THE CRYSTALLINITY OF UHMWPE COMPOSITES WITH NOVEL TYPES OF CARBON FILLER

Misiura A.[1], Mamunya Ye.[2], Pusz S.[3], Szeluga U.[3], Pylypenko A.[2,4]
[1]E. O. Paton Electric Welding Institute of NAS of Ukraine, Kyiv, Ukraine
[2]Institute of Macromolecular Chemistry of NAS of Ukraine, Kyiv, Ukraine
[3]Centre of Polymer and Carbon Materials, Polish Academy of Sciences, Zabrze, Poland
[4]Donetsk Institute for Physics and Engineering of NAS of Ukraine, Kyiv, Ukraine
andrii_misiura@ukr.net

Polymer composites with carbon fillers deserve special attention because they have a positive impact on the electrical and mechanical properties of composite materials. Common carbon fillers such as carbon nanotubes, graphene, etc. could be expensive for industrial use. New graphene-like carbon fillers gained from coal pitch coke (CP) and petroleum pitch coke (PET), which could have similar properties to other carbon fillers but at a lower cost are proposed.

Polymer composites based on UHMWPE with a segregated structure of filler distribution in the polymer matrix when the filler is located in the intergranular layer of polymer, formed after compacting a mixture of polymer granules and filler particles, were obtained. Both filler particles CP and PET have two different sizes, 1–10 μm (CP-1, PET-1) and 50–200 μm (CP-2, PET-2). The melting and crystallization behavior of UHMWPE composites with CP and PET fillers was studied using a differential scanning calorimeter (TA Instruments DSC Q2000). The degree of crystallinity (X_c, %) was calculated using the equation:

$$X_c(\%) = \frac{\Delta H_m}{\Delta H_m^o \cdot (1-\varphi)} \cdot 100$$

where ΔH_m is the experimental melting enthalpy value of the sample, φ is the mass fraction of the filler, the ΔH^0_m is the melting enthalpy of 100 % crystalline UHMWPE (theoretical value is 293 J/g).

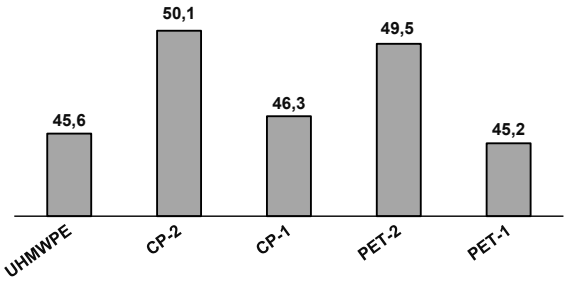

Fig. 1. Values of the degree of crystallinity (X_c, %) for the UHMWPE-coke filler composites

The values of the melting point of pure UHMWPE and its composites were obtained from DSC curves which are similar to ourselves and close to 137±1 °C. The calculation of the crystallinity degree shows that the difference in X_c is about 5 % between the composites with bigger particle sizes and smaller particle sizes. As can be seen in Fig. 1 the X_c of PET-1 and CP-1 composites containing smaller filler particles are similar to pure UHMWPE and lie in the range of 45.2–46.3 %. In PET-2 and CP-2 composites with bigger particle sizes, the degree of crystallinity of the polymer matrix is higher and varies from 49.5 to 50.1 %.

This phenomenon can be explained by the fact that larger particles enter the depth of polymer granules from the intergranular layer at a greater distance, and therefore their influence becomes noticeable. Their surface serves as centers of crystallization, which increases the degree of crystallinity of PET-2 and CP-2 composites.