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THE EFFECT OF ADDING NANO-ADDITIVES ON THE PROPERTIES OF THERMOPLASTIC POLYMERS

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Abstract
Nanotechnology is a rapidly growing interdisciplinary field of knowledge, spanning many areas of research. Depending on its nature, the introduction of a nano-additive into the matrix is intended to give the composites certain mechanical, thermal, optical, surface or biological properties. Significant improvements in nanocomposite properties are mainly due to the shape and size of the nano-additive, the surface area, level of surface development, surface energy and spatial distribution of nanoparticles in the polymer matrix. The paper presents the results of research on basic processing and thermal properties, i.e. the mass flow rate index (MFR) and the Vicat softening temperature of low density polyethylene modified by carbon nanotubes with a mass share of up to 6% of the matrix. The paper is closed with appropriate conclusions.

Experimental research
Test stands and research methodology
To test the thermal properties a machine by CEAST (Torino, Italy) was used. The mass flow rate (MFR) was determined with a plastometer with weights, Zwick type 4105.100 (Ulm, Germany). The softening temperature test was performed in accordance with ISO 306:2014-02, and MFR in accordance with ISO 1133-1:2011.

Materials
The polymer used in the experimental tests was low density polyethylene LDPE marketed under the trade name Malen E and symbol FGAN 18-D003, produced by Basell Orlen Polyolefins company.
Halloysite nanotubes (HNT), by Sigma-Aldrich company, in the form of powder of the grain diameter from 30 to 70 nm and length 1-3 nm, specific surface 64 m^2/g and density 2530 kg/m^3.
Polyethylene grafted with maleic anhydride (PE-graft-MA), by Sigma-Aldrich company, as a compatibilizer was used. Its melt temperature was 105 ^oC and density 920 kg/m^2.

Research results
Based on the conducted tests, dependency graphs depicting the dependency of Vicat softening temperature (fig. 1) and mass flow rate index (MFR) (fig. 2) on the mass content of the nanofiller.

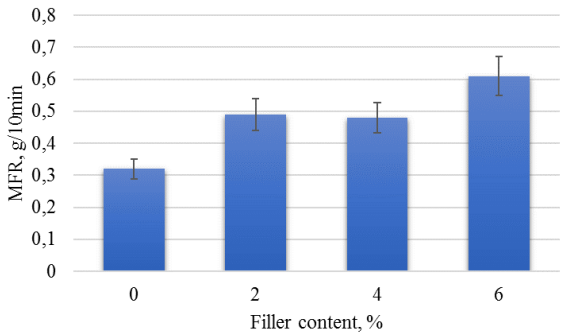

Fig. 1 Mass flow rate index (MFR) in relation to the mass content of the nanofiller with the addition (5%) of a compatibilizing agent.

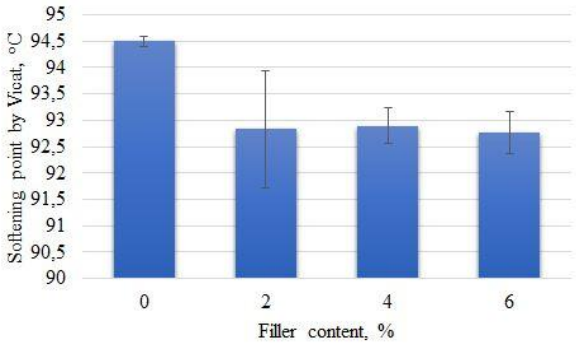

Fig. 2 Vicat softening temperature in relation to the mass content of the nanofiller with the addition (5%) of a compatibilizing agent.

Summary
Based on the presented research it can be concluded that the addition of a nanofiller in the form of nanotubes with the mass content of 2% to 6% in relation to the matrix with the addition (5%) of a compatibilizing agent to a low density polyethylene lowers the Vicat softening temperature, which causes a decrease in the range of use of products with such additives and negatively affects the heat resistance. The addition of a polymer filler to a material causes a slight increase of the mass flow rate (MFR).

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