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Influences of Thermal Treatments on Dielectric Behaviors of Carbon Nanotubes-$BaTiO_3$ Hybrids Reinforced Polyvinylidene Fluoride Composites

Authors : Benhui Fan, Fahmi Bedoui, Jinbo Bai

Abstract : Incorporated carbon nanotube-$BaTiO_3$ hybrids (H-CNT-BT) with core-shell structure, a better dispersion of CNTs can be achieved in a semi-crystalline polymeric matrix, polyvinylidene fluoride (PVDF). Carried by BT particles, CNTs are easy to mutually connect which helps to obtain an extremely low percolation threshold (fc). After thermal treatments, the dielectric constants (ε') of samples further increase which depends on the conditions of thermal treatments such as annealing temperatures, annealing durations and cooling ways. Thus, in order to study more comprehensively about the influence of thermal treatments on composite's dielectric behaviors, in situ synchrotron X-ray is used to detect re-crystalline behavior of PVDF. Results of wide-angle X-ray diffraction (WAXD) and small-angle X-ray scattering (SAXS) show that after the thermal treatment, the content of β polymorph (the polymorph with the highest ε' among all the polymorphs of PVDF's crystalline structure) has increased nearly double times at the interfacial region of CNT-PVDF, and the thickness of amorphous layers (La) in PVDF's long periods (Lp) has shrunk around 10 Å. The evolution of CNT's network possibly occurs in the procedure of La shrinkage, where the strong interfacial polarization may be aroused and increases ε' at low frequency. Moreover, an increase in the thickness of crystalline lamella may also arouse more orientational polarization and improve ε' at high frequency.

Keywords : dielectric properties, thermal treatments, carbon nanotubes, crystalline structure
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