

Soil degradation kinetics from PHB/PLLA and PHBV/PLLA blends

V. H. Grigull⁽¹⁾, L. P. Mazur⁽¹⁾, M. C. F. Garcia⁽¹⁾, A.L.S. Schneider⁽¹⁾ and A.P.T. Pezzin^{(1)*}

(1) Department of Environmental Engineering, Universidade da Região de Joinville, Santa Catarina, Brazil, e-mail: anapezzin@yahoo.com.br

* Corresponding author.

Abstract – In this work, two biodegradable blends of polymers, the poly (3-hydroxybutyrate)/ poly(L-lactic acid) (PHB/PLLA) and the poly(hydroxybutyrate-co-hydroxyvalerate)/poly(L-lactic acid) (PHBV/PLLA) were prepared in the form of films by casting. The biodegradability of these blends on soil was followed in several times of degradation by thermal and visual properties. After 50 days, the percentage of mass loss of PHBV decrease to 20%, while the percentage of mass loss of PLLA increase to 72%, confirming the fast degradation of PHBV in the soil which had the same behavior of the PHB.

The study and application of biodegradable polymers in place of polymeric materials of petrochemical origin has been a very promising area of research because of excessive amount of waste deposited in landfills. Therefore, new polymer materials (new composites, blends) have been studied to combine its functionality with its degradation. Agree with the Ferreira et al. [1] the understanding and control of these polymers degradation is from fundamental importance. The aim of this work was to study PHBV/PLLA and PHB/PLLA blends after soil biodegradation.

The blends were prepared from casting in 50/50 wt% proportion and subject to degradation in soil to 25, 50 and 75 days. Samples were evaluated by thermal and structural properties changes in function of time degradation and characterized by visual analysis and TGA. After 25 days, visual analysis of the PHB/PLLA and PHBV/PLLA films revealed the first signals of biodegradation with the presence of small colonies of microorganisms on the surface of the film. After 75 days the PHBV/PLLA film presented small holes throughout the length of the sample, while the PHB/PLLA film was completely fragmented (Fig. 1). The mechanism of degradation was very similar. However, it was not possible to compare the samples due to the difference of 5 μm in the thickness of the samples, giving greater resistance to blends of PHBV/PLLA, which had larger holes and more distant from each other. The degradation behavior of PHB and PHBV with PLLA blends observed from TGA curves was very similar, which presented two stages of mass loss (Fig. 2). For the PHBV/PLLA blend the first stage occurred at $T_{\text{onset}} = 292^\circ\text{C}$, attributed to PHBV (with 52% of mass loss) and the second with $T_{\text{onset}} = 361^\circ\text{C}$ attributed to PLLA (with 46.4 % of mass loss), which is thermally more stable than PHBV. After 25 days of soil biodegradation, PHBV started to loss mass 3°C before ($T_{\text{onset}} = 289^\circ\text{C}$), starting the degradation process of this polymer. The same profile of degradation was observed for PLLA ($T_{\text{onset}} = 358^\circ\text{C}$). It was also determined a decrease in the quantity of the PHBV present in the sample to 44.8%, suggesting that this polymer is the first to be bioassimilated by the soil microorganisms. After 50 days, the percentage of mass loss of PHBV decrease to 20%, while the percentage of mass loss of PLLA increase to 72%, confirming the fast degradation of PHBV in the soil. Finally, after 75 days, TG curve assume a typical profile with only one stage of degradation.

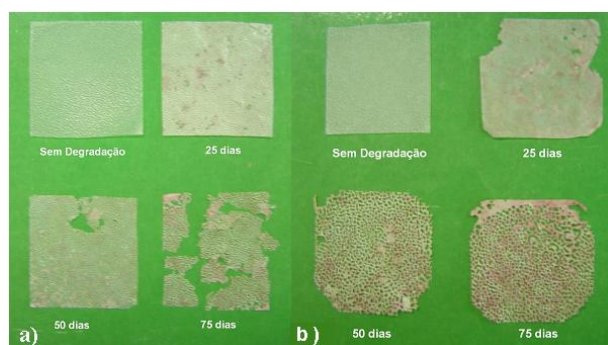


Figure 1: Visual analysis of PHB/PLLA blends a) and PHBV/PLLA in 0, 25, 50 and 75 days.50 and 75 days.

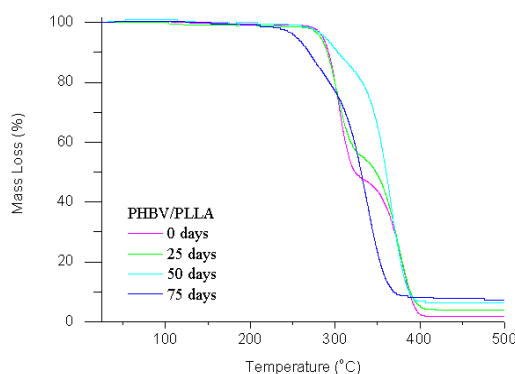


Figure 2: TG curves of PHBV/PLLA blends as function in soil biodegradation.