Effect of Cadmium Sulfide Particles on A.C Electrical Properties of (PVA-PVP) blends

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Abstract

The (PVA-PVP- CdS) composites were made with different weight percentages of Cadmium sulfide particles as a filler. All samples were prepared as films by solution casting way. The experimental outcomes show that the dielectric constant increase with rising of the frequency of applied electrical field and concentration of the filler. Dielectric loss decreases with the increasing the frequency while it increased with the increases of concentration of the Cadmium sulfide. The A.C electrical conductivity increases with increasing the filler and frequency for the (PVA-PVP- CdS) composites.

Keywords: Electrical properties, conductivity, Cadmium sulfide.

الخلاصة

تم تصنيع متراكبات (PVA–PVP– CdS) بنسب وزنية مختلفة من جسيمات كبريتيد الكادميوم كمادة مالئة. جميع العينات تم تحضيرها كأغشية بطريقة الصب. أظهرت النتائج التجريبية أن ثابت العزل الكهربائي يزداد مع ارتفاع تردد المجال الكهربائي المسلط وتركيز المادة مالئة. وايضا ان الفقدان العزلي ينخفض مع زيادة التردد، بينما يزداد مع زيادة تركيز كبريتيد الكادميوم. وان الموصلية الكهربائية المتناوبة تزداد مع زيادة المادة مالئة والتردد لمركبات (PVA–PVP– CdS).

الكلمات المفتاحية: الخصائص الكهربائية، الموصلية، كبريتيد الكادميوم.

Introduction

The study of composite materials, i.e., mixtures consisting of at least two phases of different chemical structures, has been of great interest from both fundamental and practical point of view (Al–Adam, and H. A, 1983). Prepare of polymer blends is very simple by different techniques including solution blending technique (Mudigoudra *et al.*, 2012). PVA could be regarded as a good host material for metal because its excellent thermos ability, chemical resistance, high mechanical strength, water solubility, and moderate and dopant dependent electrical (Khanna *et al.,* 2005). Polyvinyl pyrrolidone is a vinyl polymer possessing planar and highly polar side groups because the peptide bond in the lactam ring. It deserves a special attention among the associated polymers because of the easy process ability, moderate thermal conductivity and high environmental stability (Bhajantri *et al.*,2009). Poly vinyl alcohol (PVA) and poly vinyl pyrrolidone (PVP) are good encapsulating materials for metallic -particles, forming a core-shell nanostructures. On doping (with red-ox agents), the conductivity of polymers can be increased and the electrical, optical and thermal characteristics can be tailored to suit special needs (Harun *et al.,* 2009). PVA-PVP blends have application as skin dressing materials, and are also used as electrochemical membranes (Giusti, *et al.*, 1993) This paper study the effect of Cds on A.C properties of Poly vinyl alcohol (PVA) and poly vinyl pyrrolidone (PVP).

Experimental Work

The raw materials used in this work were as a powder of commercial Poly vinyl alcohol (80 wt.%) with poly vinyl pyrrolidone (20 wt.%) doped by Cadmium sulfide with weight percentages (6 and 8 wt.%). The films were prepared using the conventional casting technique by dissolving the powders within distilled water. The powders were completely dissolved by using magnetic stirrer for the mixing process for (30 minutes) with temperature (65 ^{o}C) and then placed each one of these ratios in 5×5 cm^2 glass basin then left for (5 days) to dry mixture at room temperature. The thickness of the dried films was found to be~1.5 μm measured by digital micrometer. The dielectric properties of (PVA-PVP- CdS) composites were measured using LCR meter in the frequency range (100 Hz to 5 MHz) at room temperature. The measured capacitance (C) was used to calculate the dielectric constant (έ), by using the equation(Jafar H.I et al., 2011):

$$\varepsilon' = \frac{Cd}{\varepsilon_o A} \quad \text{.................................(1)}$$

where *d* is sample thickness and A is surface area, ε_o is the permittivity of free space.

The dielectric loss ε" can be calculate using the equation(Jafar *et al.*,2011):

$$\varepsilon'' = \tan\delta \times \acute{\varepsilon} \quad \text{...............................(2)}$$

where: tanδ is dissipation factor.

The A.C conductivity (σ_{ac}) can be calculate by the equation (Hamzah *et al.*,2008):

$$\sigma_{a.c} = \omega \varepsilon_o \varepsilon'' \quad \text{..............................(3)}$$

Where: ω is the angular frequency (ω = 2πf).

Results and Discussion

Figure (1) illustrates the diversity of dielectric constant with the frequency for (PVA-PVP-CdS) composite. Form the figure, It can be observed that the dielectric constant is composite decrease when the applied field frequencies increasing, this may be attributed to the decreasing of space charge polarization to the total polarization. The space-charge polarization becomes the dominant type of polarization at low frequencies, and its less contributing with the increase of frequency (Majeed, 2013). The effect of Cadmium Sulfide concentration on the dielectric constants for (PVA-PVP-CdS) composite is shown in figure (2). The dielectric constant increases with increase of the weight percentages of Cadmium Sulfide. The reason for this increase in the values of dielectric constant are increase the carriers of charge and also formation of a continuous network of CdS ions inside the composite (Raheem, 2013).

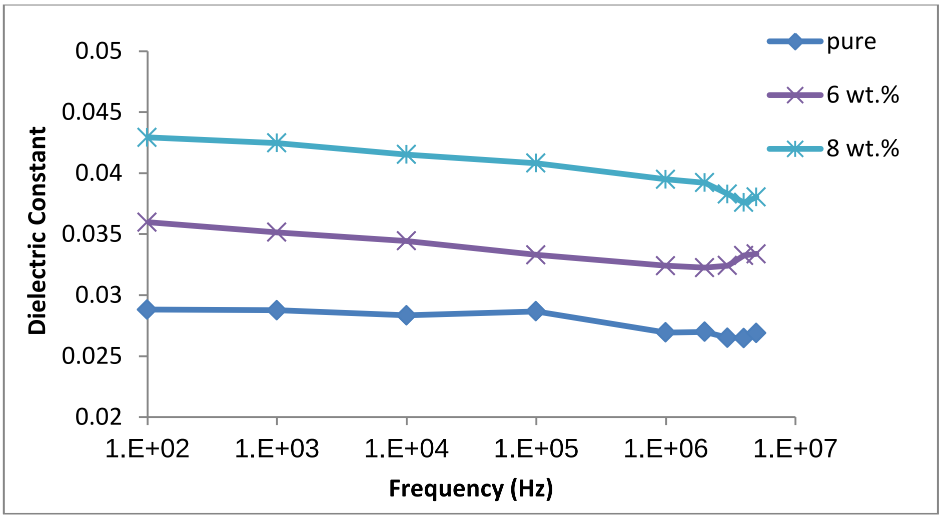

Figure (1): The dielectric constant versus frequency for (PVA-PVP- CdS) composite.

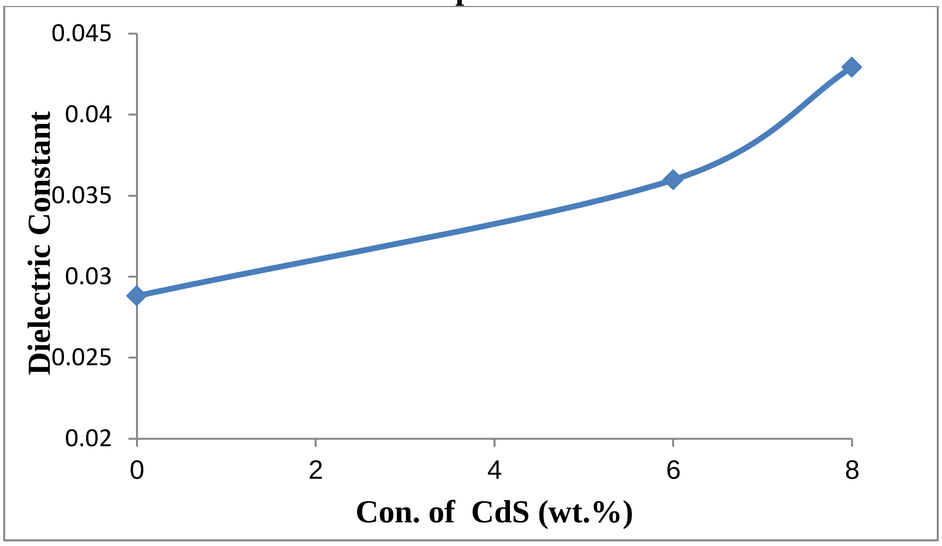

Figure (2): The dielectric constant versus concentration of Cadmium Sulfide for (PVA-PVP- CdS) composite.

The relationship between the dielectric loss with the frequency for (PVA-PVP-CdS) composites are shown in figure (3). From the figure, the dielectric loss decreases with the increasing the frequency which due to the decrease of the space charge polarization contribution when increasing the frequency (Sabah *et al.*, 2014), while the dielectric loss increases with increasing of the weight percentages of Cadmium Sulfide as a result of the dipole charge increase (Sabah *et al.*,2014) (see figure (4)).

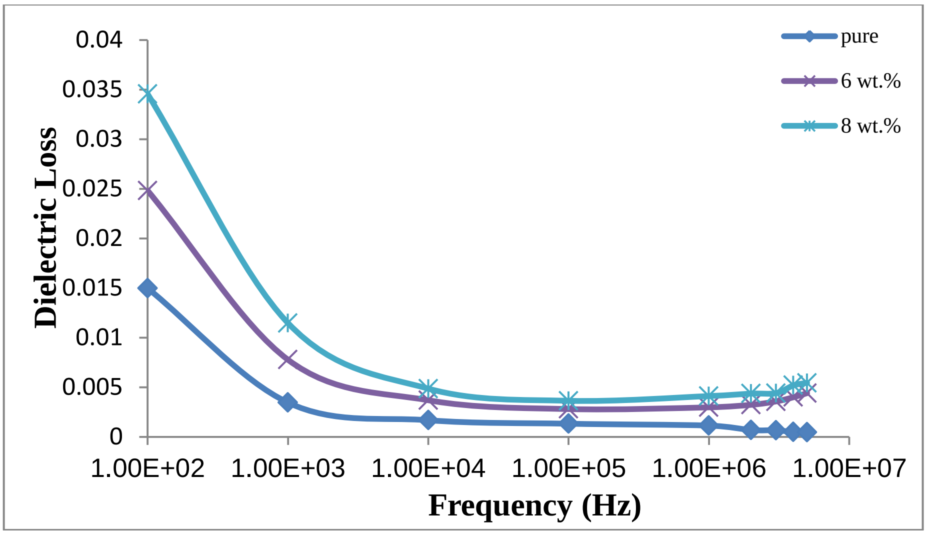

Figure (3): The dielectric loss versus frequency for (PVA-PVP- CdS) composite.

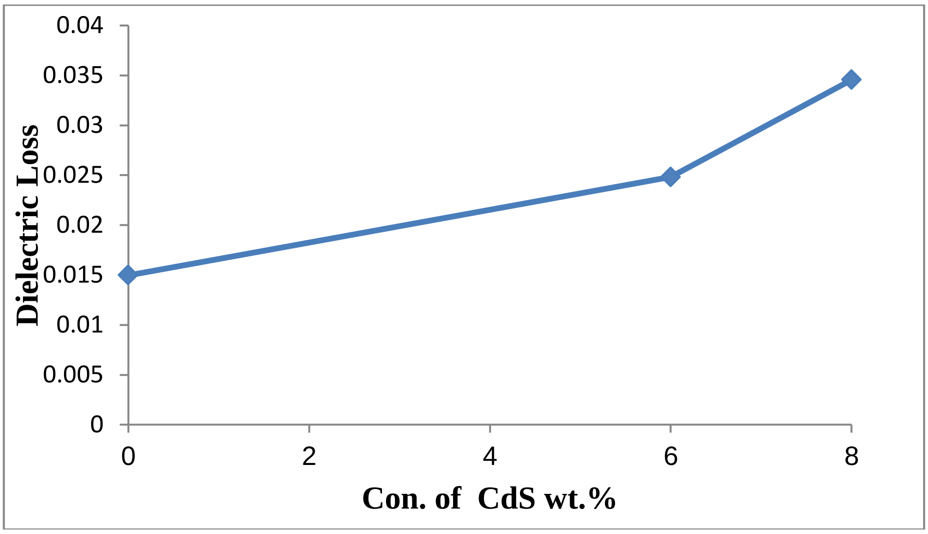

Figure (4): The dielectric loss versus concentration of Cadmium Sulfide for (PVA-PVP- CdS) composite.

Figure (5) shows the variation of A.C electrical conductivity of composites as a function of frequency. The A.C electrical conductivity increases with increase of the frequency due to electronic polarization and the charge carriers, which travel by hopping while the A.C electrical conductivity is increased with increases of the concentration of CdS (more clear in figure (6)), which attributed to increase the numbers of charge carries (Ahad *et al.*,2012)**.**

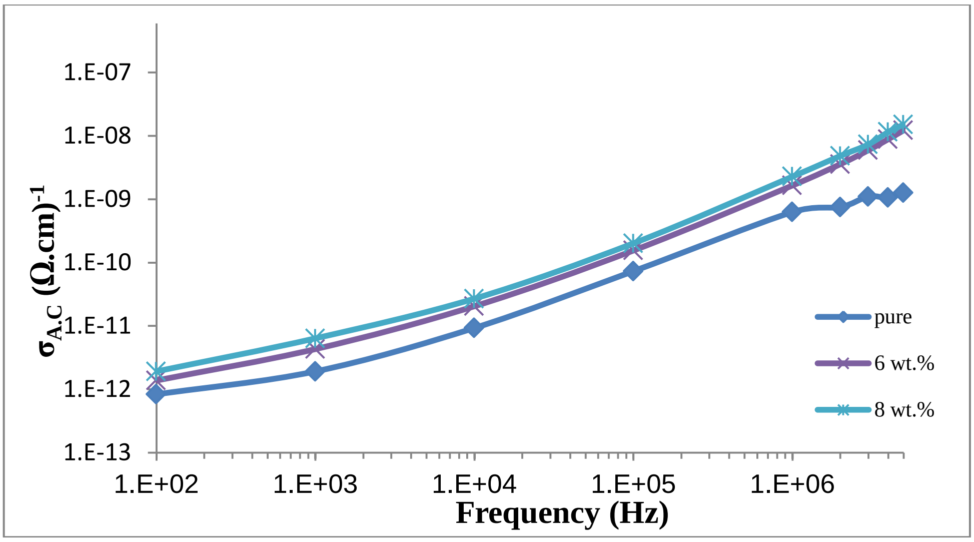

Figure (5) : The A.C electrical conductivity versus frequency for (PVA-PVP- CdS) composite.

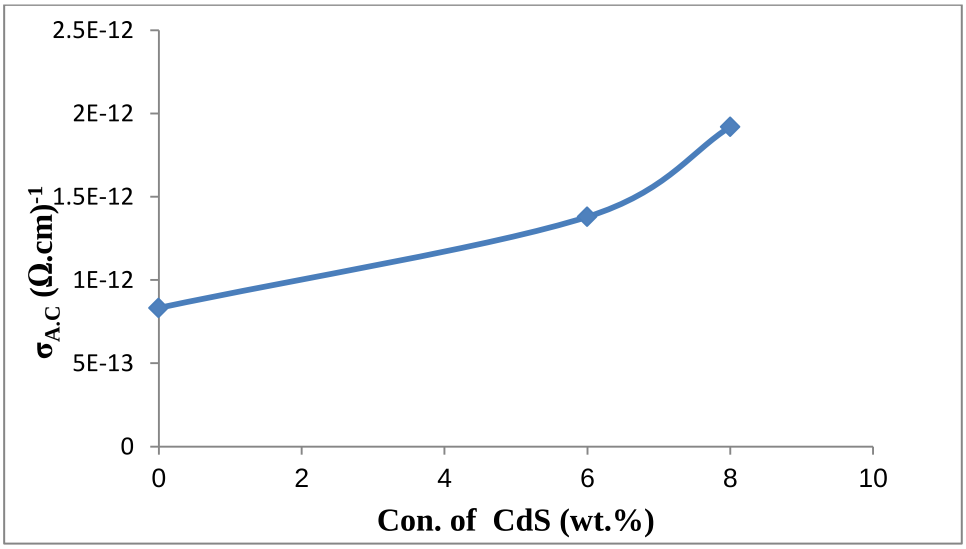

Figure (6): The A.C electrical conductivity versus concentration of Cadmium Sulfide for (PVA-PVP- CdS) composite.

4 .Conclusions

(PVA-PVP- CdS) films with various content of CdS as a filler are prepared by casting method from mixing together PVA and PVP. The dielectric constant is declines with increasing of the frequency for the (PVA-PVP- CdS) samples, and increases with increasing of the CdS filler concentrations. The dielectric loss of composites declines with increasing of the frequency while it increases with increasing of the filler concentrations. The A.C electrical conductivity values for (PVA-PVP- CdS) composites are increases with the increasing of the frequency and concentrations of CdS filler.

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