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Investigation of Thermal and Dielectric properties of HDPE+ZrO2 Polymer Nanocomposites

Polymer nanocomposites are widely used in various fields of technology due to the combination of the properties of the polymer and the filler, which allows obtaining materials with adjustable characteristics depending on the ratio of components, particle size of the filler and the synthesis conditions. These properties of the nanocomposites offer the possibility to use advantages of the polymer matrix (flexibility, resistance to mechanical stress et.c) and the change in the electrical properties over a wide range of functional fillers to create a flexible technology and reduce the cost of electronic products. Variation of matrix and filler composition, their ratio and dispersion degree and other characteristics of the filler allows obtaining materials with the required properties. High-density polyethylene matrix containing ZrO2 nanoparticles were prepared. Average sizes of the ZrO2 nanoparticles were about 20-30 nm. Thermal and dielectric properties of high-density polyethylene and its nanocomposites were investigated by differential scanning calorimetry (DSC), thermal gravimetric analysis (TGA) and electrochemical impedance spectroscopy.

Summary

The crystalline structure of high-density polyethylene and HDPE+%ZrO2 nanocomposites were studied by X-ray diffraction, which confirmed orthorhombic crystalline and monoclinic structure. The results of thermal and dielectric analysis indicated that the addition of ZrO2 nanoparticles to high-density polyethylene matrix leads to increasing degree of crystallinity and improvement of dielectric permittivity. Thermal gravimetric analysis results showed that thermal stability in polymer nanocomposites is more than that in the pure polymer. It was found that the polymer nanocomposites exhibit very different dielectric characteristics in comparison to the pure polymer. The dielectric permittivity (ε) and dissipation factor (tanδ) was studied in the frequency range from 100 Hz to 3 MHz at room temperature. The obtained results indicated that enhancements occurred in ε and tanδ by the addition of ZrO2 nanofiller.

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