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Investigating methods for the compatibilization of thermoplastic starch blends

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Abstract – Experiments have been performed under different conditions (from solution and by other compounding methods) to produce thermoplastic starch blends. Mixed films of cornstarch and poly(vinyl alcohol) have been compatibilized by addition of organically-modified clay (Fig 1). Melt processing has been used to produce thermoplastic starch blends with other immiscible polymers, such as low density polyethylene, polystyrene, and poly(hydroxybutyrate-co-valerate), in the presence of compatibilizers. Different techniques were used to characterize the resulting blends, which were also submitted to biodegradability tests (Fig 2).

For many years, synthetic polymeric materials have been produced and consumed at large scales, and have contributed to improve life quality of modern societies. However, the environment impact caused by persistent plastic materials accumulated in landfills has become a worldwide concern. This is because major volumes of plastic wastes are products from the packaging sector, rapidly discarded after a short period of use. One of the alternatives to minimize the problem consists in using biodegradable polymers. High production costs and undesirable properties have limited the commercial application of some biodegradable polymers alone. On the other hand, polymer blends have provided ways to accomplish industrial demands by creating new materials at reduced costs. Blending different polymers is a complex process. Most polymer pairs are thermodynamically immiscible. Conventionally, compatibilization may be achieved by addition or creation *in situ* of a third component, compatible with both polymers to be mixed. Recently, exfoliated organically modified silicates have been appointed as active interfacial modifiers, and some polymer blends have been successfully prepared [1, 2].

Starch is the main carbohydrate source of human diet. As a totally biodegradable and renewable raw material, starch has been considered as a component of biodegradable blends [3]. Native starch can be transformed into a thermoplastic material (TPS) through thermomechanical treatment in the presence of suitable plasticizers. Used alone, high sensitivity to the humidity atmosphere has prevented its application. In this work, experiments have been performed under different conditions (from solution and by other compounding methods) to produce thermoplastic starch blends. In general, a significant decrease in hydrophilicity and crystallinity was observed for the blends in relation to TPS alone. Improvement of particle dispersion, particle size reduction, and interfacial adhesion were evaluated by scanning electron microscopy (SEM). In these experiments, good physical properties and biodegradability of the resulting blends were the main objectives to be achieved. Figure 1 shows the effect of organically-modified Cloisite® 30B on TPS/ poly(vinyl alcohol) films prepared by casting from water solution. Figure 2b shows photographs of polyethylene (LDPE) and TPS alone, and for TPS/ maleated LDPE 50:50 blend after incubation in soil for 90 days.

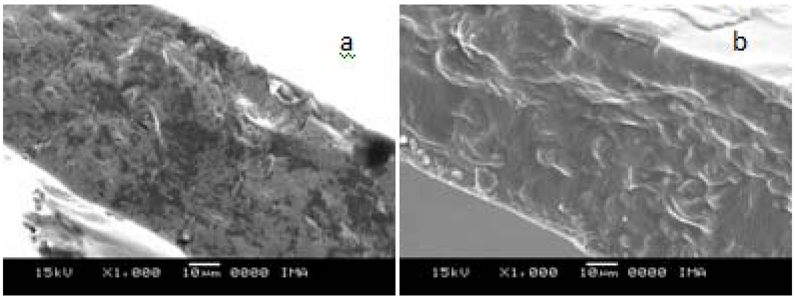

Figure 1: SEM images of TPS/ poly(vinyl alcohol) films prepared by casting; **(a)** without addition of compatibilizer, **(b)** with addition of organically-modified clay.

Figure 2: Photographs of melt processed **(a)** LDPE, **(b)** TPS/ maleated LDPE (50:50) blend reinforced with cellulose fibers and clay, and **(c)** TPS alone, after incubation in soil for 90 days.

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References

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