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Dielectric Properties of (PS-$BaSO_4.5H_2O$) Composites

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Abstract

Composites consisting of an polystyrene as matrix and $BaSO_4.5H_2O$ as a filler has been investigated with different percentages of $BaSO_4.5H_2O$ (0,3,5,7 and 10) wt.%.. The dielectric properties were measured in the frequency range from (1-10)MHz at room temperature. The Results show that the dielectric constant, dielectric loss and electrical conductivity are increasing with increase the concentration of the $BaSO_4.5H_2O$. Also the dielectric properties(dielectric constant, dielectric loss and electrical conductivity) changed with increase the frequency.

Keywords: Polystyrene, composites, dielectric properties.

Introduction

The impressive widspread of the use of composite materials at present could be explained, among other arguments, by the possibility to predict the composite's properties, on the basis of the volumic content and the corresponding properties of the matrix and the reinforcement. In fact, the user can get a new material that is tailored by his demands[1]. Measurements of the electrical properties of polymers are one of the most convenient and sensitive methods for studying polymer structure. A filled polymer differs substantially from the free one in a wide range of properties. The presence of filler affects both the electrical, as well as, mechanical properties. In most of their industrial applications, elastomers are used ascomposite materials[2]. The present work deals with the effect of $BaSO_4.5H_2O$ additive on the electrical properties of poly-vinyl alcohol composite.

Materials and Methods

The materials used in this paper are polyvinyl alcohol and $BaSO_4.5H_2O$. The weight percentages of $BaSO_4.5H_2O$ are (0,3,5,7 and 10) wt.%. The specimens were prepared using casting technique thickness ranged between (204-387)µm.

The dielectric properties (dielectric constant, dielectric loss, A.C electrical conductivity of PVA- $BaSO_4.5H_2O$ 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 equation:

$$\acute{\varepsilon}(w) = C(w)\,\frac{d}{\varepsilon_o A} \tag{1}$$

Where d is sample thickness and A is surface area of the sample . whereas for dielectric loss$\varepsilon''(w)$:

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

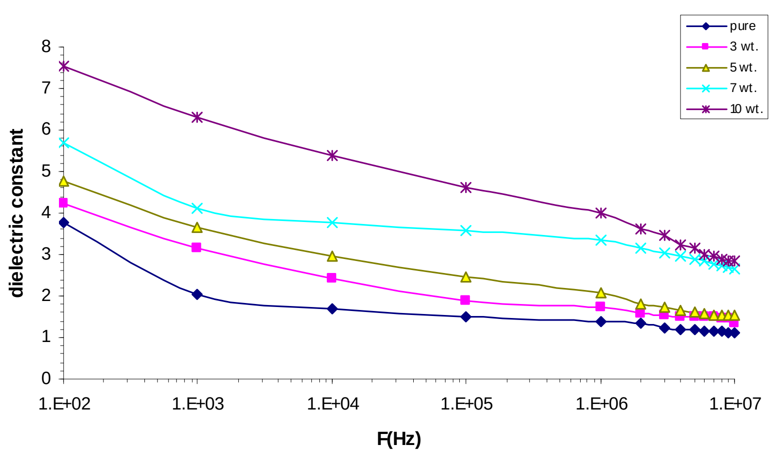
Where $\tan\delta(w)$ is dissipation factor . The A.C conductivity σ_{ac} can be calculated by the following equation :

$$\sigma ac^{(w)} = \varepsilon o w_{\varepsilon}'' \tag{3}$$

Results and Discussion

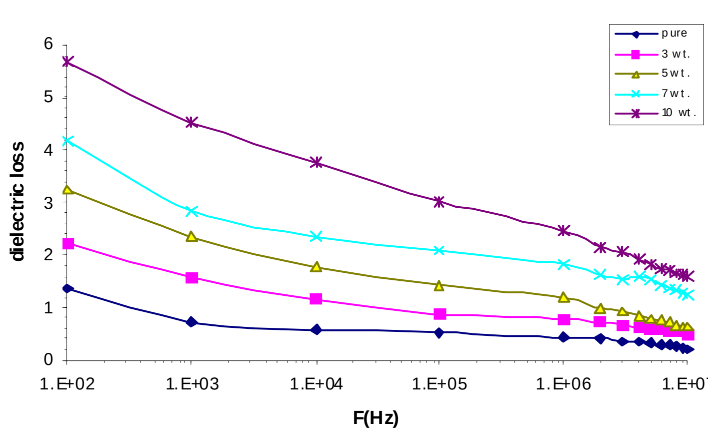
Figures(1,2) show the variation between the dielectric constant, dielectric loss and frequency at room temperature for different concentration of filler. These figures show that the dielectric constant and dielectric loss decrease with increase the frequency, this attribute to decreasing of space charge polarization to the total polarization.

Figure 1: The variation of dielectric constant with the frequency at room temperature.



At lower frequency the dipole can respond rapidly to follow the field and dipole polarization has its maximum value, so highest dielectric constant and dielectric loss. At higher frequencies polarizability will be minimum, as the field con not induce the dipole moment, so dielectric values attain minimum [3].

Figure 2: The variation of dielectric loss with the frequency at room temperature.



The variation of dielectric constant, dielectric loss with weight filler content at room temperature are shown in figures(3,4). The increase of the dielectric constant, dielectric loss with weight filler content can be attribute to increase of ionic charge which can be increased due to increasing filler content[4]

Figure 3: The variation of dielectric constant with the concentration of filler at 100Hz.

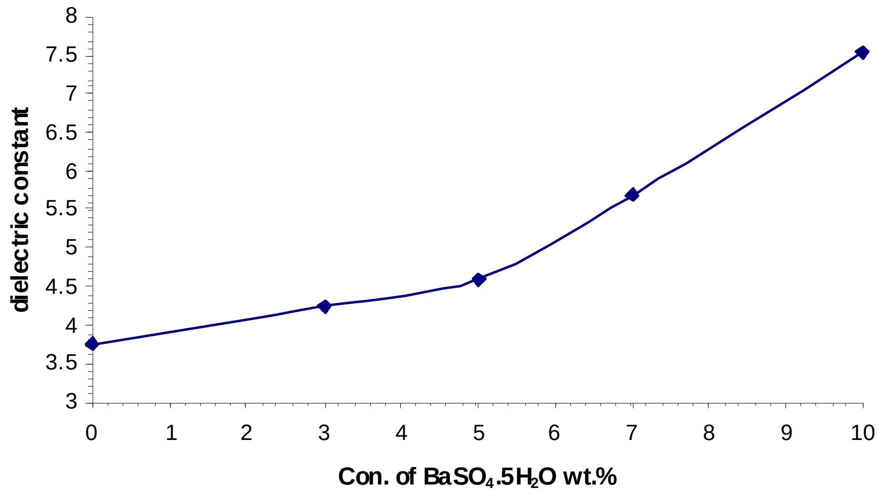


Figure 4: The variation of dielectric loss with the concentration of filler at 100Hz.

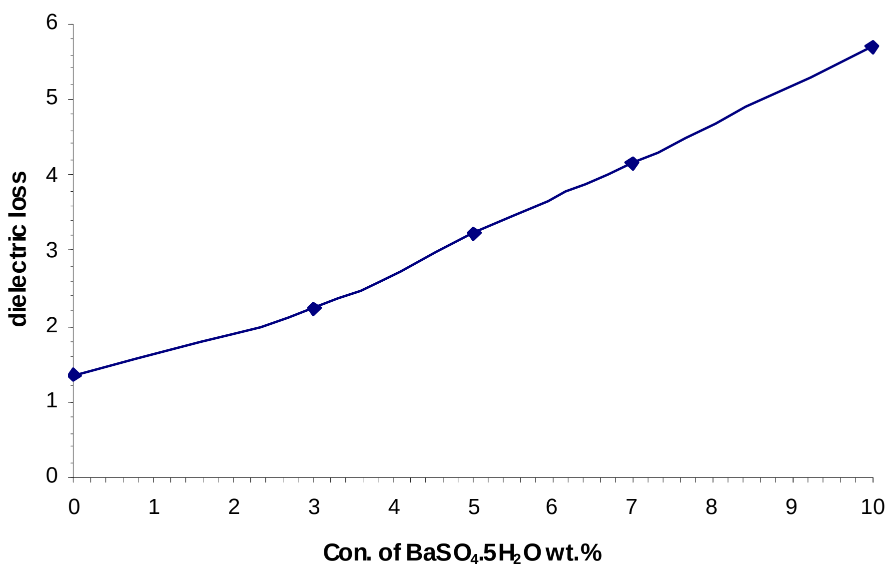
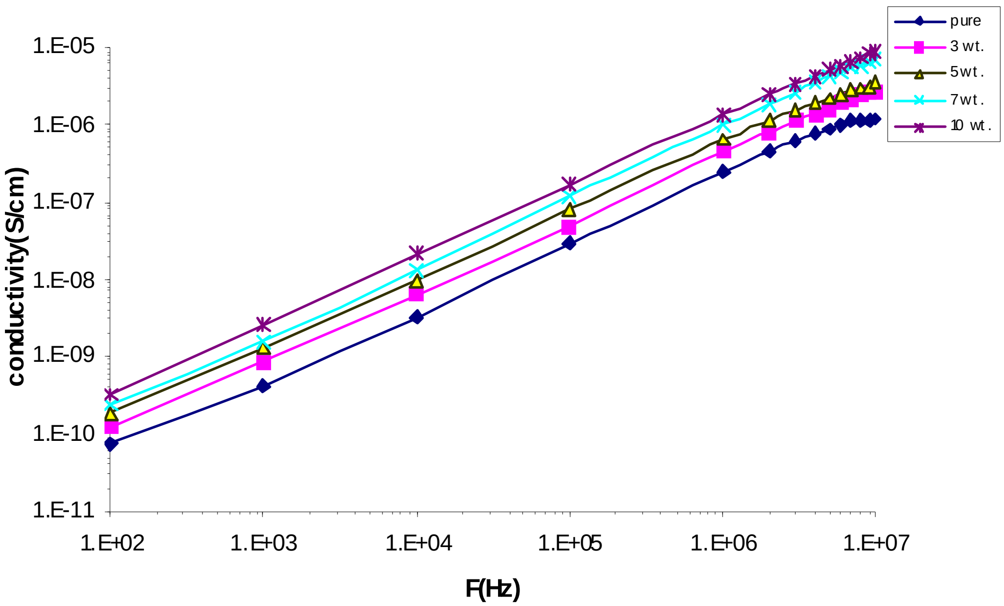


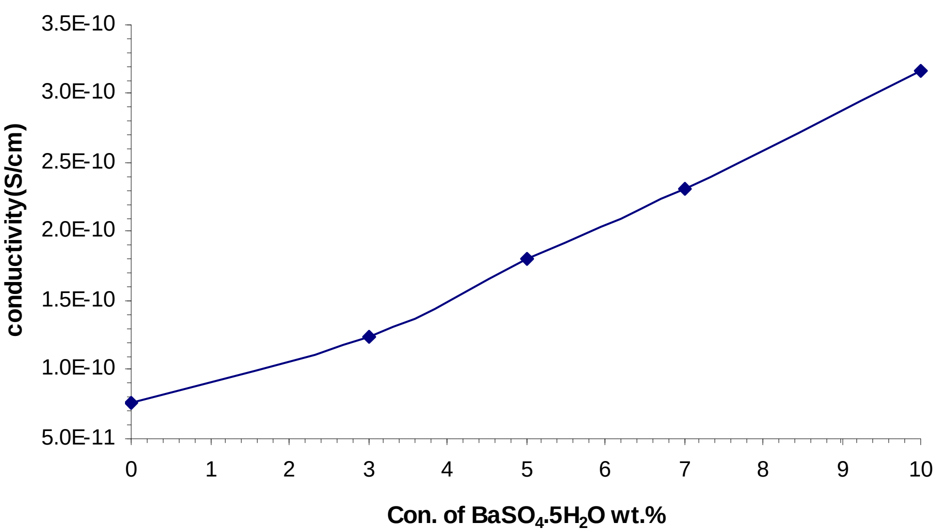
Figure (5) shows the variation of the A.C electrical conductivity of PS-$BaSO_4.5H_2O$ composite with frequency. The figure shows that the A.C electrical conductivity increases when increasing the frequency this can be attributed to the interfacial polarization[5].

Figure 5: The variation of electrical conductivity with the frequency at room temperature.



The variation of electrical conductivity as function of the concentration of $BaSO_4.5H_2O$ at 100Hz is shown in figure(6). The A.C electrical conductivity increases with increase the concentration of $BaSO_4.5H_2O$, this attribute to the increase of the charge carrier density in polymer matrix[6].

Figure 6: The variation of dielectric loss with the concentration of filler at 100Hz.



Conclusions

1. The dielectric constant decreases with increase the frequency and increases with increase the $BaSO_4.5H_2O$ wt.% content.
2. The dielectric loss decreases with increase the frequency and increases with increase the $BaSO_4.5H_2O$ wt.% content.
3. The A.C electrical conductivity of composites is increasing with increasing frequency of applied electrical field and $BaSO_4.5H_2O$ wt.% content.

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