STUDY OF THE PROPERTIES OF POLYPROPYLENE-PHB BLENDS

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ABSTRACT

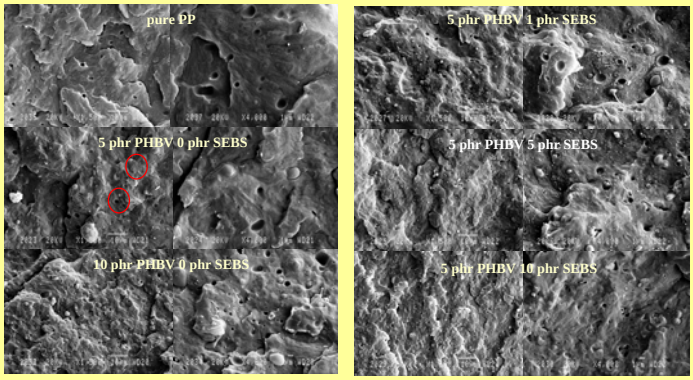
Polypropylene is ,with PVC and polyethylene, one of the most employed polymers for the production of daily life items. Although it is a thermoplastic polymer and nowadays the recycling conscience of the society is increasing, it is still found in urban wastes and therefore in landfills. Then, the main disadvantage is the permanence and the long life time of this type of plastics. The addition of biodegradable polymers has been claimed as a way to palliate this problem, since with degradation of the biodegradable fraction, the whole plastic object could collapse and practically be converted in a compostable stuff. For example, in the report published by NOLAN-ITU Pty Ltd on October 2002 [1], there is a full revision about biodegradable polymers. It is worth mentioning starch based polymers as well as biodegradable polyesters. In the biodegradable polyesters family, it is possible to find polyhydroxyalkanoates, which are produced naturally by different kind of bacteria. The most common polyhydroxyalkaonates are based on poly 3-hydroxybutyrate (PHB) and its copolymers with 3-hydroxy-n-valeric acid (PHBV). Concentrations reported in bibliography for PHB with oxidized polypropylene lie up to 10% [2], higher PHB concentrations may involve an adverse effect on mechanical properties of such blends, although the highest PHB concentrations, the most biodegradable blend is obtained. In the case of more polar polymers, as PVC, higher PHB concentrations (up to 70%) have been reported [3]. Thus, miscibility of polyhydroxyalcanoates and its effect on mechanical properties is one of the factors to have in mind. On the other hand, SEBS copolymers have also been used as a impact modifier for polypropylene[4], while in some other cases, they have been used as compatibilizers[5] between polymers of different polarities.
The aim of the present work has been the study of the properties of ternary blends PP-PHB-SEBS, where polypropylene is the major component.

MATERIALS AND METHODS

The heterophasic copolymer of polypropylene ISPLEN PB 180 G2M supplied by RepsolYPF has been employed with a PHBV copolymer (12% of valeriate) supplied by GoodFellow. The SEBS resin Calprene H6110 supplied by RepsolYPF has also been included in some formulations. Different formulations with different PHBV and SEBS content were prepared, expressing concentrations in terms of parts in weight per hundred of parts in weight of the resin of polypropylene (phr). All formulations were blended in a Brabender internal mixer at 170ºC for 10 minutes and then processed in a hot plates press for 10 minutes under a pressure of 10 atm, obtaining 1mm thickness plastic sheets.

MORPHOLOGICAL ANALYSIS

The analysis of the aspect of fractures of PP reveals, that as expected is a heterophasic copolymer. It consist on a continuous phase with a disperse phase of around 1 micron, that due to the fracture process, provokes the apparition of cavities of such size. The remaining disperse phase show a high interaction with the continuous phase. When PHBV is added to PP, a new disperse phase of higher size and lower adhesion to PP appears. Nevertheless, the apparent effect of SEBS in the PP-PHBV blends is to decrease the size of the disperse phase.

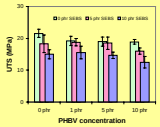


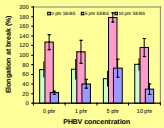
CONCLUSIONS

In the present study, ternary blends of PP-PHBV-SEBS have been obtained. PHBV slightly deteriorates tensile strenght of PP (UTS), but the presence of SEBS does not provoke any improve in UTS, in contrast to elongation at break, that presents an optimal concentration. As expected, polyblends present a lower biodegradability than pure PHBV, but at 10 phr of PHB, blends present a certain biodegradability, in view of results obtained by both test performed.

MECHANICAL PROPERTIES

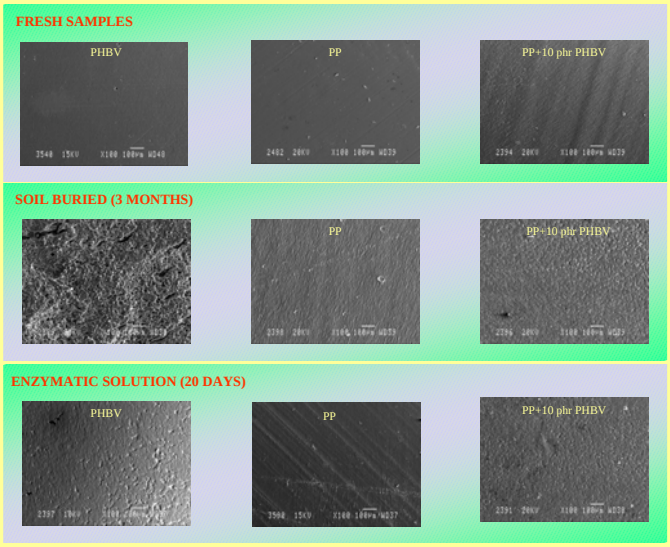
The presence of PHBV in PP at the concentrations employed tends to slightly decrease the ultimate tensile strength (UTS) of the blends obtained, although there is not any clear effect on the elongation at break. The presence of SEBS also provokes a drop on the UTS, but at low concentrations (5 phr) notably improves elongation at break, presenting a maximum; at higher concentrations, both UTS and elongation at break decreases. It could be due to the fact that SEBS contributes in certain way to improve the incorporation of PHB to blends, but it is not fully compatible with PP, and at 10 phr, this immiscibility deteriorates tensile strength.





BIODEGRADABILITY

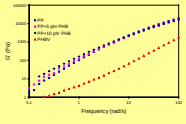
Scanning Electron Microscopy has been employed to analyze the aspect of the surfaces of specimens maintained under two different treatments: soil burying and enzymatic action. On one hand, some samples were buried in soil at room temperature for three months, while some others were introduced in a 10 mg/mL papaine buffered solution, similarly to the method employed by Batista et al.[6].

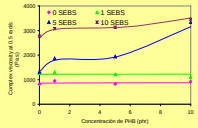


Biodegradability test performed have shown, as expected, almost not changes in PP, while PHBV and its blends with PP have been altered after the test. Soil burying has provoked a marked degradation in pure PHB, in contrast to the enzymatic treatment. However, the PHBV-PP blend show a similar aspect after both treatments.

RHEOLOGICAL PROPERTIES

Rheological properties have been determined in a parallel plates rheometer ARES. Frequency sweeps were obtained at 180ºC for all blends. As expected PHB and SEBS modifies rheological properties of PP, increasing in general terms moduli and viscosity. Although PHBV show lower moduli than PP, elastic modulus at low frequecies are higher in PP-PHBV blends, very probably as a consequence of immiscibility of PP and PHBV.





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