УДК 678.01

O. M. Kasperovich, PhD (Engineering), assistant professor (BSTU);
V. V. Yatsenko, PhD (Chemistry), assistant professor (BSTU);
A. V. Prudnikov, master's degree student (BSTU);
N. A. Skrabnevskiy, student (BSTU)

THE STUDY OF PHYSICAL-MECHANICAL PROPERTIES OF SECONDARY DROP-IN SYSTEMS

Currently, the problem of waste plastics recycling gains relevance not only from the standpoint of environmental protection, but also due to the fact that the shortage of raw polymer plastic waste becomes a powerful raw materials and energy. Among the large place occupied by waste drop-in polymer systems comprising two or more polymers. To improve the quality characteristics of such mixtures and products from them, they added compatibilizers. This process allows for compatibility of the components, thereby reliably ensured riding components miscibility and high thermo-mechanical properties of the material.

Introduction. Nowadays polymer materials are widely spread and are used practically in all branches of industry. However, the variety of «net» manufactured polymers in large scale is limited, thus today there are a lot of attempts to make new composites and mixture systems on the base of such polymers, including two and more polymers. One of the ways to achieve materials with new range of characteristics is use of mixture of incompatible polymers. In such materials rightly planned heterogeneity improves technical characteristics of polymeric matrix and adds the features, characteristic of composites. Use of materials on the ground of incompatible polymers increases. It is connected with the fact that combination of incompatible polymers provides mutual modification of properties of primary components of mixture and allows receiving polymers with subaggregates between mixture components or with absolutely new range of characteristics.

Material compatibility in such systems is achieved by several ways: by selection of polymer pairs or polymer modifications which are made to create strong molecular interaction between heterogenetic polymer chains; by chemical interactions between the components of the mixture, which lead to receiving interpolymer; by introduction of special substances (compatibilizers) – low-molecular or high-molecular compounds, enforcing inherent molecular interaction to the system, which allows approaching the problem of improving qualitative characteristics of non-miscible components of the mixture. It should be highlighted that thermodynamically compatible polymers are an exception to the rules as high-molecular compounds can rarely contribute to receiving "ideal" solutions. Thus achievement of thermodynamical compatibility in polymer compounds should not be the main aim. It is important that the compound components have technological compatibility even in the conditions of heterogeny of the structure, in which fair miscibility in the manufacturing process could be achieved.

Using the compatibilizers we can emphasize receiving technologically compatible polymers, in result of which available miscibility of components and high stress-strain properties can be safely achieved. Selection of highly effective modifiers and compartibilizers for incompatible polymer compounds is one of the main and priority research orientations to improve technology of receiving qualitative composites on their base.

Polymer reworking is very important as post-consumer plastic recycling is an urgent problem. Use of recyclable materials as new resource base is one of the most dynamically developing directions of polymer material utilization. At present the problem of polymer material waste processing becomes urgent not only regarding environmental protection, but is also connected with the fact that in the conditions of polymer materials deficiency plastic wastes become powerful raw material and energetic resource.

The problem of their utilization and reworking of secondary compound polymer-polymeric systems is complicated also by thermophysical, strength and other properties of intermixtures, in connection with which there are certain difficulties connected with their reworking, including different processing conditions for each intermixture. This problem can be solved with the help of compatibilizers which improve compatibility of material components.

Main part. The aim of the work is improvement of components compatibility of secondary polymer-polymer composition by its modification by introduction of compatibilizer and receiving composition available for recycling by casting under pressure.

The subject of the research was composition containing secondary branched polyethylene (PE) and secondary polyamide (PA), received by barrier films recycling.

As additives secondary polyethylene with high load melt index and also compatibilizer – polyethylene functionalized by maleic anhydride (MAH) inoculating were used.

The compounds were prepared at laboratory compound line on the base of double-screw extruder (screws diameters 35 mm, L / D = 40) at 240°C. Experimental dumb-bell specimen according to GOST 11262-80 were received by casting method under pressure at automatic molding machine Kuasy.

The received specimen were tested for stretching according to GOST 11262-80 at fracture testing machine Instron 5657 at pulling jaw traverse speed 500 mm/min.

Melt flow index (MFI) was determined according to GOST 11645–73 at plasticorder Ray-Ran test equipment ltd, orifice diameter 2,095 mm, testing temperature 230°C, load 21.6 N. On the basis of practical interest of reworking of this composition the MFI was measured at 230°C, as we think, that at this temperature the best fusion by qualitative fusion penetration and mixture of all components of composition. At lower temperature PA will melt incompletely.

Charpy impact resilience was determined by GOST 4647–80 (by samples with sharp notch). Charpy machine CWC-1.5 was used.

The test results are shown at the Figures 1–5.

The original samples had different PA content, with that it is obvious that with increase of PA content in the compound the tensile strength values and tensile stress at yield increase. As the samples are received at temperatures higher than PA melting points, it distributes evenly in the polymer volume and submolecular structure contributing to increase of those characteristics is formed. Besides, in connection with the use of secondary polyethylene, presence of oxigen-containing groups is possible, which controls their ability of structural and chemical interaction with PA.

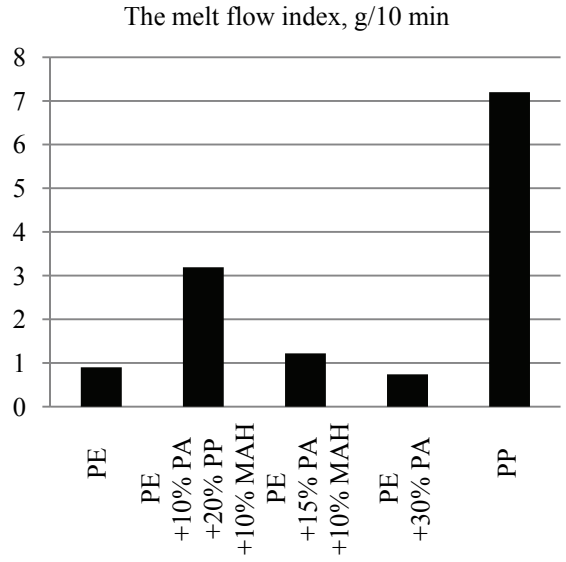

Fig. 1. Indicators of melt flow polymer compositions

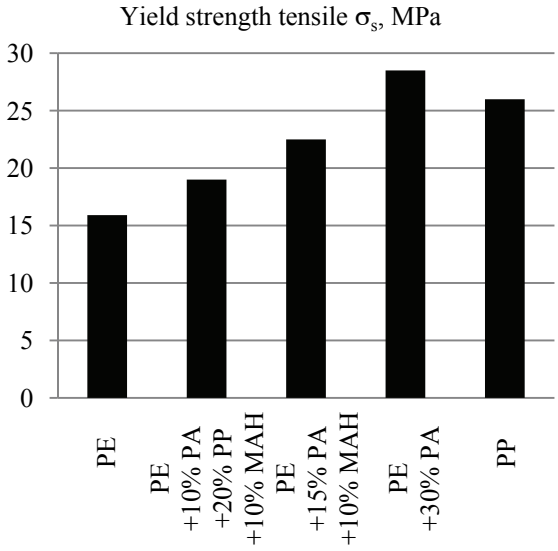

Fig. 2. Yield strength tensile for test samples

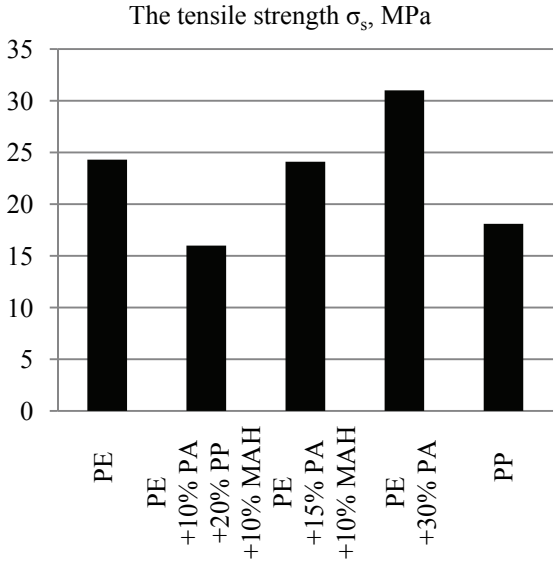

Fig. 3. The tensile strength test of samples

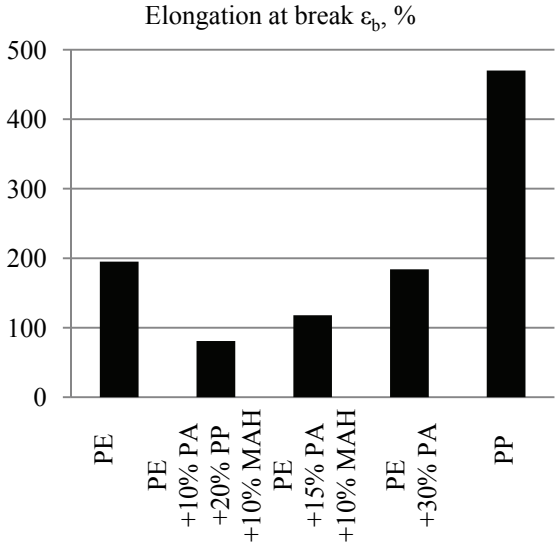

Fig. 4. Elongation at break test of specimens

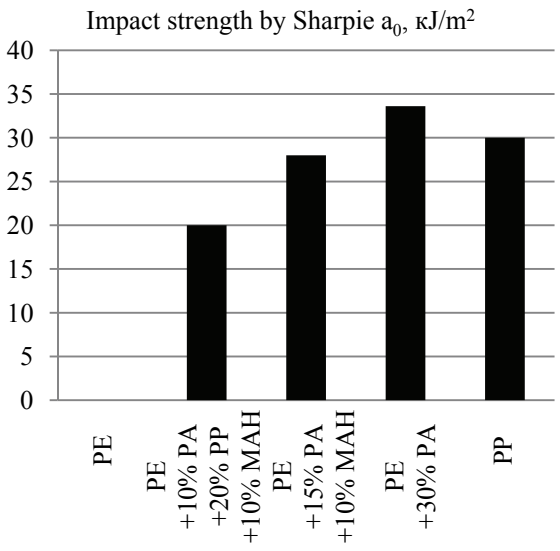

Fig. 5. Impact strength of test specimens according by Sharpie

However, at that MFI of the fusion considerably decreases as segmental mobility of polymer chains can change and system consistency increases. To increase MFI PP with low consistency was introduced, MFI 7.2 g/10 min.

To improve compatibility of components compatibilizer on the base of PP with inoculated maleic anhydride was used. It is arguable that in those compositions the compatibilizer, besides its main function showed characteristic features, in the result satisfactory polymer blending and property change was achieved. That lead to strength loss at fissuring and increase of MFI. Probably the addition of maleated polyethylene serves as antivibration inlay stacked between the layer of polymers and in such way improves segmental mobility in this system.

Conclusion. Based on the outcome of tests we can make a conclusion that addition of MAH in amount of 10% increases MFI of composition and keeps high enough strength characteristics. It allows using such composition for thin-walled articles cast work with quite good strength characteristics.

References

1. Анализ состояния вторичной переработки [Электронный ресурс] / Совместимость смесей. 2012. URL:http://www.waste.ru/uploads/library/klinkov.pdf. (дата обращения: 25.03.2013).

2. Макаров В. Г., Коптенармусов В. Б. Промышленные термопласты: справочник. М.: Химия, 2003. С.120–133.

Received 22.02.2014