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## PHYSICAL-MECHANICAL PROPERTIES OF NANOCOMPOSITES BASED ON GRAPHITE AND MODIFIED POLYOLEFINS

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**Abstract:** *The influence of the graphite concentration on the main physical-mechanical properties of nanocomposites based on such polyolefin as high density polyethylene, low density polyethylene and polypropylene is considered. Properties such as tensile yield stress, ultimate tensile stress, and ultimate bending strength, elongation at break, heat resistance, flexural strength, MFI, and melting points are analysed. To improve the compatibility of the mixed components of the mixture, we used an Exxelor PO1040 compatibilizer for all grades of polyethylene and Exxelor PO1020 for polypropylene. Graphite was introduced into the composition of polyolefin at the following concentrations: 1.0, 3.0, 5.0, 10, 15, 20, and 30 wt%. As a result of the research, it was found that the introduction of graphite into the composition of polyolefin was accompanied by an improvement in strength characteristics with maximum at various concentrations. For high density polyethylene, the maximum values of strength characteristics are observed at 3.0 wt%, for low density polyethylene at 10 wt%, and for polypropylene at 5.0 wt% content of graphite. It revealed that such a difference in the value of the threshold concentration of graphite which provides the maximum value of strength indicators, was directly related to the degree of crystallinity of the polymer matrix.*

**Keywords:** *tensile yield stress, ultimate tensile stress, ultimate bending strength, elongation at break, heat resistance, MFI, crystallinity degree*

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### Introduction

To expand application areas of industrial polyolefin, low density polyethylene (LDPE), high density polyethylene (HDPE), polypropylene (PP), various methods are applied to modify their structure and properties using fillers, plasticizers, stabilizers, nucleators, etc. [1-3]. Through changing the concentration of the above modifiers in the composition of polyolefins, one might significantly affect changes in the supra-molecular structure and properties of composite materials. In recent years, the interest of researchers in the development of nanocomposites based on

polyolefins and mineral fillers has significantly increased, following which, with a minimum concentration of the latter, it became possible to obtain materials with predetermined properties [3-6]. However, despite the above, the literature provides very contradictory information on the structure and properties of nanocomposites based on graphite and polyolefins [7].

In this regard, in this work, the main attention is paid to the study of the effect of graphite concentration on the main physico-mechanical characteristics of polyolefin-based nanocomposites.

### Experimental part

HDPE is characterized by the following properties: ultimate tensile stress – 31.3 MPa,

flexural strength – 34.4 MPa, elongation at break – 435%, density – 957 kg/m<sup>3</sup>, Vicat heat

resistance – 139°C, melting point – 145°C, crystallinity – 82%, melt flow index (MFI) – 4.65 g/10min.

LDPE has the following properties: ultimate tensile stress – 13.1 MPa, flexural strength – 16.2 MPa, elongation at break – 720%, Vicat heat resistance – 85°C, melting point – 101°C, crystallinity – 59%, density – 931 kg/m<sup>3</sup>, MFI – 2.9 g/10min at a temperature of 190°C and a load of 5.0 kg.

PP is characterized by the following properties: ultimate tensile stress – 33.0 MPa, flexural strength – 35.0 MPa, elongation at break – 130%, Vicat heat resistance – 160°C, melting point – 169°C, density – 903 kg/m<sup>3</sup>, crystallinity – 65%, MFI – 3.6 g/10min.

Compatibilizer (PEMA) – high density polyethylene functionalized with maleic anhydride (MA) – Exxelor PO1040 for all grades of polyethylene and Exxelor PO1020 for polypropylene. The MA grafting degree in HDPE is 5.6 wt%.

Graphite (Gr) as one of the allotropic modifications of carbon has a layered structure. The layers of the crystal lattice, located relative to each other, form a number of structural modifications, with symmetry from hexagonal

to trigonal. The layers are slightly wavy, almost flat, composed of hexagonal layers of carbon atoms. As an object of research, we used graphite with a particle size of 80-110 nm.

In order to modify the properties of the above polyolefins, up to 5.0 wt% of PEMA was introduced into their composition on hot rollers at a temperature of 170° C, and then graphite nanoparticles were added to the molten polymer mixture in parts. The amount of graphite in the HDPE composition varied within 1.0, 3.0, 5.0, 10, 15, 20, 30 wt%.

The particle size of the graphite was determined on an STA PT1600 Linseis Germany instrument.

Heat resistance was determined according to Vica.

The MFI of polymeric materials was determined on a capillary rheometer of the MELT FLOW TESTER, CEAST MF50 (INSTRON, Italy) at a temperature of 190°C and a load of 5 kg.

The melting point was estimated from the data of the derivatographic analysis of the Paulik-Paulik-Erdey system.

## Results and Discussion

Carrying out complex investigations to study the effect of graphite on the physico-mechanical properties of polyolefins was due to the fact that it has a noticeable effect on the electrical conductivity of polymers, and on the other hand, it opens up great opportunities for significant reduction in the abrasion and the coefficient of friction of composite materials [7-9]. At the same time, the literature contains fragmentary information on the study into physical-mechanical characteristics of graphite-filled polymer composites. Research on the effect of graphite nanoparticles on properties is very limited. Also, it is also known that polyolefins haven't well enough compatibility with mineral fillers and graphite. In this regard, in this work we will try to show a systematic approach to the study of the role of graphite in the formation of the basic physical-mechanical and physical-chemical properties of nanocomposites in compatibilizers [10, 11].

For this purpose, Table 1 shows the results of the study into the effect of graphite concentration on the properties of HDPE modified with compatibilizer. Properties such as tensile yield stress, ultimate tensile stress, elongation at break, heat resistance, ultimate bending strength, melting point, and melt flow index (MFI) were investigated.

As can be seen from the Table, the main attention is focused not only on the study into the concentration dependence of the properties of HDPE on graphite but also the effect of such a compatibilizer as PEMA on the compatibility of the mixed components. Data on the effect of sulphur on the HDPE vulcanization process are presented to be detailed below.

From a comparative analysis of the data presented in Table 1, it can be established that the introduction of 2 wt% PEMA in the composition of the initial HDPE leads to a slight decrease in the strength parameters which is

apparently associated with plasticizing effect of the latter (sample 2). As the concentration of graphite in HDPE increases, there is a slight increase in the tensile yield stress and ultimate tensile stress with a maximum at 3.0 wt% graphite content (sample 4). A further growth in the concentration of graphite leads to a natural decrease in strength indicators and elongation at break of nanocomposites (sample 5-9). When

the concentration of graphite exceeds 10 wt%, a sharp deterioration in the elongation at break is observed, up to brittle fracture at its 20-30 wt% content (sample 8-9).. The very fact that the values of the tensile yield strength and ultimate tensile stress are equal is a confirmation of the brittle fracture of the considered samples of nanocomposites.

**Table 1.** Physical-mechanical properties of nanocomposites based on HDPE, graphite (Gr) and PEMA

№	Composite formulation, %	Tensile yield stress, MPa	Ultimate tensile stress, MPa	Elongation at break, %	Vicat heat resistance °C	Flexural strength, MPa
1	HDPE	32.3	31.3	435	139	34.4
2	HDPE+2PEMA	32.0	32.8	105	139	33.5
3	HDPE+1Gr	32.5	31.6	150	140	34.1
4	HDPE+3Gr	32.9	31.8	85	140	34.4
5	HDPE+5Gr	32.0	31.5	40	141	35.0
6	HDPE+10Gr	29.3	28.8	25	141	35.6
7	HDPE+15Gr	28.2	27.6	15	142	35.8
8	HDPE+20Gr	27.7	27.7	-	142	35.0
9	HDPE+30Gr	25.1	25.1	-	142	34.0
10	HDPE+2PEMA+1Gr	33.3	32.9	160	139	34.5
11	HDPE+2PEMA+3Gr	35.8	34.5	110	140	36.3
12	HDPE+2PEMA+5Gr	34.6	33.6	70	141	38.8
13	HDPE+2PEMA+10Gr	33.9	32.8	50	142	39.6
14	HDPE+2PEMA+15Gr	31.4	31.0	40	142	39.5
15	HDPE+2PEMA+20Gr	29.6	29.2	30	143	38.6
16	HDPE+2PEMA+30Gr	28.0	27.6	20	144	37.0
17	HDPE+2PEMA+5Gr+5S	36.3	35.4	75	143	38.7
18	HDPE+2PEMA+10Gr+5S	34.1	33.8	60	144	39.0

S – sulfur

However, the introduction of PEMA into the composition of graphite-containing HDPE nanocomposites made it possible to look differently at the general picture of changes in the physico-mechanical properties of nanocomposites. Analysing the data presented in Table-1, it can be noted that regardless of the concentration of graphite the introduction of PEMA into the composition of nanocomposites contributes to significant improvement in the complex of their physical-mechanical properties, in particular the tensile yield stress, ultimate tensile stress (sample 10-16), and elongation at break. According to the data obtained, the maximum strength in the

compatibilized nanocomposites falls on a sample with 3.0 wt% graphite content (sample 11). It is characteristic that even at 20-30 wt% filler content, nanocomposites do not undergo brittle fracture (samples 15-16). Another indicator of the strength of nanocomposites is that the ultimate bending strength almost constantly increases with an increase in the concentration of graphite in the HDPE composition. Only with a high content of graphite (over 20 wt%) there is a slight decrease in the value of this indicator.

Following the comparison of data on the heat resistance of nanocomposites, it becomes obvious that the introduction of graphite is

accompanied by rise in their heat resistance in the presence of PEMA from 139 to 144°C. An increase in the value of this indicator by 5.0°C might be due to the existence of an adhesive contact in the polymer-filler system and indicates the physical thermal stability of the spherulite structure of nanocomposites. In this case, the use of PEMA, apparently, makes it possible not only to improve the compatibility of the mixed components of the mixture, but also contributes to the orientation of the macro-chains of the compatibilizer and the polymer matrix on the developed surface of graphite nanoparticles. It is this circumstance that can interpret the appearance of heterogeneous nucleation centers.

The melting point of nanocomposites was investigated by derivative-graphic analysis. According to the data obtained, the melting point is practically independent of the graphite concentration and is equal to the melting temperature of the initial HDPE – 145° C. Only at a graphite concentration of 20 wt% and higher is the melting peak shifted to 146°C.

At the same time, account has to be taken of the fact that the introduction of 5.0 wt% graphite into the HDPE composition led to the rise in the MFI value from 4.65 to 6.35 g/10 min. This is explained as being due to the fact that graphite has a layered structure, which has a lubricating effect that improves the melt flow of the nanocomposites.

It seemed interesting to consider the effect of sulfur on the nature of changes in the physico-mechanical properties of nanocomposites. It is quite obvious that here we are not talking about the full-fledged vulcanization of the polymer matrix, since HDPE lacks a sufficient number of vinyl groups. These are mainly terminal vinyl groups and partially trans-vinylene double bonds. As can be seen from table 1, the introduction of 5.0 wt% sulfur leads to an improvement in all physico-mechanical characteristics (sample 17-18). A slight increase in properties in

comparison with samples 12-13 indicates, first of all, a partial crosslinking of macro-chains, and on the other hand, a decrease in the MFI of HDPE+5.0 wt% graphite nanocomposites (sample 12) from 6.35 to 4.78 g/10 min directly accounts for the formation of a sparsely reticulated spatial structure with a subsequent increase in the viscosity of the melt.

Table 2 shows the results of research into physical-mechanical properties of nanocomposites based on LDPE and graphite. Comparing the data in this Table makes it possible to establish that the properties of nanocomposites change according to a certain pattern. So, for example, in samples 3-9, with an increase in the concentration of graphite from 1.0 to 30 wt%, the maximum value of the tensile yield stress and ultimate tensile stress appears at its 10 wt% content. As can be seen from the Table, the elongation at break of nanocomposites is very sensitive to the concentration of graphite. Even at 1.0 wt% content, a noticeable decrease in elongation at break from 720 to 200% is observed (sample 3). A rather sharp deterioration in strength indicators and elongation at break was recorded at a graphite concentration of more than 15 wt%. At 20 wt% graphite content in the LDPE composition, the sample becomes practically brittle and loses its ability to uniaxial deformation, as a result of which the tensile yield stress becomes equal to the ultimate tensile stress. In comparison with the initial LDPE, the heat resistance of nanocomposites at 30 wt% graphite content rises by 3°C, i.e. from 85 to 88°C. Ultimate bending strength constantly grows as the graphite content grows up to 15 wt%. At the same time, according to the data of derivative-graphic analysis, the melting temperature of nanocomposites at 30 wt% graphite concentration rises from 101 to 102°C. Thus, in LDPE-based nanocomposites, the melting point remains practically unchanged depending on the graphite content.

**Table 2.** Physical-mechanical properties of nanocomposites based on LDPE, Gr and PEMA

№	Composite formulation, %	Tensile yield stress, MPa	Ultimate tensile stress, MPa	Elongation at break, %	Vicat heat resistance °C	Flexural strength, MPa
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1	LDPE	12.2	13.1	720	85	16.2
2	LDPE+2PEMA	11.0	12.5	305	85	16.5
3	LDPE+1Gr	12.7	13.9	200	85	16.9
4	LDPE+3Gr	14.6	14.0	115	85	17.4
5	LDPE+5Gr	15.1	14.5	60	87	18.0
6	LDPE+10Gr	15.6	15.0	35	87	19.5
7	LDPE+15Gr	15.2	14.8	25	87	21.8
8	LDPE+20Gr	11.7	11.7	10	88	20.2
9	LDPE+30Gr	9.5	9.5	-	88	20.4
10	LDPE+2PEMA+1Gr	13.6	14.2	230	85	19.6
11	LDPE+2PEMA+3Gr	15.4	15.0	160	85	21.2
12	LDPE+2PEMA+5Gr	16.1	15.3	90	86	23.8
13	LDPE+2PEMA+10Gr	17.0	16.2	60	87	24.6
14	LDPE+2PEMA+15Gr	17.5	16.8	40	87	25.5
15	LDPE+2PEMA+20Gr	14.6	14.0	30	89	25.6
16	LDPE+2PEMA+30Gr	12.2	11.9	20	89	26.0
17	LDPE+2PEMA+5Gr+5S	16.9	15.7	75	90	26.8
18	LDPE+2PEMA+10Gr+5S	17.6	16.5	60	92	27.6

S – sulfur

It has been experimentally established that the introduction of graphite into the LDPE composition (samples 3-9) is accompanied by rise in MFI in the following sequence 3.2, 4.0, 5.0, 5.8, 6.9, 5.5, and 4.8 g/10min. Analysing these data, it can be unambiguously asserted that, as in the case of HDPE, the graphite, due to its layered structure, improves the melt flow. The maximum MFI value is observed for a nanocomposite with 15 wt% graphite content. The existence of a maximum MFI in the concentration dependence of nanocomposites testifies to the fact that in the process of supersaturation, nanoparticles agglomerate in the melt which, to a certain extent, can result in increase in the viscosity of the polymer matrix accompanied by a slight decrease in the MFI. But, despite this, the MFI of nanocomposites always remains higher than that of the initial LDPE.

It is characteristic that the introduction of PEMA into the composition of nanocomposites improves all the physical-mechanical properties of LDPE nanocomposites. The latter circumstance is explained as being due to the fact that the introduction of PEMA actually exhibits the ability to improve the compatibility and adhesive contact of nanoparticles with a polymer matrix. This circumstance becomes possible due to the uniform dispersion of nanoparticles throughout the entire volume of the polymer matrix which minimizes the

probability of their agglomeration, so the samples do not lose plasticity even at 30 wt% graphite content (sample 16) [16].

During sulfur vulcanization of nanocomposites (samples 17 and 18), the peak of their melting temperature at 5.0-10 wt% graphite content rose to 103°C. At the same time, all strength characteristics, elongation at break and heat resistance increased. These noticeable changes in physical-mechanical properties in the process of partial sulfur vulcanization make it possible to assert the formation of a sparsely reticulated spatial structure in the polymer matrix. In contrast to HDPE, the number of terminal, trans-vinylene and vinylidene double bonds in LDPE is relatively higher. It is possible that this very circumstance confirms some significant changes in the properties of cross-linked nanocomposites [16, 17]. It is known that in the process of crosslinking of a polymer matrix, a drop in the MFI of composites is observed. In particular, we found that after sulfur crosslinking, the MFI of nanocomposites with 5.0 and 10 wt% graphite content (samples 17-18) decreases, respectively, from 5.0 and 5.8 g/10 min to 4.2 and 5.0 g/10 min, which confirms the occurrence of partial crosslinks in the structure of the polymer matrix.

Another representative of the class of polyolefins is isotactic polypropylene (PP), which, due to a number of structural features, is



widely used in various industries. In this respect, it seemed interesting to consider the possibility of changing its properties by introducing graphite nanoparticles. The results of studying the properties of nanocomposites

are shown in Table 3. As can be seen from this Table, the concentration of graphite in the PP matrix has a significant effect on the main physical and mechanical properties of nanocomposites.

**Table 3.** Physical-mechanical properties of nanocomposites based on PP, Gr and PEMA

№	Composite formulation, %	Tensile yield stress, MPa	Ultimate tensile stress, MPa	Elongation at break, %	Vicat heat resistance, °C	Flexural strength, MPa
1	PP	34.9	33.0	130	160	35.0
2	PP+2PEMA	34.2	32.5	140	160	34.6
3	PP+1Gr	35.3	33.6	110	160	36.7
4	PP+3Gr	36.6	35.2	75	160	37.4
5	PP+5Gr	38.1	36.5	50	161	38.0
6	PP+10Gr	35.2	34.6	25	163	39.6
7	PP+15Gr	31.5	31.2	15	163	41.4
8	PP+20Gr	27.7	27.7	-	165	39.3
9	PP+30Gr	25.5	25.5	-	165	38.5
10	PP+2PEMA+1Gr	36.7	34.5	120	160	37.6
11	PP+2PEMA+3Gr	37.4	35.6	85	160	39.2
12	PP+2PEMA+5Gr	39.7	38.1	60	160	40.8
13	PP+2PEMA+10Gr	36.5	36.0	35	162	41.6
14	PP+2PEMA+15Gr	33.8	33.1	25	163	43.5
15	PP+2PEMA+20Gr	30.6	30.4	15	165	43.1
16	PP+2PEMA+30Gr	28.3	28.2	10	166	40.2
17	PP+2PEMA+5Gr+5S	41.4	39.8	85	162	42.6
18	PP+2PEMA+10Gr+5S	38.5	36.9	60	164	43.8

*S – sulfur*

The differences are manifested mainly in the quantitative expression of the data. For example, as the concentration of graphite in the PP composition rises in the absence of a compatibilizer, a change in the strength characteristics (tensile yield stress, ultimate tensile stress) is observed with a maximum at 5.0 wt% filler content. Accordingly, a sharp decrease in the elongation at break is observed already at 3.0 wt% graphite content. And this is quite understandable, since when using nano-scale particles, their number per unit volume is hundreds of times greater than when using the same amount of conventional dispersed fillers. As in the case of using HDPE and LDPE as a polymer matrix, the introduction of graphite (samples 3-9) into the PP composition leads to

The introduction of PEMA has a positive effect on improving the compatibility of the mixture components and, accordingly, on the physical-mechanical characteristics of PP

nanocomposites. In this case, the point is not about thermodynamic, but technological compatibility which ensures uniform miscibility and the existence of adhesive contact between

rise in the MFI of nanocomposites in the following sequence: 4.1, 4.8, 6.2, 7.9, 8.2, 6.6, 4.2 g/10 minutes. According to these data, the maximum MFI value is observed for specimens with 15 wt% graphite content (8.2 g/10 min). There are grounds to believe that such a sharp decrease in the MFI of the samples after the maximum confirms once again our arguments over the existence of a peculiar threshold concentration of graphite after which the spontaneous formation of agglomerates of filler nanoparticles is observed which results in a regular increase in the viscosity of the nanocomposites. Moreover, the MFI of nanocomposites is always higher than that of the initial PP (3.6 g/10 minutes).

nanocomposites. In this case, the point is not about thermodynamic, but technological compatibility which ensures uniform miscibility and the existence of adhesive contact between

the components of the mixture. Table 3 shows the results of a research into the effect of sulfur crosslinking on the nature of changes in physical-mechanical properties (samples 17-18). It can be noted that in this case, the use of sulphur as a crosslinking agent contributes to a noticeable improvement in the main physical-mechanical properties of nanocomposites. A drop in the MFI of these samples from 6.2 and 7.9 g/10 minutes, respectively, to 5.1 and 6.5 g/10 minutes reaffirms the probability of crosslinking in the PP structure.

From a comparative analysis of the data shown in Tables 1-3, it can be established that the maximum value of the strength characteristics in HDPE is achieved at 3.0 wt%, in LDPE at 15 wt%, and in PP at 5.0 wt% graphite content. Of course, the type of polyolefin and the degree of its crystallinity are fundamental factors that determine the optimal content of graphite in its composition. For example, in HDPE which is characterized by a linear macro-chain structure, the degree of crystallinity is 82%, in LDPE - 59%, and in PP - 65%. From this it follows that the lower the crystallinity of the polyolefin, the greater the "vacant free volume" in the interspherulite region for filling with graphite nanoparticles.

Based on the foregoing, it can be concluded that the use of graphite as a filler makes it possible to obtain a whole set of nanocomposites with predetermined properties. This circumstance allows us to assert the receipt of a high-tech construction material intended for use in special fields of engineering and technology. Based on the data obtained, it can be assumed that the considered nanocomposites

are characterized by satisfactory MFI values which allow them to be processed by the most common processing methods such as extrusion and injection moulding.

Thus, according to the results of the experimental studies performed, one can come to the conclusions as follows:

1. The effect of graphite concentration on physical-mechanical properties of nanocomposites based on HDPE, LDPE, and PP, such as tensile yield strength, ultimate tensile stress, elongation at break, heat resistance, flexural strength, melting point and MFI, has been studied. It found that, depending on the type of polyolefin used, the limiting values of the graphite concentration change at which comparatively high values of the strength characteristics of nanocomposites are observed for HDPE at 3.0 wt%, LDPE at 10 wt% and PP at 5.0 wt% graphite content.
2. It was found that the introduction of compatibilizer – PEMA into the composition of graphite-filled polyolefins leads to significant improvement in the complex of physical-mechanical properties of nanocomposites.
3. The influence of sulfur on the character of changes in the properties of nanocomposites is considered. It is shown that the introduction of sulfur into the composition of polyolefins leads to some improvement in the properties of composite materials while maintaining the MFI at a satisfactory level, sufficient for their processing by extrusion and injection molding.

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**QRAFİT VƏ MODİFİKASIYA OLUNMUŞ POLİOLEFİNLƏR ƏSASINDA  
NANOKOMPOZİTLƏRİN FİZİKİ-MEXANİKİ XASSƏLƏRİ****X.V. Allahverdiyeva**

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Qrafitin miqdarının yuxarı sıxlıq polietileni, aşağı sıxlıq polietileni və polipropilen kimi poliolefinlər əsasında nanokompozitlərin əsas fiziki-mexaniki xassələrinə təsiri nəzərdən keçirilmişdir. Dartılmada axıcılıq həddi, dartılmada möhkəmlik həddi, əyilmədə möhkəmlik həddi, nisbi uzanma, istiliyədavamlılıq, əyilmədə möhkəmlik, ərintinin axıcılıq həddi və ərimə temperaturu kimi xassələr tədqiq edilmişdir. Qarışıqın qarışdırılan komponentlərinin uyğunluğunun yaxşılaşdırılması üçün bütün polietilen markaları üçün Exxelor PO1040 markalı, polipropilen üçün isə Exxelor 1020 markalı kompatibilizatorlardan istifadə edilmişdir. Poliolefinlərin tərkibinə qrafit aşağıdakı miqdarlarda daxil edilmişdir: 1.0, 3.0, 5.0, 10, 15, 20, 30 kütlə%. Aparılmış tədqiqatlar nəticəsində müəyyən olunmuşdur ki, qrafitin poliolefinlərin tərkibinə daxil edilməsi onun müxtəlif miqdarlarında maksimumun əldə edilməsi ilə möhkəmlik xüsusiyyətlərinin yaxşılaşması ilə müşayiət olunur. Yuxarı sıxlıqlı polietilen üçün möhkəmlik xüsusiyyətlərinin maksimal qiyməti qrafitin 3.0 kütlə%, aşağı sıxlıqlı polietilen üçün 10 kütlə%, polipropilen üçün isə 5.0 kütlə% miqdarında müşahidə olunur. Göstərilmişdir ki, möhkəmlik göstəricilərinin maksimal qiymətini təmin edən qrafitin bu hədd miqdarının qiymətində belə fərq birbaşa polimer matrisanın kristalliklik dərəcəsi ilə bağlıdır.

**Açar sözlər:** dartılmada axıcılıq həddi, dartılmada möhkəmlik həddi, əyilmədə möhkəmlik həddi nisbi uzanma, istiliyədavamlılıq, ərintinin axıcılıq göstəricisi, kristalliklik dərəcəsi.

**ФИЗИКО-МЕХАНИЧЕСКИЕ СВОЙСТВА НАНОКОМПОЗИТОВ НА ОСНОВЕ  
ГРАФИТА И МОДИФИЦИРОВАННЫХ ПОЛИОЛЕФИНОВ****X.B. Аллаxвердиева**

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Рассмотрено влияние концентрации графита на основные физико-механические свойства нанокomпозитов на основе таких полиолефинов, как полиэтилен высокой плотности, полиэтилен низкой плотности и полипропилен. Исследованы такие свойства, как предел текучести при растяжении, разрушающее напряжение, предел прочности на изгиб, относительное удлинение, теплостойкость, прочность на изгиб, показатель текучести расплава и температура плавления. Для улучшения совместимости смешиваемых компонентов смеси использовали компатибилизатор марки Exxelor PO1040 для всех марок полиэтилена и Exxelor PO1020 для полипропилена. Графит вводили в состав полиолефинов в следующих концентрациях: 1.0, 3.0, 5.0, 10, 15, 20, 30 %масс. В результате проведенных исследований установлено, что введение графита в состав полиолефинов сопровождается улучшением прочностных характеристик с максимумом при различных его концентрациях. Для полиэтилена высокой плотности максимальные значения прочностных характеристик наблюдаются при 3.0 %масс., для полиэтилена низкой плотности - при 10%масс., а для полипропилена - при 5.0 %масс. содержания графита. Показано, что такое различие в значении пороговой концентрации графита, обеспечивающей максимальное значение прочностных показателей, напрямую связано со степенью кристалличности полимерной матрицы.

**Ключевые слова:** предел текучести при растяжении, разрушающее напряжение, предел прочности на изгиб, относительное удлинение, теплостойкость, показатель текучести расплава, степень кристалличности.