers[27,34].



Figure(7):Variation relaxation amplitude with the Concentration of Nanosilver Particles for (PVA-PVP-Ag)nanocomposites

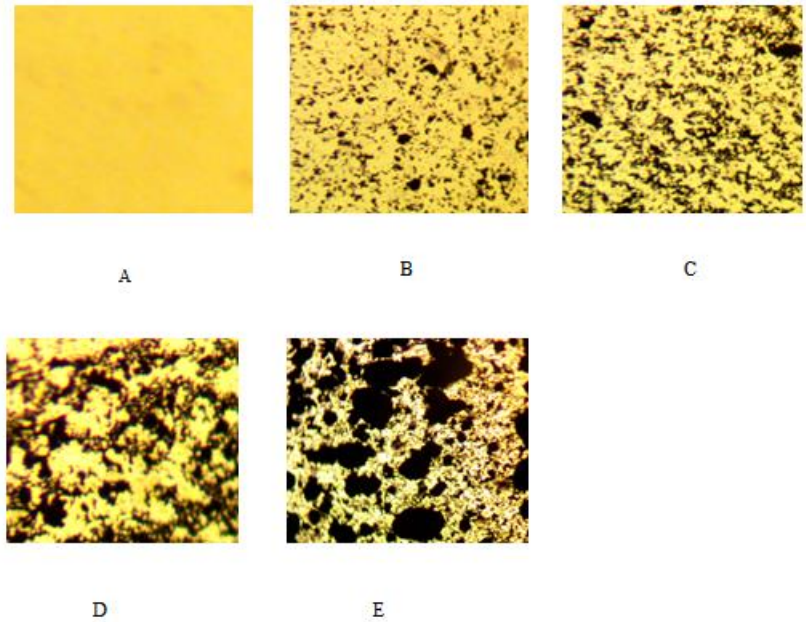


Figure (8) :Photomicrographs for (PVA-PVP-Ag) nanocomposites(A) for pure,(x100) . (B) for 4wt.% Ag ,(x100). (C) for 8wt.% Ag ,(x100). (D) for 12wt.% Ag ,(x100). (E) for 16wt.% Ag ,(x100).

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