

Study of the electrical properties of poly(p-phenylene sulfide) PPS doped with Copper Phthalocyanine (CuPc)

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Abstract – We have studied some electrical properties of Poly(p-phenylene sulfide) (PPS) doped with Copper Phthalocyanine (CuPc) obtained in amorphous films form in the thickness range of 50 -100µm. The samples were thermal treated at 60 °C in different time in the range of 1.0 h to 180 h. From I/V characteristics, it is found that the conduction is Ohmic in the low-field region and space charge limited current (SCLC) type at high field and high temperature. Furthermore, in the study of the electrical conduction, it can be observed the Schottky conduction mechanism below glass transition temperature (T_g). Above T_g, the conduction is dominated by Poole-Frenkel mechanism.

Nowadays conducting polymers have received great interest of many researchers in the world. During the last forty years the industry of plastic have get a fantastic technological advance with the discovery of a new class of synthetic material, which open new frontier for applications as alternative material to metals. The uses of conducting polymers are still restricted due to some characteristics such as instability. The needs of a material with better quality, and easy processability leads the researchers to study several properties such as electrical, optical and magnetic. The better understanding of these properties allowed some suggestions for new applications. Hence, the conducting polymers, called synthetic metals are used in photo electrochemical cells, light battery and solar cells, p-n function, Schottky barrier and as electrical conductors. PPS/CuPc composite films were obtained with different Copper phthalocyanine contents as: 3%, 5%, 8%, 13%, 15%, 18% and 23% in weight. The powders were mixed and placed between two steel plates. The plates were hot pressed at 300°C with 10 MPa. After that the film was quenched in water/ice bath. The analysis of isothermal and non-isothermal depolarization current in dielectric materials is generally interpreted as dipolar reorientation or the movement of carriers released from traps. TSDC measurements were carried out in film with 8% of CuPc after thermal treatment. The heating rate was used for 2° C/min, and the applied voltage with 360 V. The behavior of depolarization current for different poling temperatures can be seen at a peak of 52°C, which is independent of polarization temperature. This peak is due to phthalocyanine since sample of pure PPS has no peak at this temperature. The magnitude of this peak is increased with the increase of PuCu content as shown in Figure 1. The relation between ε' and ε'' is shown in figure 2. From the figure it is clear that there is a distribution of relaxation times. The relaxation times (τ) were obtained using the equation;

$$\frac{U}{V} = (w \tau_o)^{1-\alpha}$$

and

$$\tau = \frac{2\epsilon' + \epsilon'_{\infty} \tau_o}{3\epsilon'_o}$$

ω = 2πf is the angular frequency and τ_o the molecular relaxation time, which can be obtained using equation; Where ε'₀ and ε'∞ are static and optical dielectric constant, respectively.

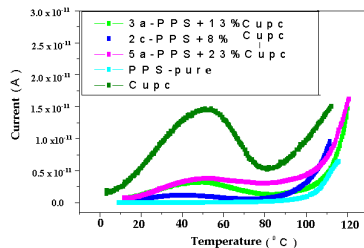


Figure 1 – TSDC curve for pure PPS and composite films with a different content CuPc. E_p = 6MV/m, T_p = 120°C

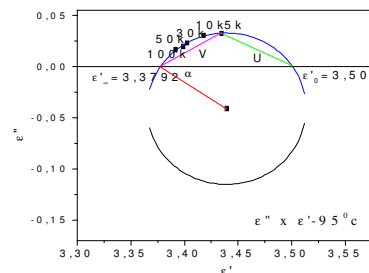


Figure 2 - Relationship between ε' and ε''

[1] Poole-Frenkel effect in amorphous poly(p-phenylene sulfide) *J POLYM SCI POL PHYS.* v.34, p. 623-629 , 1996.

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[3] Takada, Masaki, H. Yoshioka, H. Tada, K. Matsushige, Electrical characteristics of phthalocyanine films prepared by electrophoretic deposition, *Jpn. J. Appl. Phys. Pt. 2: Lett. 41 (2002) L73.*