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Effect of natural weather on the thermal properties of PA11/Sepiolite nanocomposites

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ABSTRACT

The degradation under natural weathering of PA11/Sepiolite (5wt %) nanocomposites was investigated up to 180 days of exposure. The morphology of the nanocomposite samples was characterized by transmission electron microscopy (TEM), whereas the changes in thermal properties induced by natural weathering were evaluated by differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). For comparison, the neat PA11 was also considered. The morphological observations by TEM showed a well homogeneous dispersion of Sepiolite in PA 11 matrix. Differential scanning calorimetry (DSC) data of both neat PA11 and PA11 nanocomposite samples indicated a decrease in the melting temperature, while the crystallinity index remained unchanged after 180 days of exposure to natural weather. A decrease in thermal stability was however observed for both neat PA11 and PA11 based nanocomposite.

Introduction

Polyamide 11 (PA11) is a bio-based engineering thermoplastic derived from a renewable resource (castor oil) [1]. PA11 is one of the most common polymer materials used in a large range of fields from automotive to offshore applications. However, PA11, which is a semi-crystalline thermoplastic exhibits some drawbacks such as poor impact strength, tensile strength and thermal properties. To enhance the functional properties of PA11, the addition of reinforcing nanofillers such as mineral clays is considered as one of the most efficient methods to produce nanocomposites with improved properties. On the other hand, PA11 and PA11-based nanocomposites are sensitive to degradation are exposed to environmental factors. As a result, the degradation leads to loss of mechanical properties and subsequently shortens the lifetime of the polymers [2]. In this work was to investigate the effect of natural weather on the thermal properties of PA11/Sepiolite nanocomposite at filler content of 5wt % up to 180 days.

Materials and Methods

PA11 was provided in powder form by Arkema (France) under the grade Rilsan ES Naturelle. Sepiolite clay was provided by Sigma Aldrich

Films of~60-µm thick based on PA11 and PA11/SEP (5wt. %) nanocomposite were prepared by melt

compounding. The preparation of samples has been detailed by Kaci et al. in a recent paper [1]

Natural weathering exposure

The natural weathering exposure of both neat PA11 and PA11/SEP (5wt.%) nanocomposite samples was carried out according to ASTM D1435. The natural exposure was carried out at Pretoria in South Africa. The samples were exposed up 180 days and periodically removed for analysis.

Results and discussion

Morphological analysis of PA11/SEP

Figure 1 shows the TEM micrographs of PA11/SEP (5 wt. %) nanocomposite before exposure at 100 nm scales. TEM results show a high level of dispersion of small bundles and of single dispersed sepiolite needles.

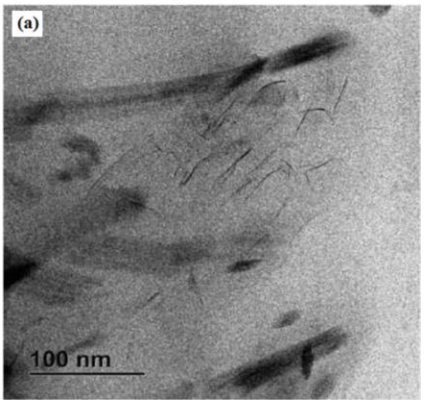

Figure1. TEM images of PA11/SEP (5 wt%) nanocomposite at a scale of 100 nm.

Thermal stability by TGA analysis

The TGA thermograms of PA11 and PA11/SEP (5wt. %) nanocomposite before exposure are shown in Figures 2. Before exposure, the TGA curve for the neat polyamide shows gradual mass loss between 350 and 480°C. For PA11/SEP nanocomposite the curve is shifted to higher temperatures, indicating an increase in thermal stability.

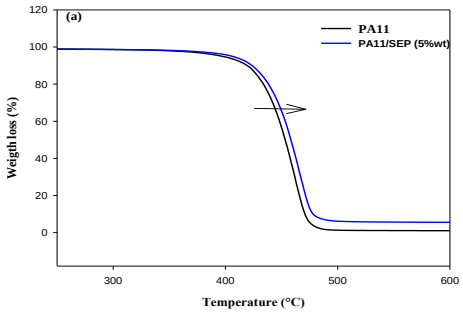

Figure 2. TGA curves of PA11 (a), and PA11/SEP (5%) (b) before exposure.

Under natural weathering exposure shown in figure 3, TGA curves show that both PA11 and PA11/SEP (5wt. %) nanocomposite samples have lower thermal stability. But no significant difference in thermal stability is noted between the two materials up to 180 days of exposure. Accordingly, the effect of Sepiolite on the thermal stability of PA11 is almost negligible in natural weathering up to 180 days.

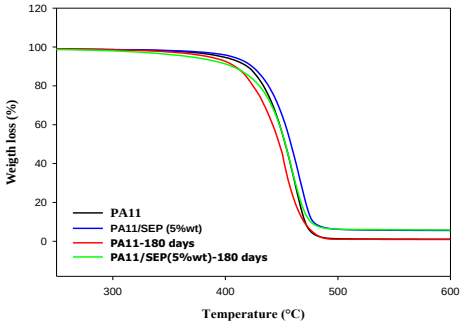

Figure 3. TGA curves PA11and PA11/SEP (5%) before and after 180 days of exposure in natural weathering.

Thermal properties by DSC analysis

DSC data are summarized in Table 1. It is observed that neat PA11 and PA11/SEP nanocomposite samples exhibit a double melting temperature before exposure due probably to the formation of two forms of crystal or one type of crystal exhibiting different sizes or degrees of perfection [1]. After exposure, it is observed that the melting temperatures of both irradiated samples are shifted toward the lower temperatures, whereas, crystallinity index remained unchanged.

Table 1. Thermal characteristics determined by DSC

Samples	Days	T_c (°C)	T_{m1} (°C)	T_{m2}(°C)	X_c(%)
PA11	0	164	183	188	30
	180	165	178	186	28
PA11/SEP	0	165	185	187	31
(5%wt.)	180	166	173	184	30

Conclusion

All results lead to the conclusion that the thermal properties of exposed samples are reduced after natural weather

References

[1] Kaci , N. Dehouche, W. W. Focke , E. M. van der Merwe, (2019**),** A Degradation Study of Polyamide 11/Vermiculite Nanocomposites under Accelerated UV Test Polymer Engineering and Science, DOI 10.1002/pen.25115.

[2] Iggui, K., Kaci, M., Le Moigne, N., Bergeret, A. (2018). The effects of accelerated photooxidation on molecular weight and thermal and mechanical properties of PHBV/Cloisite 30B bionanocomposites. Journal of Renewable Materials, 6(11), 288-298.