EVALUATION OF INFLUENCE OF THE ADDITION NANOFILLERS ON THE MECHANICAL AND THERMAL PROPERTIES TERPOLYMERS ESTER-ETHER-AMIDE

OCENA WPŁYWU DODATKU NANONAPEŁNIACZY NA WŁAŚCIWOŚCI MECHANICZNE I TERMICZNE TERPOLIMERÓW ESTROWO-ETEROWO-AMIDOWYCH

The results of studies of mechanical and thermal properties of synthesized elastomeric nanocomposites have been presented. An elastomeric multiblock terpoly(ester-b-ether-b-amide) as polymeric matrix and nanoparticles SiO$_2$ and TiO$_2$ used as fillers. It was shown that the introduction of multiblock thermoplastic elastomer matrix of SiO$_2$ and TiO$_2$ nanoparticles allows to obtain nanocomposite materials with improved mechanical properties compared to the terpolymer before modification. An increase in glass transition temperature, which has a positive effect for the processing of terpolymers.

Keywords: thermoplastic elastomers, nanocomposites, mechanical properties

1. Introduction

Polymer nanocomposites are used in a variety of industries as products for the electronics, construction as well as for medicine. There are known nanocomposites with thermoplastic matrices, duroplastic or elastomer. The use of different nanofillers allows modeling properties of materials in the direction of obtaining the best possible interaction with the matrix, and which translates into the properties of the final product [1].

The aim of this study was to obtain and examine the properties of polymer nanocomposites, where matrix was multiblock thermoplastic elastomer – terpoly(ester-b-ether-b-amide)s – (BS-b-PTMO-b-PA12)$_n$ – consisting of a oligoester hard segment BS and oligoamide hard segment PA12. Soft segment was oligo(oxytetramethylene) PTMO. Nanometric SiO$_2$ and TiO$_2$ as a reinforcing phase were used.

2. Materials and methods

Multiblock terpolymers, terpoly(ester-b-ether-b-amide) – (BS-b-PTMO-b-PA12)$_n$ – with of oligoamide – oligo(auracetam) (PA12) – hard block and oligoether – oligo(oxytetramethylene) dio! (PTMO) – soft block and oligo(butylene se-
The basic physical and chemical properties of the terpolymer -(BS-b-PTMO-b-PA12)_n before and after the modification of SiO₂ and TiO₂ are shown in Table 1. Terpolymers after modification of nanofillers are characterized by an increase in both hardness and limiting viscosity numbers.

For the identification of temperature phase transition of terpolymer and nanocomposites obtained with SiO₂ and TiO₂ tests were carried out by the DSC method. Figure 1 shows the results of the second heating of the polymers.

The terpolymer and the resulting nanocomposites are characterized by low-temperature glass transition (T_g) attributed to soft segments phase derived from PTMO. The glass transition temperature range after modification of nanofillers moves to higher temperatures suggesting the placement of nanoparticles in the amorphous phase of the soft segment. In case of application of nanometric TiO₂ increase of the glass transition temperature is higher than when SiO₂ for modification of material were used. For terpolymers containing nanoparticles there were no significant changes in the crystalline phase derived from both the segments soft PTMO and hard PA12.

On Figure 2 are presented stress-strain curves, while Table 1 shows the results of measurements of the mechanical properties for the -(BS-b-PTMO-b-PA12)_n-terpolymers before and after modification of SiO₂ i TiO₂.

These results indicate that the addition of nanofiller positively influences to improve the mechanical properties, acting at the same time reinforcement for multiblock terpolymer matrix.
Spectra of storage modulus $E'$ of terpolymers -(BS-b-PTMO-b-PA12)$_n$ (Fig. 3) characterize different temperature ranges where values of $E'$ change with the change after modification of SiO$_2$ and TiO$_2$.

In the temperature range from -100°C to -50°C functions $E' = f(T)$ have a flat course, the modulus does not change and -(BS-b-PTMO-b-PA12)$_n$ is in the glassy state.

In the interval from -50°C to -25°C modulus occurs decrease and in the macromolecules there is viscoelastic relaxation processes connected with the glass transition of amorphous phase of the PTMO soft block. This interval moves towards higher temperatures after modification SiO$_2$ and TiO$_2$. The third temperature range is a ‘flexibility plateau’, the modulus in this interval is constant. The fourth region observed in the temperature range 0°C to 25°C is characterized by a further slight decrease of the modulus associated with the melting of the crystalline phase transformation of the PTMO soft block.

For the terpolymer after modification TiO$_2$ melting transition of the PTMO is observed in higher temperatures compared to the SiO$_2$, which was confirmed in the DSC studies.

In the temperature range of 80°C to 130°C terpolymers achieve the predominance of viscous on elastic properties, and their storage modulus is rapidly declining.

Inflection on the curves related to this decrease determine temperature of polymer softening, and therefore also the upper temperature range of applicability decreasing after modification of nanofillers. On the curves $E'' = f(T)$ and $\tan \delta = f(T)$ -(BS-b-PTMO-b-PA12)$_n$- there is a maximum of $\alpha$ relaxation associated with glass transition temperature of PTMO overlapping with the results of DSC.

4. Conclusion

The addition of a thermoplastic elastomer multiblock structure of SiO$_2$ and TiO$_2$ nanoparticles, allowing to obtain a nanocomposite material with improved mechanical properties in comparison with the initial terpolymer. Even a small amount of nanoparticles (0.2%). Increases the glass transition temperature, resulting in to improve the physicochemical properties of -(BS-b-PTMO-b-PA12)$_n$ terpolymers.

Acknowledgements

The financial support from the Ministry of Science and Higher Education, contract No N N209 216538 (2010–2013) is gratefully acknowledged.

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