

BIODEGRADABLE POLYESTER NANOCOMPOSITES: THE EFFECT OF STRUCTURE ON MECHANICAL AND DEGRADATION BEHAVIOR

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The study describes the effect of the content and dispersion of the layered silicate on resulting mechanical behavior of poly(ϵ -caprolactone) (PCL) nanocomposites (NC) and its corresponding changes during the degradation in a phosphate buffer at 37 °C. Two nanocomposite systems are compared: intercalated and exfoliated nanocomposites. They were prepared by melt-compounding of a high-molecular-weight PCL with in situ polymerized silicate masterbatches or an organophilized montmorillonite (MMT). It has been shown that Young modulus increases with the increasing silicate content and at the same time, the highest increase in the modulus is observed for the exfoliated system. The stiffness

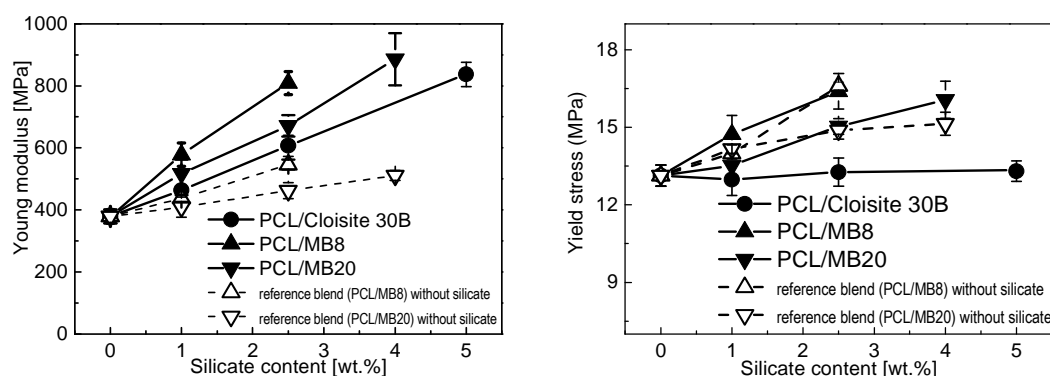


Figure 1: Young modulus (left) and yield stress (right) as a function of the silicate content. PCL/Cloisite 30B - intercalated NC prepared via melt compounding of PCL with MMT; PCL/MB8, PCL/MB20 - NC prepared via melt compounding of PCL with in-situ polymerized masterbatches with exfoliated (PCL/MB8) and intercalated (PCL/MB20) morphology. The composition of the reference blends without silicate corresponds to the nanocomposite composition (HMW/LMW PCL ratio).

enhancement is predominantly caused by the dispersed inorganic phase but it is also supported by the contribution of the low-molecular-weight PCL

(LMW PCL) fraction, which comes from the masterbatch, to the total degree of crystallinity. In contrast, the increase in the yield stress is driven mainly by the present LMW PCL with higher crystallinity.

The degradation behavior reflects both the presence of the layered silicate as well as the LMW PCL fraction. They accelerate the degradation in the phosphate buffer at 37 °C. The evolution of mechanical behavior during the degradation is affected by both secondary crystallization and the chain scission. Thus, Young modulus tends to increase with exposure time as a result of increasing crystallinity. The increase in the crystallinity causes also the increase in the yield stress. However, this increase is observed only up to certain degradation time (6 months). With prolonged exposure time in the degradation environment, the effect of the degradation processes prevails and both stiffness and strength tend to decrease. These trends are more pronounced for PCL/masterbatch systems with the highest silicate content. At the same time, the strain-at-break values of these nanocomposites are markedly reduced to 10 % after 6 month exposition. This significant drop in ductility is shifted to higher exposure times with decreasing silicate content and decreasing LMW PCL fraction. Observed evolution of mechanical behaviour reflects the nanocomposite structure and its changes during degradation.

References

1. Kotek J., Kubies D., Baldrian J., Kovářová J., Eur Polym J 47:2197-2207, 2011.