PROCESSING AND CHARACTERIZATION OF NANO COMPOSITES OF POLY (VINILIDENE FLUORIDE) DOPED WITH SILVER NANO-PARTICLES

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In the last decades it has been increasing interest on polymer materials for electronic and other technological applications [1]. One recent area in this field is the inclusion of metallic nanoparticles within dielectric polymers in order to vary and/or tune their optical and dielectric properties [2].

In this work, nano-composites of metallic nanoparticles dispersed in an electroactive polymer matrix have been investigated. The polymer chosen as a matrix is poly (vinilidene fluoride) PVDF, as it shows interesting piezoelectric, pyroelectric and ferroelectric properties [1, 3]. The metallic nanoparticles are silver (Ag) nanospheres stabilized with polyvinylpirrolidone (PVP) [4]. The main objective of this work is the processing of nano-composites of PVDF@Ag with different mass percentages of silver nanoparticles (%Ag) with the polymer both in the non-electroactive α and the electroactive β crystalline phases, respectively. The mass-percentages of nanoparticles were 0,005%, 0,007%, 0,012% and 0,020%. The silver nanoparticles, embedded in DMF show spherical geometry with a diameter of 26 nm. The effect of the silver nano-particles in the macroscopic response on the material was also studied.

The processing conditions have been optimized in order to obtain a better dispersion of nano-particles within the polymer matrix. We used the method of crystallization from solution followed by fusion in order to obtain α-PVDF@Ag. The β-PVDF@Ag samples were obtained by uniaxial stretching of originally α-phase samples [5].

In this study we will focus on the discussion of the processing method of PVDF@Ag and on the influence of the silver nano-particles in the microstructure, the α to β phase transformation, the degree of crystallinity and the resulting influence in the macroscopic optical and dielectric response.

In particular it has been concluded that samples of α–PVDF@Ag grow directly from the melt with a similar spherulitic microstructure than the pure polymer samples (Figure 1).

By mechanical stretching, the α → β phase transition is gradually induced, as it is in pure PVDF. For the nano-composites, the maximum amount of β-phase obtained by stretching ranges from 60 to 71%. These values are lower than the ones obtained for pure PVDF (80%)

Samples of α-PVDF@Ag with 0012% and 0020% show an absorption band in the UV-Visible spectra around 400 nm, related to the surface plasmon resonance –SPR- (Figure 2). The SPR band weakens during the α → β phase transformation due to a decrease of the effective concentration of nano particles with mechanic drawing.

The melting temperature (T_f) and the degree of crystallinity of the PVDF@Ag samples are larger than for pure PVDF, which indicates increased stability of the lamellar structure and that the nano particles might act as nucleating agents for crystallisation.

With increasing mass percentage of Ag nano-particles, the value of the dielectric constant increases, due to the additional polarizability induced by the presence of nano-particles (Figure 3). The dielectric values are larger for the β-PVDF material due to the polar structure of these samples.

References:

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Figures:

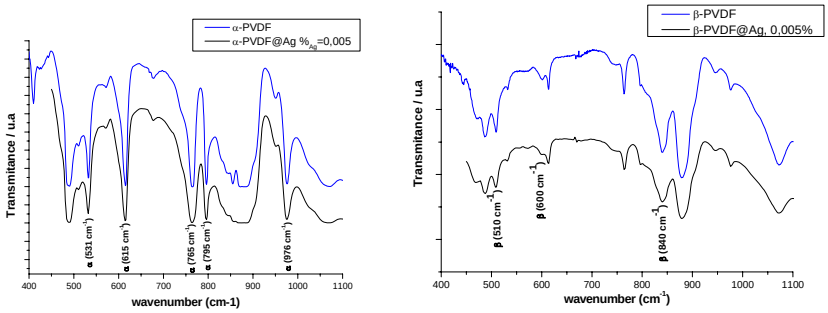

Figure 1: Far infrared spectra of α and β-PVDF and the corresponding nano composites

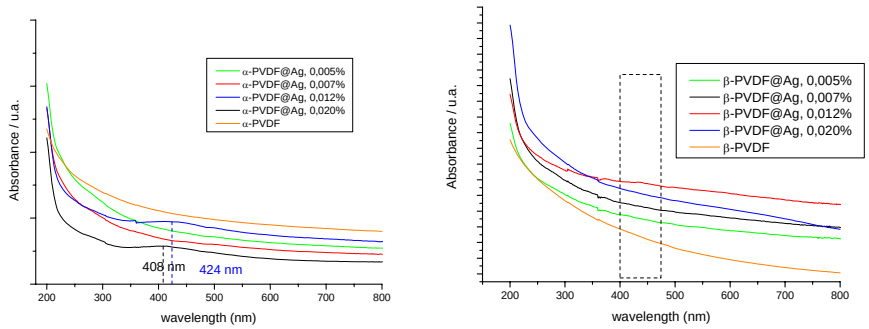

Figure 2: UV-Vis espectra of α and β-PVDF Ag nano composites for several Ag concentrations

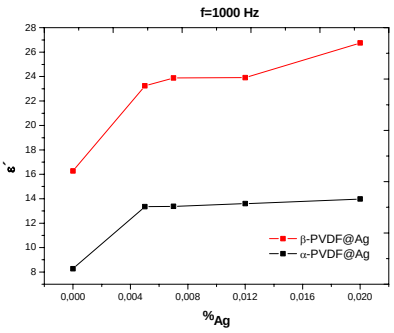

Figure 1: Dielectric constant as a function of Ag concentration for α and β-PVDF Ag nano composites