Characterization of (PVA- $BaSO_4.5H_2O$) Composites

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Abstract

In this study , the dielectric properties of composites of poly-vinyl alcohol(PVA) as matrix and $BaSO_4.5H_2O$ as additive have been studied with different weight percentages of $BaSO_4.5H_2O$. The composites were prepared using casting technique. The dielectric properties were measured in the frequency range from (100-10^7) Hz at room temperature. The results show that the dielectric properties are increasing with increase the weight percentages of $BaSO_4.5H_2O$. Also, dielectric constant, dielectric loss and A.C electrical conductivity are changed with increase the frequency.

Keywords: (PVA- $BaSO_4.5H_2O$) Composites, Dielectric properties, Casting technique, A.C. electric conductivity.

keywords: dielectric loss, composites, dielectric constant, poly-vinyl alcohol.

دراسة خصائص متراكبات (PVA- $BaSO_4.5H_2O$)

المستخلص

في هذه الدراسة، قد تم دراسة خصائص العزل من المواد المتراكبة من بولي فينيل الكحول (PVA) و BaSO4.5H2O و المضافة مع نسب مختلفة من الوزن $BaSO_4.5H_2O$. أعدت المتراكبات باستخدام تقنية الصب. وتم قياس خصائص العزل في مدى التردد من (10^7-100) هرتز في درجة حرارة الغرفة. بينت النتائج أن خصائص العزل تتزايد مع زيادة نسب الوزن من $BaSO_4.5H_2O$. أيضا يتم تغيير ثابت العزل الكهربائي، الخسارة العزلية، والتوصيلية الكهربائية مع زيادة التردد.

Introduction

Composite materials, which are usually fabricated with an emphasis on properties such mechanical strength, have also been used in electronic applications. Integrated decoupling capacitors, angular acceleration accelerometers, acoustic emission sensors and electronic packing are some potential applications[1].In the last decades research has focused a growing attention to low environmental impact, recyclable and eco-sustainable products. For this reason, the trend in developing polymers and blends, in which natural organic and inorganic additives are employed is increasing in a significant way[2]. Nowadays, thermoplastic polymers are widely used in various aspects of human society. They have several good properties such as good chemical resistance, better mechanical properties, cost effectiveness that make them the polymers of choice for numerous applications. Due to that superior properties of these materials, they have used both mixed with natural fillers and in manufactured composite forms. The use of thermoplastic polymer composites reinforced with natural fillers has been rapidly increasing in the automotive industry[3]. This paper deals with study effect of $BaSO_4.5H_2O$ additive on dielectric properties of poly-vinyl alcohol.

Experiment

The materials used in this study are poly-vinyl alcohol and $BaSO_4.5H_2O$. The weight percentages of $BaSO_4.5H_2O$ are (0,3,5,7 and 10)wt.%. The samples were prepared using casting technique thickness ranged between (245-570)µm.

The dielectric properties of composites were measured using (Agilent impedance analyzer 6500B).

In the frequency(f) range (1-10) MHz at room temperature. The measured capacitance, C(w) was used to calculate the dielectric constant ,έ(w) using the following expression:

$$\frac{d}{\varepsilon_o A}\varepsilon'(w) = C(w) \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where d is sample thickness and A is surface area of the sample . whereas for dielectric loss ε"(w):

$$\varepsilon''(w) = \acute{\varepsilon}(w) \times \tan\delta(w) \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where tanδ(w) is dissipation factor . The AC conductivity σac Can be calculated by the following equation :

$$\sigma_{ac}(w) = \varepsilon_o w \varepsilon'' \qquad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Results and Discussion

Figure (1) shows the variation of the dielectric constant of composite with frequency for different $BaSO_4.5H_2O$ concentration. The dielectric constant decreases with increasing of frequency, this may be attributed to the tendency of dipoles, the high value of dielectric constant at low frequency might be due to the interfacial effect. At low $BaSO_4.5H_{2O}$ concentration, the dielectric values are low, characteristics of dielectric behaviour, and increasing the $BaSO_4.5H_2O$ concentration caused an increase in the average number of concentrations among

the conductive particles. At high concentrations of $BaSO_4.5H_2O$ the dielectric constant is due to formation of a continuous network of $BaSO_4.5H_2O$ particles through the composite[4] .

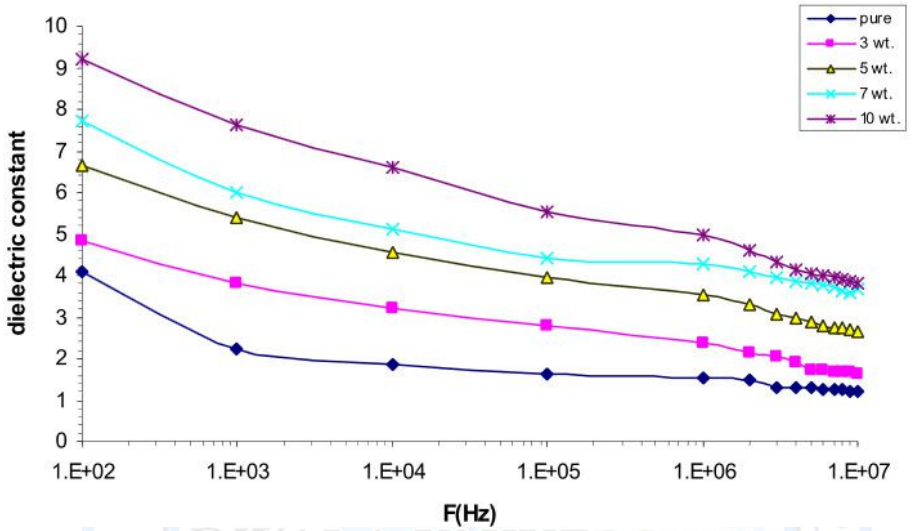

Figure.1. Variation of dielectric constant for (PVA- $BaSO_4.5H_2O$) composite with Frequency

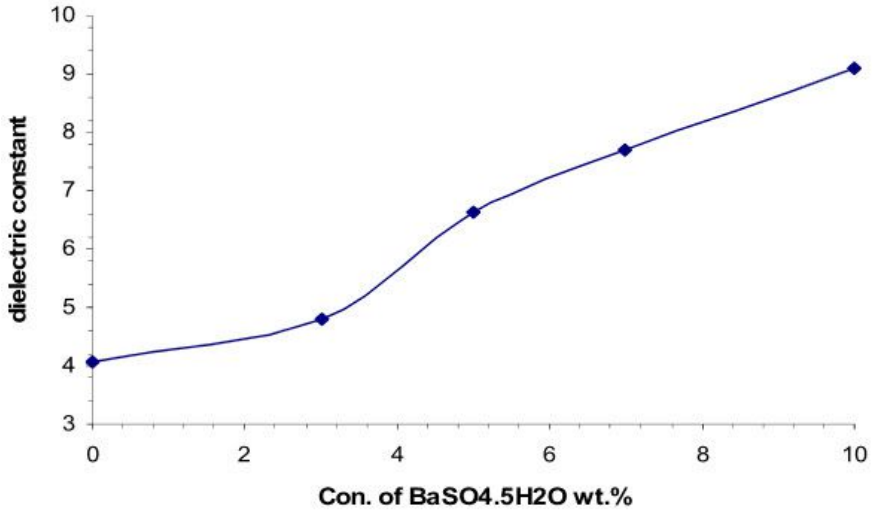

Figure.2. Effect of $BaSO_4.5H_2O$ concentration on dielectric constant for composite at 100Hz.

The relation between dielectric loss factor and frequency is shown in figure (3) the values of dielectric loss factor are decreasing with increasing of frequency this is due to some relaxation processes with usually occur in heterogeneous system [5].

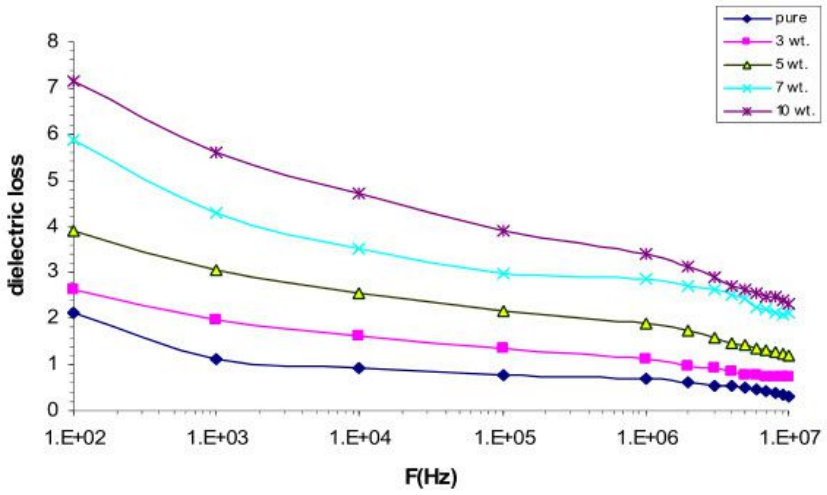

Figure.3. Variation of dielectric loss for (PVA- $BaSO_4.5H_2O$) composite with Frequency

The variation of dielectric loss factor with $BaSO_4.5H_2O$ concentration is shown in figure (4) , this figure shows increasing of dielectric loss factor by in creasing of $aSO_4.5H_2O$, this is due to the overlapping of relaxation process which are attributed to some structural charges that take place in the composite as result of filler concentration[6].

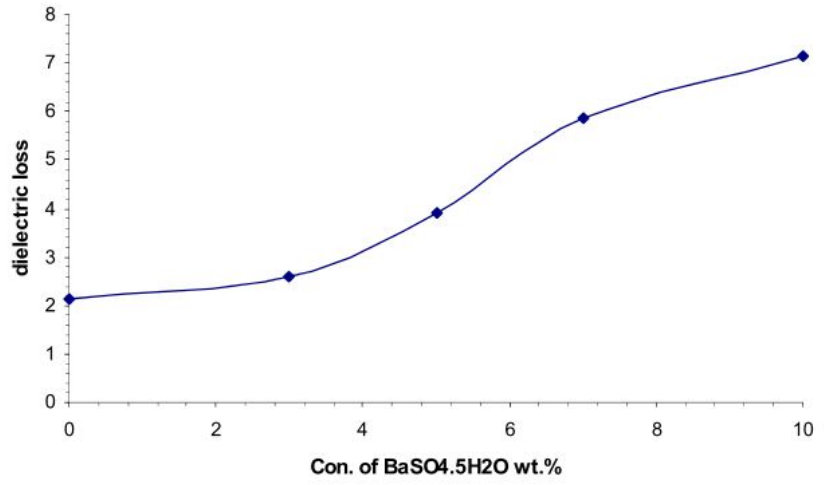

Figure.5. Effect of $BaSO_4.5H_2O$ concentration on dielectric loss for composite at 100Hz.

The variation of A.C electrical conductivity as a function of frequency for (PVA$BaSO_4.5H_2O$) composites of different $BaSO_4.5H_2O$ concentrations at 303K is given in figure (4). The figure shows that in low, intermediate and higher frequency region the electrical conductivity for all (PVA- $BaSO_4.5H_2O$) composites is increasing with frequency. The increasing of A.C electrical conductivity with angular frequency in the low frequency region can be attributed to the interfacial polarization [4].

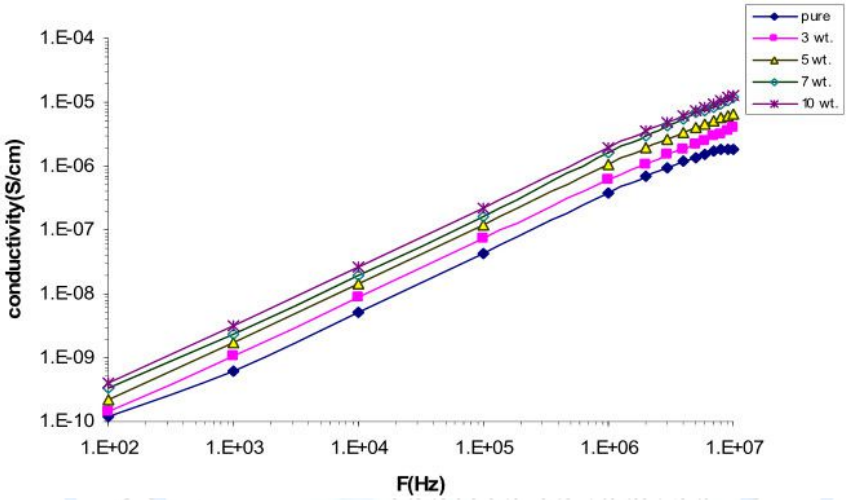

Figure.5. Variation of A.C electrical conductivity for (PVA- $BaSO_4.5H_2O$) composite with Frequency

The increasing of A.C electrical conductivity in high frequency region can be related to the electronic polarization as well as to the hopping of charge carrier over a small barrier height. Figure(6) indicates that $\sigma_{A.C}$ is increasing with increasing $BaSO_4.5H_2O$ wt.% content, a result which supports the suggestion of hopping of charge carrier conduction mechanism [7].

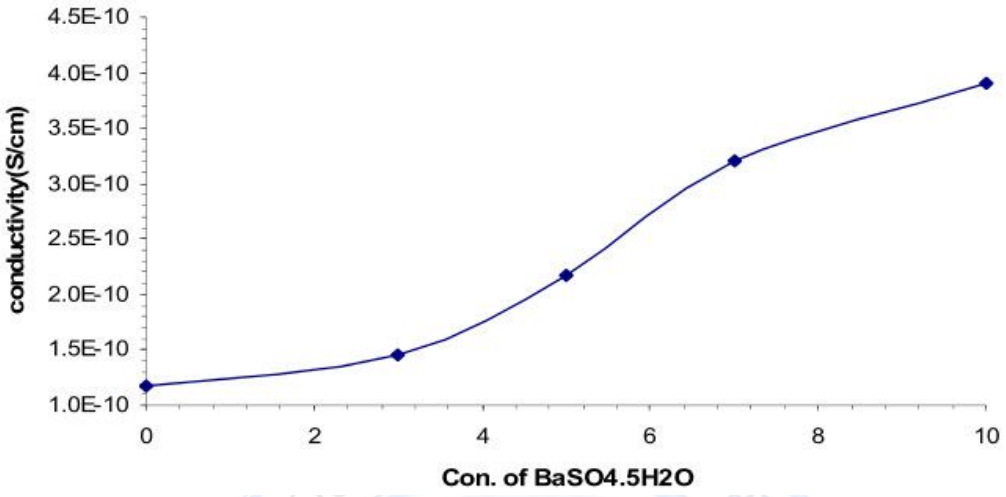

Figure.6. Effect of $BaSO_4.5H_2O$ concentration on AC electrical conductivity for composite at 100Hz.

Conclusions

1. The dielectric constant decreases with increase the frequency and increases with $BaSO_4.5H_2O$ wt.% content .

2. The dielectric loss decreases with increase the frequency and increases with $BaSO_4.5H_2O$ wt.% content

3. The A.C electrical conductivity of PVA- $BaSO_4.5H_2O$ composites is increasing with increasing frequency of applied electrical field and $BaSO_4.5H_2O$ wt.% content .

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