LIMITING POLY(LACTIC ACID) DEGRADATION DURING PROCESSING BY REACTIVE EXTRUSION

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As an eco-friendly material, Poly(Lactic Acid), is considered to replace traditional oil-based thermoplastics. Nevertheless PLA degradation during processing limits its use at an industrial scale. Degradation is due to several reactions including hydrolysis, oxidation and transesterification which cause chain scissions and a decrease in average molecular weight [1,2]. The loss in molecular weight can be counterbalanced by blending PLA with additives which can react with PLA end chains [3]. For instance, Pyromellitic anhydride (PMDA) is known to react with polyester such as poly(ethylene terephthalate) by reactive extrusion [4].

In this study, additives with three or four functional groups (such as ester and anhydride) have been used together with specific catalysts. Whereas anhydrides are able to react with PET during its processing without using any catalyst, the processing temperature used in order to limit PLA degradation is too low to trigger this reaction [5]. Therefore using a catalyst (titanium butoxide) was necessary in this study and its effect on PLA macromolecules has been investigated. All the reactions are performed during PLA extrusion and optimal processing conditions have been determined.

Results show that increasing the catalyst amount leads to a decrease in PLA average molecular weight. This means that chain scission occurs in presence of catalyst whereas it was not observed during pure PLA processing in this study. We also characterized how this decrease in average molar mass impacted PLA's physical properties (Fig 1).

Then, with the same catalyst amounts we investigated the effect of incorporating reactive species. We demonstrate that some additives (Fig2) allow to limit the loss in average molecular weight by promoting some chain exteion and branching.

As a conclusion this study demonstrates that favoring reactive chain extension and branching with appropriate processing conditions is an effective way to limit PLA degradation by chain scission.

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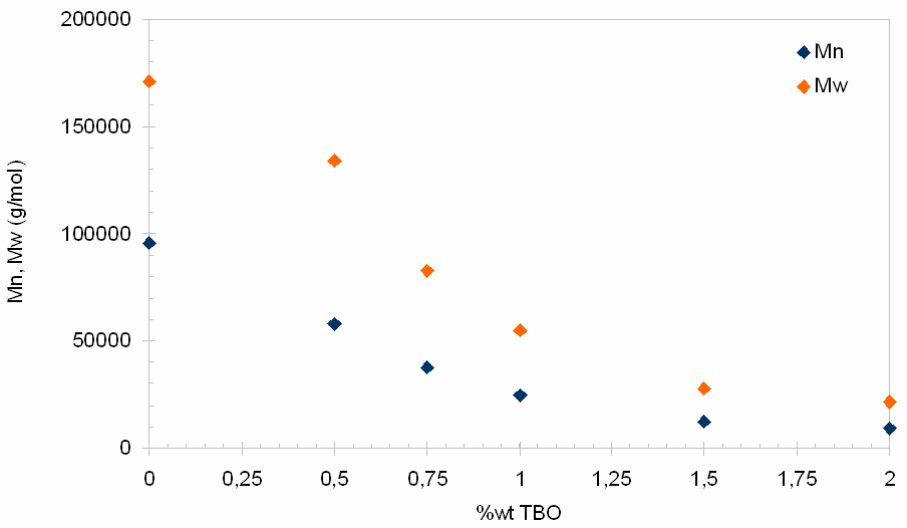

Figure 1. Average molecular weight of PLA versus catalyst amount.

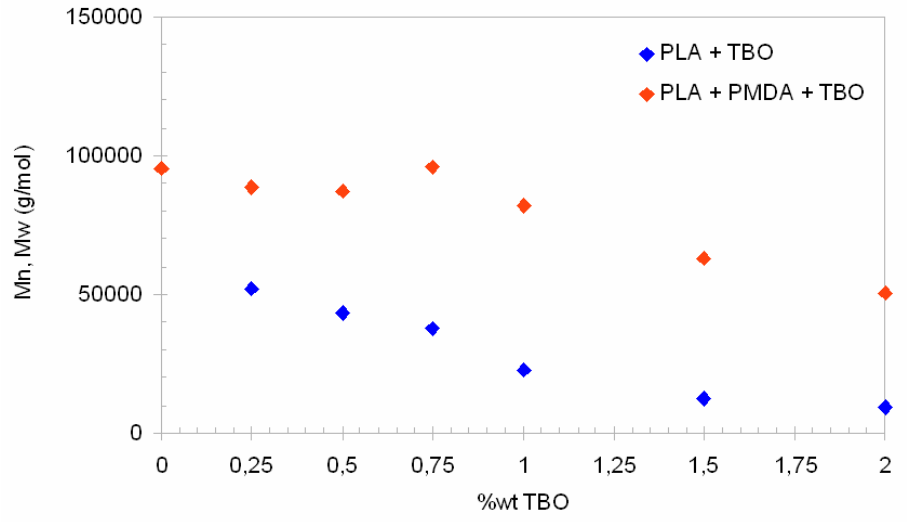

Figure 2. Average molecular weight of modified PLA with PMDA versus catalyst amount.