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MECHANICAL PROPERTIES OF LOW-DENSITY POLYETHYLENE WITHOUT AND WITH COMPATIBILIZER

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Nanotechnology and nanomaterials are a rapidly growing interdisciplinary fields of knowledge, spanning many areas of research. Nanomaterials can be classified into nanostructured materials and nanophase/nanoparticle materials. The former usually refer to condensed bulk materials that are made of grains (agglomerates), with grain sizes in the nanometer size range, whereas the latter are usually the dispersive nanoparticles. The nanometer size covers a wide range, from 1 nm to as large as 100 to 200 nm. Nanocomposites are materials that comprise a dispersion of nanometer-size particles in a matrix. The matrix may be single or multi-component and it can be either metallic, ceramic, or polymeric. It may contain additional materials that add other functionalities to the system (e.g., reinforcement, conductivity, toughness, etc.) [1]. The nanoparticles are classified as lamellar, fibrillar, shell-like, spherical, and others. For the enhancement of mechanical and barrier properties, the anisometric particles are preferred. Polymer nanocomposites based on inorganic clay minerals have drawn a great deal of attention during the last two decades. The major reason is related to the peculiar and fascinating properties of the polymer matrix that could be obtained at very low filler contents. Compared to the neat polymer matrix, clay-based polymer nanocomposites exhibit enhanced mechanical properties, reduced gas permeability and improved thermal stability and flame retardant behaviour [2-4]. The final properties of nanocomposites depend greatly on several factors including the chemistry of the polymer matrix, its compatibility with the clay filler, the geometry of the filler, its degree of dispersion and orientation inside the matrix and also the preparation method [5].

The Low-Density Polyethylene (LDPE), a polymer produced by Basell Orlen Polyolefins com., was used in experimental tests. The selected properties of the test polymer LDPE (producer data): density 921 kg/m³, tensile strength at break 21 MPa, tensile strain at break 360%, tensile modulus 220 MPa, Shore hardness 50°ShD. Nanosized tubular halloysite, also called halloysite nanotube (HNT), is the dominant form of naturally occurring halloysite. Halloysite is chemically similar to kaolinite, but the unit layers in halloysite are separated by a monolayer of water molecules; accordingly, halloysite has a structural formula of Al₂(OH)₄Si₂O₅·nH₂O. HNT produced by Sigma-Aldrich company, in the form of powder of the grain diameter from 30 to 70 nm and length 1-3 µm, specific surface 64 m²/g and density 2530 kg/m³ were used as nanofiller. Polyethylene grafted with maleic anhydride (PE-graft-MA) was used as a compatibilizer. Material for experiments was blended at the volume concentrations of 2, 4 and 6 wt% of HNT within LDPE matrix and volume concentration of 5wt% of compatibility factor in LDPE polymer. The specimens were made using a single-screw, double cavity injection molding machine ARBURG 320C according to ISO 527-1:2012 standard. Mechanical properties of materials were tested by static tensile test, Charpy impact test and Shore hardness test according to standards. Tensile strength of tested materials without and with compatibilizer is shown on Fig.1 and Fig.2 shows the structure of selected tested materials.

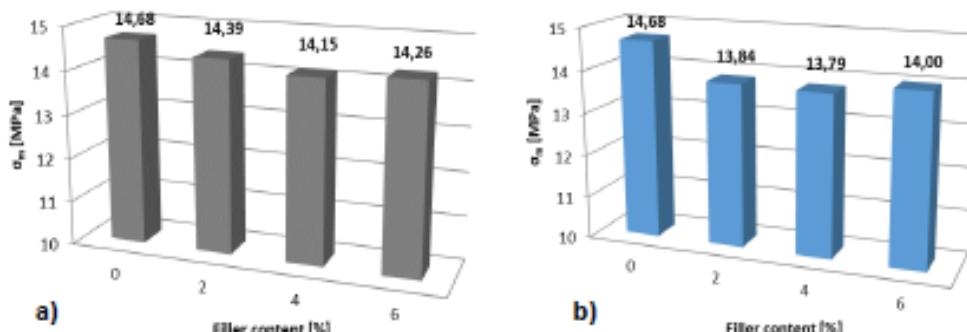


Fig. 1 Dependence of tensile strength on nanofiller mass content without (a) and with compatibilizer (b)

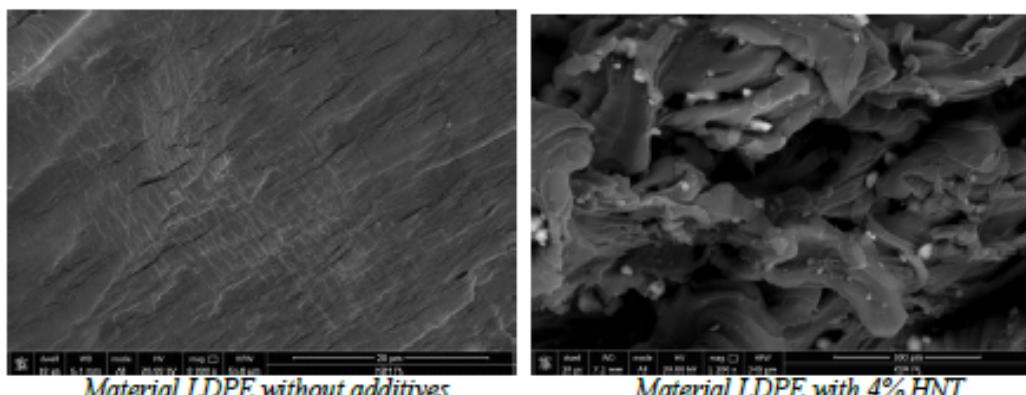


Fig. 2 SEM structure of tested materials

This study investigated the influence of HNT and compatibilizer within a LDPE matrix on the mechanical properties. Tensile strength was increased by adding the filler and compatibilizer, strain at strength was decreased by adding the fillers and compatibilizer within a LDPE matrix. Added of the filler within a LDPE matrix had no significant effect on hardness of tested materials. The largest deterioration of the investigated properties was observed for the tested material by the Charpy impact test where the impact strength values of tested materials were decreased about 9.5%.

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