

PHYSICO-MECHANICAL CHARACTERISTICS OF THE PDCPD-EPDM-30 COMPOSITES

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Currently, more attention is paid to polymer composite materials. Among polymers, polydicyclopentadiene (PDCPD) takes a special place and compositions based on it, due to its high strength characteristics and chemical inertness [1]. Introduction of different elastomers in the PDCPD allows obtaining a material with a set of optimal physico-mechanical characteristics. In this work, ethylene-propylene rubber (EPDM) was used as the modifier.

Ethylene-propylene rubber does not contain double bonds in the molecule, colorless, has excellent resistance to heat, light, oxygen and ozone [2].

The choice of this elastomer is justified by the fact that its structure contains dicyclopentadiene units that have unsaturated double bonds and, possibly, enter a copolymerization reaction with dicyclopentadiene (Fig. 1).

In the present work physico-mechanical properties of composite materials on the basis of PDCPD, containing from 1 to 5% of synthetic rubber of the brand EPDM-30, were investigated.

Dicyclopentadiene was purified by boiling it with sodium at a temperature of 130 °C for 4 hours in an inert atmosphere. Then, at a given tempera-

ture and a pressure of 200 mbar, a solvent stripper containing unreacted with sodium oxidized forms of dicyclopentadiene was distilled off. After removing the oxides from the reaction mass, pure dicyclopentadiene was distilled off at the same temperature and pressure of 50-80 mbar. In parallel, the rubber was dissolved in xylene at a temperature of 80 °C, after which it was mixed with pure dicyclopentadiene and the solvent was distilled off.

The polymerization was carried out in the form at 180 °C at a ratio of the monomer to the second-generation Hoveyda-Grubbs catalyst of 10,000 : 1.

For all the composites obtained, the elongation at break was determined, and also the modulus of elasticity under tension and bending. The results of the studies are presented in Table 1.

As a result, a gradual increase in the tensile stress at break was revealed, the modulus of tension was then changed insignificantly, the elongation at break also increased, the modulus of flexibility gradually decreased in composites with a rubber content of 1 to 4%, but at a rubber concentration of 5%, an increase occurs.

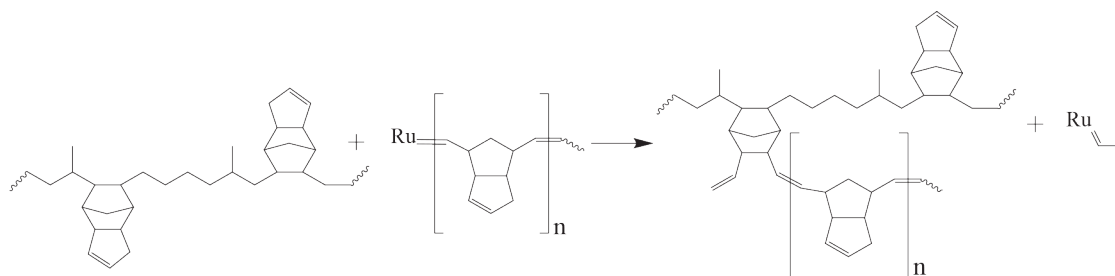


Fig. 1. Possible mechanism for the formation of a copolymer of PDCPD-EPDM in the process of polymerization of dicyclopentadiene

Table 1. Physical and mechanical properties of the composites

Index	Tensile stress at break σ_{pp} , MPa	Modulus of tension E_p , MPa	Breaking elongation ε_{pp} , %	Modulus of flexibility $E_{изг}$, MPa
PDCPD+1% EPDM-30	—	1092.52	46	1163.38
PDCPD+2% EPDM-30	20.42	1407.11	2.7	1152.45
PDCPD+3% EPDM-30	32.17	1458.79	15	1075.72
PDCPD+4% EPDM-30	33.73	1365.1	28	982.29
PDCPD+5% EPDM-30	34.057	1422.09	28	1099.58

References

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THE INFLUENCE OF PULSED e-BEAM TREATMENT ON PROPERTIES OF ELECTROSPUN PLLA SCAFFOLDS

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Nowadays bioresorbable polymers are widely used in regenerative medicine and tissue engineering due to its biocompatibility and biodegradability. Some structures made from these materials can be used for bones and soft tissues recovering [1]. One of the main aspects of biodegradable polymers application is a correlation between the rate of degradation and the speed of tissue regeneration. Poly-L-lactic acid (PLLA) has a low rate of degradation because of large molar mass and hydrophobic properties. Hydrolytic degradation of PLLA is a heterogeneous process, which undergoes by the invasion of water into the material. The autocatalytic nature often results in faster degradation of the inside of a PLA component. For this reason, PLLA characteristically degrades from the inside-out, giving hollow and porous structures before complete bioabsorption leading to the burst release. As a result, scaffolds might lose its mechanical and rheological properties resulting in its abruption in vivo.

In order to avoid this phenomenon and control the rate of degradation number of surface modification methods have been proposed. One of the most promising methods of polymer modification is the pulsed electron beam (e-beam) treatment because of its larger absorbed dose than continuous e-beam due to pulsed duration.

Materials and methods. The scaffolds were prepared using PLLA PL38 (Purac) solution in tri-

chloromethane (Ekros) with 4 % wt. The nonwoven materials were produced by electrospinning method using NANON-01A (MECC) device. The spinning cylinder 210×100 mm was used as a collector under following conditions: feeding speed was 6 ml/h, the potential on the needle was 20 kV, distance between the collector and needle was 190 mm [2].

E-beam treatment of nonwoven scaffolds was conducted using pulsed e-beam accelerator TEA-500 under following conditions: the diameter of e-beam was 5 cm, kinetic energy of electron beam – 350 keV, electron beam current – 6 kA, electron beam current pulse duration at half height – 60 ns. The thickness of titanium foil was 50 μm.

The process of scaffolds degradation was carried out in phosphate buffer saline (PBS) according to GOST R ISO 13781-2011, degradation of scaffolds proceeded under 70 °C, time of degradation – 1 and 7 days.

Investigation of molar mass was conducted by gel-permeation chromatography (GPC) using liquid chromatograph Agilent 1200.

Results and discussions. Results of measurements of molecular weight are presented in Table 1.

The results of GPC show that the reduction of molecular weight is depending on absorbed dose. It means that more scissoring chains are formed under degradation process. Significant decrease of molar mass stands at 25 kGy by reason of cleavage

Table 1. Dependence of molecular mass from absorbed dose

№	D, kGy	Molecular weight, g/mol		
		0 days	1 day	7 days
1	0	$(67.40 \pm 6.47) \cdot 10^4$	$(22.40 \pm 2.24) \cdot 10^4$	$(35.50 \pm 3.55) \cdot 10^4$
2	25	$(7.47 \pm 0.75) \cdot 10^4$	$(4.71 \pm 0.47) \cdot 10^4$	$(2.41 \pm 0.24) \cdot 10^4$
3	50	$(2.93 \pm 0.29) \cdot 10^4$	$(1.68 \pm 0.17) \cdot 10^4$	–
4	100	$(2.23 \pm 0.22) \cdot 10^4$	$(0.20 \pm 0.02) \cdot 10^4$	–
5	150	$(1.39 \pm 0.14) \cdot 10^4$	$(0.07 \pm 0.01) \cdot 10^4$	$(0.05 \pm 0.01) \cdot 10^4$