



HETEROGENEITY AND STRENGTH OF POLYMER MATERIALS UNDER THE INFLUENCE OF ZEOLITE PARTICLES

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The paper investigates the strength properties of polyolefins (LDPE and HDPE) filled with highly dispersed zeolite particles. It is established that an increase in the filler content leads to an increase in the tensile stress at rupture. Heterogeneity manifests itself in the destruction of all standard injection molding samples without exception during stretching in the part of the working area that is as far away from the gate as possible. The reasons for the rupture, the decrease in strength and the unequal strength along the length of the injection samples during stretching are explained.

The results obtained show (Figure 1) that the farther away from the gate, the lower the strength of the sample. A similar pattern was established when studying the deformation properties of dispersed-filled polymer composite materials. It has been experimentally established that, regardless of the nature of the polymer and the highly dispersed filler, the destructive tensile stresses of the samples near the gate are significantly higher than at the point as far away from it as possible.

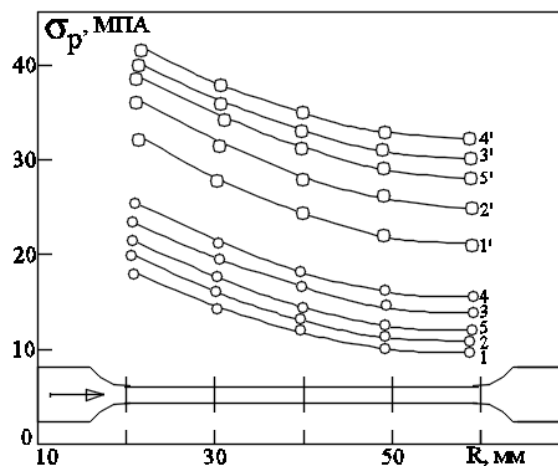


Figure 1. The dependence of the destructive tensile stress of filled injection molding samples of LDPE (1-5) and HDPE (1'-5') on the distance to the gate. Zeolite content in polymer (wt.%): 1,1' – 0, 2,2'-5, 3,3'-20, 4,4'-35, 5,5'-50%. The arrow shows the direction of casting

Significant structural macro-heterogeneity of injection molded products from components can be detected not only by standard mechanical tests, but also by the method of swelling of micro samples in physically active liquid media [1].

It has been established that almost all standard injection molding samples tested for strength under uniaxial tension are destroyed in the part of the working area that is as far away from the gate channel as possible [2, 3]. The observed phenomenon is explained by the fact that the maximum degree of orientation is achieved in the injection zone of the material into the mold, and at the opposite wall of the mold it is minimal [4]. In addition, the orientation of

macromolecules, which occurs, as a rule, during injection molding, is mainly across the direction of movement of the polymer melt flow [5]. The longitudinal orientation of macromolecules occurs only when the melt flows in very narrow channels with a cross section of less than 1 mm². Only in the first section of the product, located directly after the gate channel, macromolecules are located along the flow axis and this leads to an increase in the strength of the composition. In addition, crystal lamellae are regularly arranged in injection molding products mainly perpendicular to the direction of casting [6]. Intensive shear effects on the polymer melt activate transformations leading to changes in its molecular mass characteristics [7]. The resulting change in these indicators is determined by the ratio of the reaction of breaks of macromolecules and the addition of macroradicals during the molding of the product. A consequence of the specific conditions of injection molding is the difference in the levels of change in the molecular weight characteristics of the polymer in the volume of the mold cavity. The heterogeneity of these polymer characteristics in the section of the product perpendicular to the direction of melt injection is considered in [4, 5, 7-10]. According to IR spectroscopy and gel chromatography, it was found that the low-molecular fraction of the polymer is located near the surface of the injection sample. For unfilled HDPE [7], as well as components [11], it was found that the presence of the material in the plasticization node, its passage through the gate system leads to the dominance of the destruction process. At the same time, at distances of 20 and 60 mm from the gate channel, the value of M_w is $201 \cdot 10^3$ and $140 \cdot 10^3$, respectively.

Thus, it is established that with the help of highly dispersed zeolite as a modifying additive, it is possible to regulate the technological and physico-mechanical characteristics of structural polymer materials. The packing density of macromolecules, structural defects, the degree of crystallinity and strength characteristics of injection molded products made of polymer composite materials are closely related to the heterogeneity of the molecular mass characteristics of the polymer matrix and the uneven distribution of filler particles in the morphological zones of the product and can be explained by the difference in the conditions of forming the material in the cross section of the mold.

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