

Dielectric Response and Relaxation Dynamics of GE/P(VDF-TrFE) Nanocomposites: Influence of Graphene Loading and Temperature

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Abstract: Graphene/poly (vinylidene fluoride-trifluoroethylene) [GE/P(VDF-TrFE)] nanocomposites were prepared by mechanical melt mixing, and their dielectric and electrical properties were investigated as functions of graphene content and temperature. The dielectric response of the materials was examined using impedance spectroscopy over a wide frequency range (10^2 – 10^7 Hz) and over the temperature range 260–380 K. The results show that the dielectric constant increases significantly with graphene loading, reaching its highest value in the composite containing 10 wt.% graphene. At low frequencies (< 1 MHz), the dielectric spectra deviate clearly from ideal Debye behavior, indicating a broad distribution of relaxation times [1,2]. Two relaxation mechanisms were detected in both the P(VDF-TrFE) copolymer matrix and the corresponding nanocomposites. The β -relaxation, observed mainly below the glass transition temperature ($T < T_g$), is associated with the micro-Brownian motion of polymer chains in the amorphous phase. Conversely, the α c-relaxation appearing above T_g is attributed to molecular motions occurring within the crystalline regions of the copolymer. The dielectric relaxation processes were further interpreted using the Havriliak–Negami model [3]. In addition, morphological observations obtained by scanning electron microscopy and thermal analysis performed by differential scanning calorimetry provide complementary evidence supporting the dielectric behavior of the investigated nanocomposites.

Keywords: P(VDF-TrFE), graphene (GE), Dielectric properties, Relaxation dynamics, Havriliak-Negami

References

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