End of life of PLA and flax fiber reinforced PLA biocomposite

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END OF LIFE OF PLA AND FLAX FIBER REINFORCED PLA BIOCOMPOSITE

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ABSTRACT

This work aims to investigate the impact of artificial and natural weathering on the end of life of polylactic acid and flax fiber reinforced polylactic acid composite. The studied end-of-life scenarios are reprocessing, composting and incineration. Numerous characterization test results lead to understand the degradation behaviors involved through weathering and end-of-life treatments.

INTRODUCTION

With the ever-growing use of PLA and PLA biocomposites, their end-of-life issue is expected to get larger and increasingly difficult and expensive. Thus efficient waste management solutions are necessary. Although PLA is a compostable material, which would significantly reduce its waste issue, the knowledge about the material recycling and changes in the properties of PLA upon its multiple processing cycles is a relevant topic. Incineration is also a substantial end-of-life treatment.

Reprocessing usually involves mechanical and thermal degradation of both the matrix and the reinforcement. Several works highlighted PLA chain scission and natural fiber damage caused by multiple reprocessing cycles. Numerous papers reported good biodegradability of neat PLA and PLA biocomposites under composting conditions. Incineration is the most common PLA waste treatment nowadays as it enables to reduce efficiently the waste amount.

Moreover PLA and PLA/natural fiber biocomposite are well known to be sensitive to weathering. Thus, this work proposes to investigate the impact of an artificial humidity weathering or a natural climatic weathering on the end of life of PLA and PLA/flax composite by reprocessing, composting and energy recovery (incineration).

RESULTS AND CONCLUSIONS

The results from the flexural tests are shown in Fig. 1. Yield strength and deformation at yield were measured on PLA and PLA/flax compression molded samples after different combination of degrading conditions such as reprocessing and humidity weathering. The reprocessing cycles (C3) induce a strong decrease of neat PLA properties due to chain scission degradation. On the contrary, the PLA/flax composite exhibits no significant degradation. The humidity weathering (WC1) causes a significant drop of mechanical properties due to hydrolysis degradation by chain scission. Weathering is much more detrimental than reprocessing under these specific conditions. The reprocessing of weathered samples leads to a recovery of flexural properties of neat PLA thanks to macromolecular

chain rearrangements. The PLA/flax composite presents a slight recovery but not sufficient to reach its initial values.

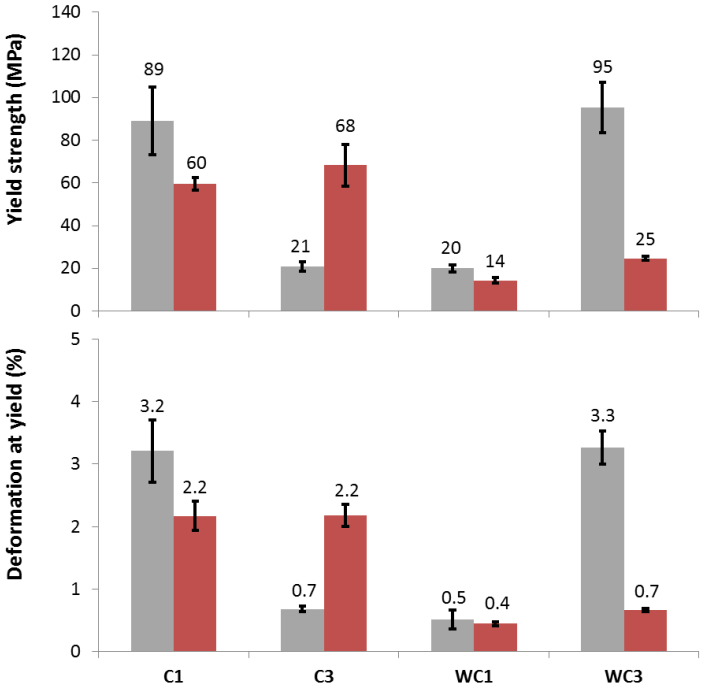

Fig.1 Flexural properties of neat PLA (grey bars) and PLA/flax fiber composite (red bars) obtained by compression molding at the initial state (C1), after reprocessing (C3), after weathering (WC1) and after reprocessing of weathered samples (WC3)

This study shows that there is a beneficial effect of reprocessing thanks to a mechanical property recovery. Results will be presented for composting and incineration scenarios by taking into account degradation caused by weathering. This work leads to substantial results proving the ability of PLA and PLA biocomposite waste to be disposed efficiently.

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