

RESEARCH OF THERMAL ANALYSIS OF POLYETHYLENE COMPOSITES BASED ON CARBON NANOTUBES

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Abstract. In this article, composite materials based on carbon nanotubes were obtained. DTA and TGA analyzes of differential thermal analysis of composite materials obtained on the basis of this polyethylene were studied. According to the obtained results, when 0.01% of carbon nanotubes are added to 1561 polyethylene, the PE liquid temperature increases from 105 to 131°C. It was also observed that the temperature increased to 136.17 °C when carbon nanotubes modified with triethylamine were added.

Keywords: carbon nanotubes, triethylamine, DTA and TGA, polyethylene.

1.Introduction.

Owing to the unique physico-mechanical properties, multi-walled carbon nanotubes (MWCNTs) are of interest to researchers around the world and are one of the main materials of developing nanotechnologies[1,2]. High-density polyethylene (HDPE) composite films filled with carbon fibers (CF), carbon nanotubes (CNT) as well as hybrid filler of CF and CNT were prepared by melt mixing. Results showed that: when the total content of filler was the same, (i) the electrical resistivity of composite films filled with hybrid fillers was lower than those with single filler; (ii) the composite films filled with hybrid fillers displayed more excellent self-heating performance such as a higher surface temperature (T_s), a more rapid temperature response, and a better thermal stability[3].

Figure-1. Application of Carbon Nanotube-Based Materials as Interlayers[4].

The dependence of strength, deformation, and electrophysical properties and structure of polyethylene-based polymer composites on the type and quantity of the filler are shown[4].

Over years, thermal degradation kinetic studies of thermoplastic polymers are a topic of immense interest because the commercial and scientific importance of these materials plays a vital role in various industrial applications[5]. In general, the thermal decomposition of polymers consists of some alteration in the physical properties and chemical structure because of external physical and/or chemical stresses. However, an essential resource of these types of stresses is due to bond scissions in the backbone of the macromolecules [6]. Thermal degradation studies of polymers are extensively measured using thermogravimetric (TG) and derivative thermogravimetric (DTG) analyses. For performing overall kinetic analysis, experimental data, viz., change in mass of a specimen with temperature/time, may be recorded under different experimental conditions. In this context, various isothermal (constant temperature) and/or non-isothermal (constant heating rate) methods have been reported [7]. The theoretical analysis of the experimental data depends on the reliable estimation of the kinetic parameters [viz., apparent activation energy (E_a), pre-exponential factor (A), reaction order (n), and reaction rate constant (k)] and essentially provides a mathematical explanation required to extrapolate the degradation reaction behavior to conditions dissimilar from the experimental ones [8]. However, the extraction of the maximum relevant information from isothermal/non-isothermal data obtained by TG analysis techniques and the modeling of the kinetic process are crucial tasks in TG data treatment[9].

2. Experimental part

Carbon nanotubes were obtained using a catalyst based on the pyrolysis of acetylene. A method of producing carbon nanotubes by converting carbon nanotubes and carbon material with high hydrogen content under the combined effect of acetylene to a metal catalyst gas was considered. This technology can be used to solve the resource efficiency problem related to environmentally sound management based on deep processing of natural and associated petroleum gases into carbon material (carbon nanotubes) and hydrogen.

3. Results and Discussion

3.1. Differential thermal analysis of carbon nanotubes and polyethylene composite material. Modification of PE with UNT has a significant effect not only on the physical-mechanical properties of the composites, but also on the whole set of properties related to thermal physics. According to the thermomechanical method, when 0.1 wt.% UNT is added, the melting point of base PE increases from 105 to 131°C (Fig. 3.8).

According to differential thermal analysis data (Figure 3.8), modification of base PE with 0.01wt% UNT at a melting temperature of 124°C leads to an increase in melting temperature to 131°C, and the addition of a modifier (triethylamine) increases the melting temperature to 132°C.

Figure 2. Differential thermal analysis of I-1561 polyethylene modified with 0.1% UNT

Polyethylene 1561 brand and UNT additive. As can be seen from Figure 3.8, the endoeffect occurring in the first 137.70S in DTT does not go away with mass reduction. This indicates that the sample is liquefied. The subsequent endoeffect mass loss occurring at 474.65 °C indicates the destruction process of the sample. The total mass loss is 99.905%.

Figure 3. Differential thermal analysis of I-1561 polyethylene modified with 0.5% UNT

As can be seen from Fig. 3, the endoeffect occurring at the first 136 0C in DTT does not go with mass reduction. This indicates that the sample is liquefied. The subsequent endoeffect mass loss occurring at 469.04 0C indicates the destruction process of the sample. The total mass loss is 100%.

As can be seen from Fig. 3, the endoeffect occurring in DTT at the first 135.22 0C does not go away with the decrease in mass. This indicates that the sample is liquefied. The subsequent endoeffect mass loss occurring at 471.55 0C indicates the destruction process of the sample. The total mass loss is 97.841%.

Fig. 4. Differential thermal analysis of I-1561 brand polyethylene modified with UNT in the amount of 0.1%

As can be seen from Fig. 4, the endoeffect occurring at the first 136.17 0C in DTT does not go with mass reduction. This indicates that the sample is liquefied. The subsequent endoeffect mass loss occurring at 469.55 0C indicates the destruction process of the sample. The total mass loss is 99.322%. Incorporation of 0.1 wt.% UNT into PE does not affect the heat of fusion. In addition, 0.1 mas. The addition of % results in an increase in the heat of fusion. The increase in the heat of fusion when adding additives gives an indication of the structure of the system.

The low effect of PE UNT filling on the heat of fusion may be due to the thermodynamic flexibility of the polyethylene chains and the low interaction energy between the matrix and modifier phases. The addition of only 0.1 wt.% UNT leads to an increase in the heat of fusion, which can be explained by an increase in the adhesion between the matrix and the modifier. Thus, the composite is modified with malenized UNT, resulting in increased adhesion of the polymer matrix to the modifier, causing the system to contract. Addition of 0.1 wt.% UNT and triethylamine to PE results in an increase in Vic's heat resistance from 137 to 138°C.

At the same time, fire resistance of this composite is increased compared to the base PE, at the same time, strong coke formation was observed on the surface of the composite samples, which inhibits the propagation of fire. Addition of 0.1 wt.% UNT and triethylamine to PE allows to increase the corrosion resistance. According to the previously described method, the loss of mass of the samples in abrasive bending stability tests is reduced from 1% for the base PE to 5% for the UNT (1wt.%) and triethylamine PE composite.

4. Conclusion

In general, obtaining composite materials based on PE by adding 0.1 wt.% UNT and simultaneous modification of triethylamine allows to improve the set of physico-mechanical

properties, increase the melting temperature, heat and fire resistance, which is practical for the production of packaging materials with improved operational properties. increases interest.

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