

THE INFLUENCE OF THE THERMOPROCESSING ON DEFORMATION PROPERTIES AND PHYSICAL STRUCTURES OF POLYMER COMPOSITIONS

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The influence of the preliminary thermoprocessing on deformation properties and the physical structure of polypropylene and polyethylene of the low density (PELD) compositions with different submolecular structures has been studied. It has been shown, that the value of the relative deformation ε % on the stretching reduces depending on the duration and the temperature of the preliminary thermoprocessing. It is explained by the change of the physical structure, i.e. by the growth of the crystallization degree in slow-cooling (SC) and quick-cooling (QC) samples of PP-PELD compositions.

The experimental results of physical-mechanical characteristics research of polymer composite materials may be divided into 3 groups unequal by the amount of data. The first is the large collection of results, obtained for polymer composition at different concentrations of various fillers [1]. This conclusion has found the practical reflection in formulations of worked-out materials, in which the dispersed fillers content does not exceed 30 mass % [2]. Compositions with the high fillers concentration have comparatively recently appeared and their properties are considerably distinguished from initial polymers characteristics. As a rule, they are materials with the high module, but with low breaking characteristics. The second data group is separate examples, demonstrating the opportunity of the high deformational characteristics achievement at the high fillers content. So, high-molecular polyethylene (HMPE) compositions, which are deformed up to 30 % at the fillers content 50-60 mass %, are obtained by the method of polymerized filling [3,4]. Compositions, worked out by Sapcofile firm, represent the polypropylene, filled up to 50 mass %. From series of materials one has the relative stretching at the breakdown up to 50 %, while this value does not exceed 30 % at rests.

Data analysis of physical-mechanical properties shows, that the third group of composition materials, i.e. compositions on the base of polymer-polymer, have the essential distinctions in values of the hardness, creep, elasticity module, deformational heat-resistance indices. It is worth to mention, that these classes of compositional materials are also essentially distinguished by the production volume and the price [5].

Growing demands to polymer materials dictate the necessity of the working-out of compositions with the complex of optimal properties. Special demands to the form and structure retention at high temperatures are presented to them at the use of the polymer compositional material in electron apparatus products. Therefore the research of thermal effect influence on deformational properties and the physical structure of PP-PELD 80:20 mass % compositions is the important problem, since it has been earlier shown by us, that PP-PELD compositions possess by optimal stable and deformational properties [6,7] exactly at such components relation.

The thermoprocessing has been carried out at temperatures 343, 353, 363 and 383 K during 0.5, 1, 1.5 and 2 months. The heat effect on polymer compositions films has been realized by thermostatic processing in the air atmosphere in the thermocabinet, after that the relative deformation ε % on the stretching has been measured, the value of the crystallization degree C of initial components and compositions, exposed to the thermal effect versus the thermoprocessing temperature and duration, has been determined. Samples crystallization degree C has been determined by method [8] with the exactness up to 6 %, as the square relation under the crystal peak (S) to the hole square ($S+S$) under the curve with the exclusion of the background and value of these results are given in tables 1 and 2:

$$K_s \% = \frac{S_K}{S_K + S_A}$$

Table 1.

Values of the crystallization degree of initial components and PP:PELD=80:20 mass % compositions are preliminary exposed to the thermal effect at different processing temperatures T :

Regime of samples receipt	PP Initial	PELD initial	PP:PELD = 80:20 Initial	PP:PELD = 80:20. $t=2$ months at different T . K			
				343	353	363	383
Slow cooling	70	60	65	70	74	82	87
Quick cooling	48	40	38	41	44	49	55

It is seen from tables 1 and 2, that the crystallization degree of SC and QC compositions increases with the growth of T (at the constant t) and t (at the constant T).

Curves of relative deformation dependences ε % on the stretching on the temperature T of the deformation measurement for initial and preliminary exposed to the

thermal effect of slow-cooling (SC) samples of PP:PELD=80:20 mass % composition at different processing temperatures T during 2 months and during different thermoprocessing T durations at the temperature 383 K, respectively, at the other equal conditions ($\sigma=10$ Mpa, $t=6$ sec., at the constant temperature) are presented on fig. 1 and 2.

Table 2.

Values of the crystallization degree of initial components and PP:PELD=80:20 mass % compositions are preliminary exposed to the thermoprocessing at different thermal treatment durations t

Regime of samples receipt	PP initial	PELD initial	PP:PELD=80:20 initial	PP:PELD=80:20. at $T = 383$ K. in different t , a month			
				0.5	1	1.5	2
Slow cooling	70	60	65	68	71	79	87
Quick cooling	48	40	38	39	42	46	55

It has been established on the obtained thermomechanical curves base, that, first, the value of ϵ % on the stretching of SC composition samples, in both cases, beginning with the temperature 353 and 363 K increases with the growth of the measurement temperature. Second, at measurement temperatures constants ϵ %, at which the large deformations are observed, the value ϵ % on the stretching reduces with the growth of the preliminary processing temperature T and the thermoprocessing duration t .

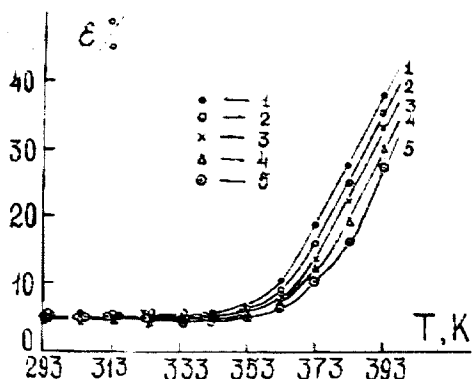


Fig. 1. Thermomechanical curves of slow-cooling PP:PELD=80:20 mass % composition, treated at various temperatures during 2 months: 1 - initial, 2 - $T = 343$ K, 3 - $T = 353$ K, 4 - $T = 363$ K, 5 - $T = 383$ K

Dependences of ϵ % on the stretching on the preliminary processing temperature T for SC samples of the optimal composition, exposed to thermal effects during 2 months are presented on fig.3. This dependence is constructed on the base of thermomechanical diagrams, given on fig.1. It follows from fig.3, that noticeable reductions of ϵ % on the stretching of SC samples of the optimal composition versus T at other equal conditions, are observed higher the glass temperature. It is seen analogously from fig.2, that the value of ϵ % on the stretching versus the thermoprocessing t duration also reduces.

So, it has been shown at the given research stage, that changes of ϵ % on the stretching both depending on the preliminary thermoprocessing temperature, and thermoprocessing duration are uniform. Corresponding data for quick cooling (QC) samples of the optimal PP:PELD=80:20 mass % composition are similar.

Obtained results (for SC composition samples, fig. 3) allow to assume, that the maximal reduction of ϵ % on the stretching of SC and QC samples of the optimal composition versus T at the temperature of the deformation measurement 383K makes ~27% and 40%, respectively. Observed reduction of ϵ % on the stretching of SC and QC samples of PP:PELD=80:20 mass % composition versus T are the result

of the fact, that the crystallization degree grows at the thermal effects in them.

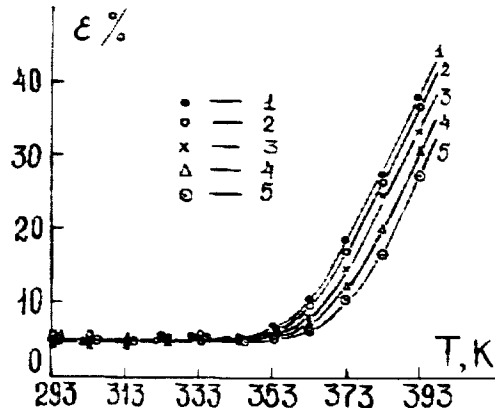


Fig. 2. Thermomechanical curves of slow-cooling PP:PELD=80:20 mass % composition, treated at $T = 383$ K at various thermoprocessing durations: 1- initial, 2 - $t = 0.5$ months, 3 - $t = 1$ month, 4 - $t = 1.5$ months, 5- $t = 2$ months

The research of the deformational properties dependence on thermoprocessing conditions has also shown, that the reduction of ϵ % on the stretching of SC and QC samples of the optimal composition is observed with the growth of the temperature and the thermoprocessing duration. So, at the treatment temperature 383 K and the thermoprocessing duration during 2 months ϵ % on the stretching for SC sample falls from 27% to 7%, and for QC sample- from 40% to 17%.

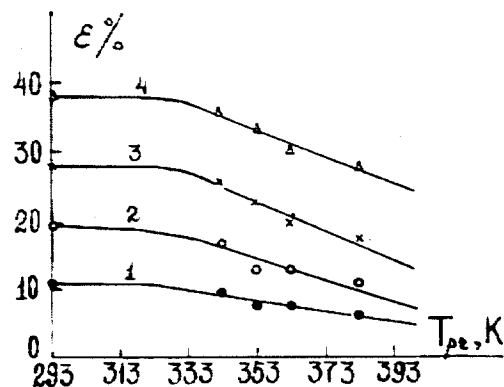


Fig. 3 Relative deformation ϵ % dependence of slow-cooling PP:PELD=80:20 mass % compositions samples, treated during 2 months, on the thermal treatment temperature: 1- $T = 363$ K, 2- $T = 373$ K, 3- $T = 383$ K, 4- $T = 393$ K.

Therefore, obtained experimental results show, that reductions of deformational and thermotechnical properties

occur at the thermal effect on the polymer PP:PELD=80:20 mass % composition and the nature of these changes depends on the temperature and the thermoprocessing duration. It has been shown at the result of structural researches, that the physical structure of the initial SC PP:PELD=80:20 mass % composition is characterized by rather high crystallization degree ($\alpha=65\%$), and QC PP:PELD=80:20 mass % composition- by relatively low crystallization degree ($\alpha=88\%$, table.1 and 2). As it is seen from tables 1 and 2, the crystallization degree grows versus the temperature and samples thermoprocessing duration. For example, the crystallization in SC and QC samples of PP:PELD=80:20

mass % increases up to 87 % and 55 % after the thermal effect at 383 K during 2 months, respectively, and it is gone with the considerable growth of the samples density, with the increase of the crystallization size. Above-molecular regularity grows. And, on that reason the relative deformation value of $\varepsilon\%$ on the stretching reduces at the samples thermoprocessing of PP:PELD=80:20 mass % compositions.

Therefore, it follows from aforesaid, that the stability of polymer compositional materials to the thermoprocessing and the nature of deformational properties changes are explained by the growth of the crystallization degree.

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TERMİK İŞLƏNMƏNİN POLİMER KOMPOZİSİYALARININ DEFORMASIYA XASSƏLƏRİNƏ VƏ FİZİKİ QURULUŞUNA TƏSİRİ

Termik işlənmənin müxtəlif üst molekulyar quruluşa malik polipropilen aşağı sıxlıqlı polietilen kompozisiyalarının deformasiya xassələrinə və fiziki quruluşuna təsiri öyrənilmişdir. Göstərilmişdir ki, $\varepsilon\%$ nisbi dartılma deformasiyasının qiyməti termik işlənmənin müddətindən və temperaturundan asılı olaraq azalır. Bu, fiziki quruluşun dəyişməsi ilə, yəni yavaş soyudulmuş və tez soyudulmuş kompozisiya nümunələrində kristallaşma dərəcəsinin artması ilə izah olunur.

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ВЛИЯНИЕ ТЕРМООБРАБОТКИ НА ДЕФОРМАЦИОННЫЕ СВОЙСТВА И ФИЗИЧЕСКУЮ СТРУКТУРУ ПОЛИМЕРНЫХ КОМПОЗИЦИЙ

Изучено влияние предварительной термообработки на деформационные свойства и физическую структуру композиций полипропилен – полиэтилен низкой плотности (ПП-ПЭНП) с различными надмолекулярными структурами (НМС). Показано, что значение относительной деформации $\varepsilon\%$ на растяжение уменьшается в зависимости от длительности и температуры предварительной термообработки. Это объясняется изменением физической структуры, т.е. увеличением степени кристаллизации в медленно охлажденных (МО) и быстро охлажденных (БО) образцах композиции ПП-ПЭНП.