EFFECT OF NANOFILLERS ON BEHAVIOUR OF HDPE/PA6 MICROFIBRILLAR COMPOSITE

Ivan Kelnar

Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, Heyrovsky Sq. 2, 162 06 Prague, Czech Republic E-mail: kelnar@imc.cas.cz

ABSTRACT

Microfibrillar composites (MFCs) are short fiber composites with reinforcement formed in situ, optimally in the course of melt or cold drawing of polymer blend. The fibrils are formed by semicrystalline polymers like PET or PA6, of importance is their higher melting point in comparison with processing temperature of matrix polymer (PE, PP). In this case, composite with many advantages may be obtained. Limitations are reduced mechanical parameters and thermal resistance of fibrils together with necessity of control the structure of original blend.

Combination of reinforcement and interfacial activity of nanofillers (NF) in nanocomposites (NC) with multiphase polymer matrix can lead to synergistic effects consisting, e.g., in formation of complex morphologies with favourable load bearing capacity. As a result, simultaneous enhancement of basic mechanical parameters can be achieved. Moreover, NF may also support drawing, (trans)crystallinity etc. This study deals with elimination the shortcommings of MFCs consisting of HDPE/PA6 combination using layered silicates.

Layered silicates (montmorillonite) with various modifications were added to HDPE/PA6 (80/20) blend in different protocols including pre-made nanocomposites together with varied conditions of melt-drawing (draw ratio 0-15). The addition of clay affects structure of original blend and rheological parameters of components, as a result, both finer fibrils with favourable aspect ratio and less developed irregular fibrils can be obtained. Of importance is also clay localization, best mechanical behaviour was found in the case of clay inside the fibrils with single platelets at the interface whereas presence of their stacks at the surface of fibrils leads even to decrease in modulus. The reason seems to be poor slip resistance and affecting of (trans)crystallinity in the interfacial area. Clay also leads to more marked dependence of fibril parameters and thus mechanical behaviour on draw ratio due to affecting of break up of molten fibrils. Best results were achieved in the case of unmodified polymer components and one step addition of clay with high affinity to PA6, where the migration of clay into PA6 phase in the course of processing and drawing is more effective than application of pre-made NC. Due to the fact that overall crystallinity of HDPE and PA6 phases was similar in all neat and clay modified MFCs prepared, the significant variations in properties seems to be a consequence reinforcement and influencing interphase parameters The results indicate high potential of nanofillers to upgrade MFCs, at the same time, the complex effects of nanofillers must be harmonised to avoid antagonistic effects such as the unfavourable alteration of the rheological parameters of the components

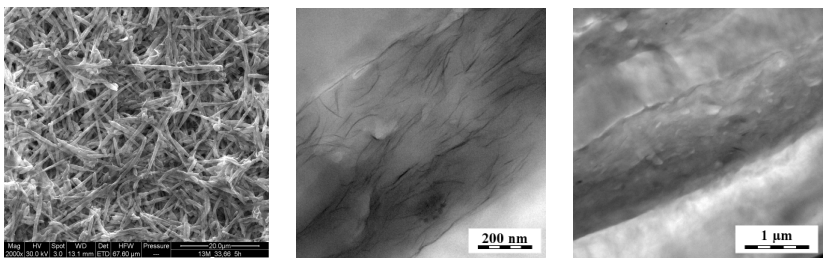

Fig. 1: SEM (matrix extracted by xylene) and TEM observations of clay-modified fibrils

Acknowledgement: This work was supported by Czech Science Foundation (Grant No 13-15255S)