Effect of artificial weathering on PLA/nanocomposite molecular weight distribution

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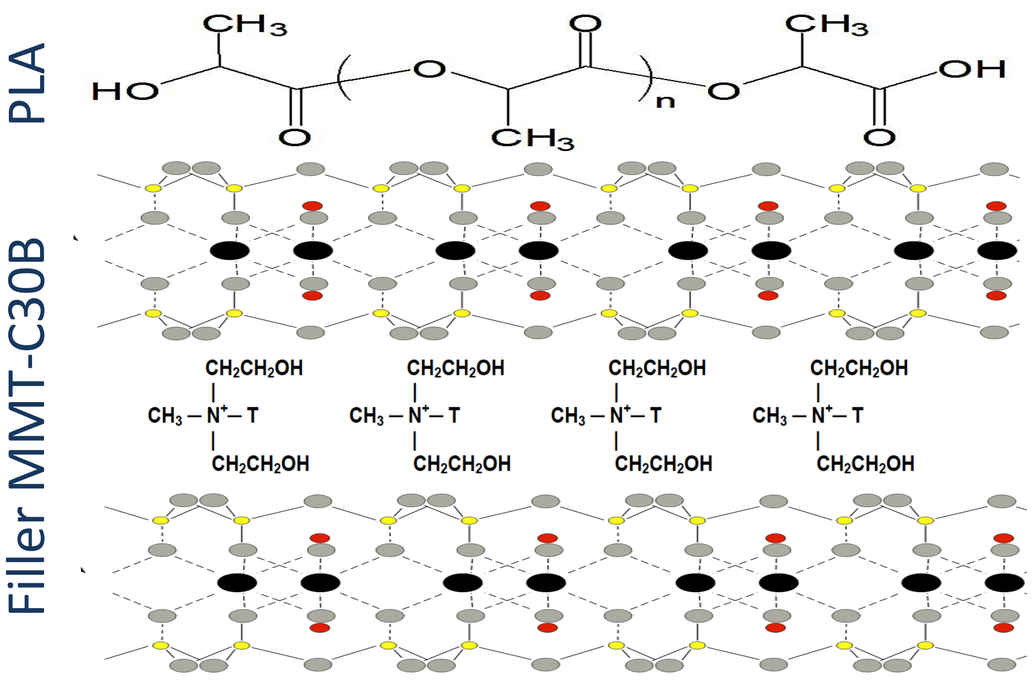
Abstract

The reduction of poly-lactid acid (PLA) molecular weight for amorphous and semicrystalline nanocomposites was investigated in periods up to 360 h under artificial weathering. Moreover a correlation between artificial and natural weathering was established.



Experimental

Blends of amorphous (PLA-A) and semicrystalline (PLA-S) PLA were performed with 5 wt% load of C30B by Brabender DDRV752 corder model extruder. Flexion test tubes were prepared by injection molding The samples were subjected at times of 0, 56, 104, 176, 224, 272, 320 and 360 h on a UV Accelerated Weathering Tester Q-Panel LabProducts according to cycle 1 of the ASTM G154.

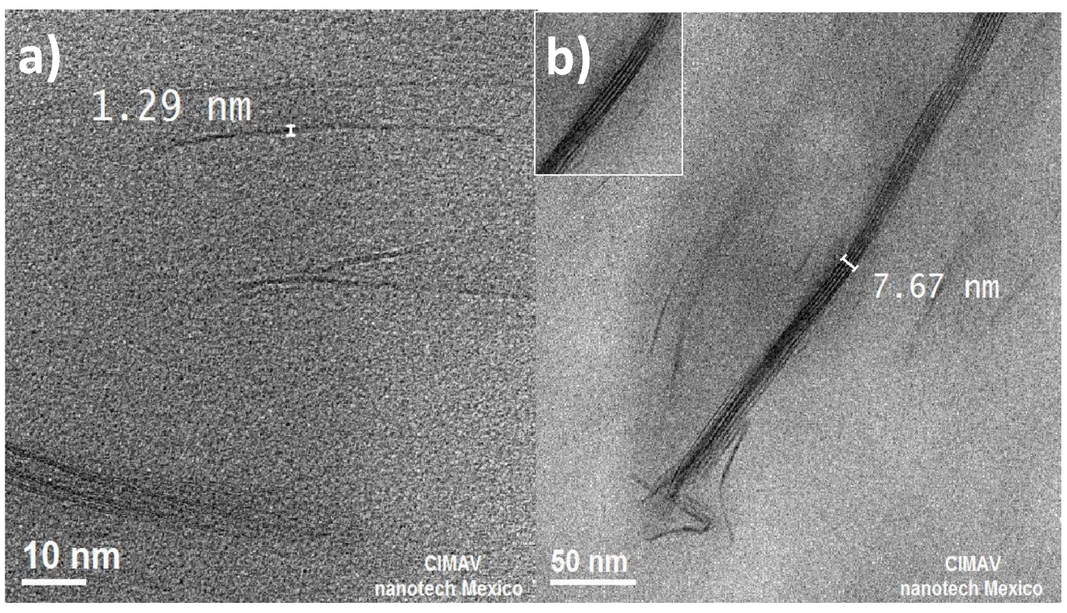


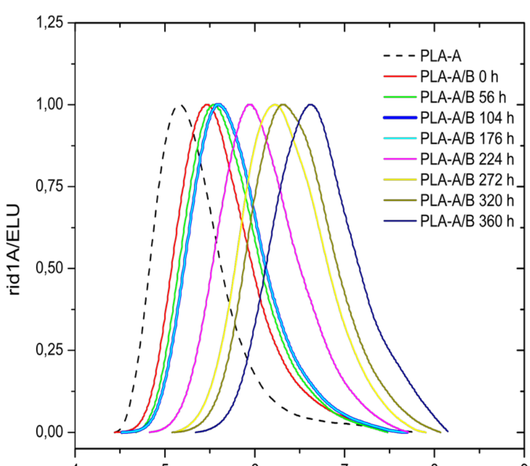
Fig 1. TEM micrographs of a) PLA-A/C30B single platelet, b) PLA-S/C30B 4 stacked platelets

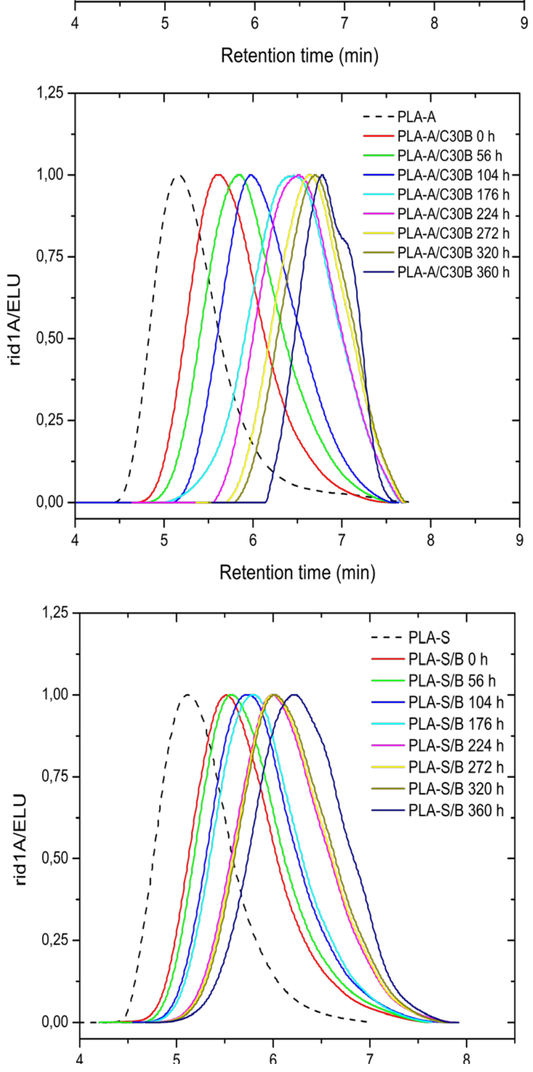
Table 1. Correlation of natural and artificial weathering

Exposure to artificial weathering (h)		
	33	30726.38

Introduction

PLA is a biopolymer produced from renewable sources. The combination of PLA and C30B, at nanoscale, often results in remarkably improved mechanical and thermal properties with respect to pure polymers or conventional composites Furthermore, the molecular weight of PLA is an important property as a degradation indicator. Weathering as a main source of plastic's molecular weight decay deals with impacts of solar radiation, temperature, and moisture.





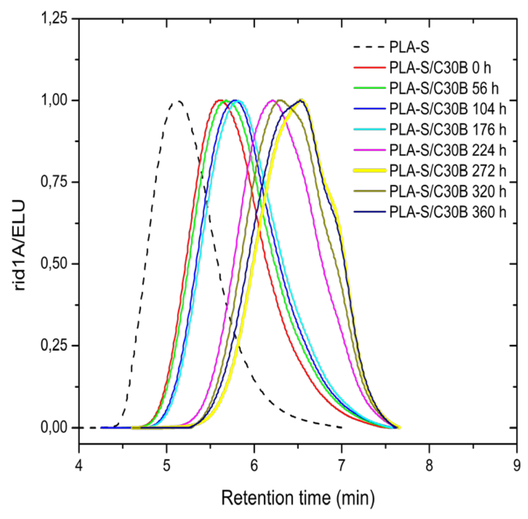


Fig 2. MWD of a) PLA-A/B, b) PLA-A/C30B, c) PLA-S/B and d) PLA-S/C30B; at different times of exposure to artificial weathering.

Results and discussion

TEM showed C30B dispersion at nanoscale (Fig 1). Dark lines correspond to the cross section of the clay layers and the gap between the two adjacent lines is the interlayer space. The clay galleries were broken down due to the applied shear stress during extrusion and injection. Elution of materials obtained by GPC (Fig 2) shift to shorter retention times as the exposure time to artificial weathering was increased, indicating a reduction in chain size of the PLA. This effect was more pronounced in nanocomposites than in PLA without C30B. The initial M_w on PLA-A/C30B was reduced from 157.84 to 15.8 $kgmol^{-1}$ after 360 h under artificial weathering. M_w of PLA-S/C30B decrease from 222.69 to 22.2 $kgmol^{-1}$ of its initial M_w after 360. PLA-A has a major molar mass decrease than PLA-S. It was possible to simulate c.a. 1-7 years of natural weathering.

Conclusions

Through extrusion and injection molding, we obtain nanocomposites with a partially exfoliated structure. It was found a major decrease on nanocomposites molecular weight due to artificial weathering, which can be attributed to the presence of C30B. The weather testing experimental could greatly accelerate natural weathering of tested materials.