THERMOMECHANICAL AND THERMOPHYSICAL PROPERTIES OF POLYAMIDE-6 BASED NANOCOMPOSITES

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Abstract - Research of the influence of (MPB) montmorillonite-polyvinylpyrrolidone blend content and production conditions on the thermomechanical properties of polyamide-6-containing nanocomposites. Thermomechanical analysis showed that the nature of the curves depends on polyamide mixture composition and modified filler concentration. It was determined that the modification of polyamide 6 can effect the structure and properties of nanocomposites as well as regulate their technological and working properties.

Key words: polyamide 6, montmorillonite-polyvinylpyrrolidone blend, Vicat softening point, thermomechanical properties, modification.

Introduction

Research and study of polymer composites in recent years has focused its interest towards nanosized fillers. A special place takes layered silicates, a bright representative of which is montmorillonite improving physical and mechanical properties of nanocomposites as well as characterized by low cost. As the modifier for polyamide the montmorillonite (MMT) - polyvinylpyrrolidone (PVP) blend obtained in ultrasound field [1] with the component correlation MMT: PVP – 1:5 was applied. Into the derived polyamide complex the MPB in amount of 5, 10, and 20 % of the mass relative to the mass of PA-6 was added. The sedimentation of the resulting blends was carried out using a mixture of solvents, in particular acetone and benzene with optimal correlation 1:1 vol. unit. [2].

The research of montmorillonite-polyvinylpyrrolidone blend content and derivation conditions impact on thermomechanical properties of PA-6 nanocomposites were conducted by the authors [3].

Research results and discussion

Morphological changes in polymer blends are closely related to the flexibility of macromolecules and the nature of polymer matrix. Mentioned ones can be studied applying the method of thermomechanical analysis. It allows us to determine the effect of modified montmorillonite on the manufacturability of polyamide-6 based nanocomposites obtained from the solution.

The nature of thermomechanical curves significantly depends on the component composition of polymer based on PA-6, primarily on the content of the modified filler. It was found that with increasing filler content, the deformation of the samples becomes extreme in the temperature range of 303-343 K. Above-mentioned being explained by the similarity of supramolecular structures in the systems as well as the presence of microheterogeneity and the transition layer at the interface of PA-6 - MPB. During the heating of polymer blends over 343 K a mesophase probably being formed. The last one contains hexagonal cylindrical packing in some areas [4].

For modified PA-6 based polymer compositions the transition layer, obviously formed as the result of change of the free system volume. At the same time the macromolecules transition of one polymer into another one’s layer causes a forming of fluctuation grid which significantly affects the properties of the polymer mixture and depends on the flexibility of the

macromolecules of these polymers. Thus, by the modification of polyamides in the viscous state with MPB macromolecules possible to influence the structure of supramolecular formations in PA-MPB blends as well as regulate their technological and working properties.

Adding of modified montmorillonite into the polymer composition had a significant effect on the Wick's heat resistance, as far as the temperature difference reached more than 293 K. The nanocomposite containing modified MMT content of 10% by mass has the highest heat resistance. A further increase in the content did not significantly affect the thermophysical parameters of polymer compositions based on PA-6. Obviously, this is related to the compaction of the composite structure.

It known that the conditions of obtaining can affect the properties. The samples obtained by the method of precipitation from the solution also showed high values of Vick softening point in comparison with the initial polyamide. Mechanically mixed composites possess the highest characteristics and it can be explained via the ordering of the supramolecular structure of polymer composite [5].

The obtained results can be applied to create “new” polyamide materials of improved thermophysical features and a complex of valuable specific properties.

Conclusions

It was found that increasing the concentration of modified filler in PA-6 composites leads to significant change of the deformation of the samples within the temperature range of 303 - 343 K. Has been studied that the nature of thermomechanical curves is determined both by the method of obtaining nanocomposites based on PA-6 and the temperature at which it occurs.

It was determined that the thermophysical parameters of nanocomposites are significantly influenced by the derivation conditions. PA-6 composites obtained by the mechanical mixing are characterized by significantly higher values.

It was found that by the modification of MPB with polyamide can affect the structure and properties of nanocomposites based on polyamide 6, regulate their technological and working (thermomechanical) properties, as well as temperature intervals of physical transitions, mostly determined by the nature of polyamide 6 and the montmorillonite-pyrrolidone blend.

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