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# Reinforced biocomposites with guaranteed degradability in soil

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*The addition of cotton fibers to a starch-based commercial material maintains its thermal stability and assures its biodegradation.*

Polymeric materials from renewable sources, such as thermoplastic starch polymers, are ecologically attractive because they come from renewable sources and their life cycle is closed without any environmental hazard. Novel biocomposites based on a biodegradable matrix reinforced with natural fibers have been developed in order to improve properties and reduce costs. The suitability of natural fibers as reinforcements of thermoplastic starch polymers is well studied.[1,2] However, less attention has been paid to their biodegradability in soil.

We assessed the influence of reinforcing a thermoplastic starch-based matrix (Mater-Bi KE03B1®) with cotton fibers on the composite's biodegradability. We subjected the biocomposites to a standardized accelerated degradation in soil test (DIN 53739) for 535 days to mimic likely post-disposal environmental conditions. Thermal analysis can be an alternative to mass-loss conventional techniques to assess the degradation in soil of biopolymers, providing useful information about the irreversible macroscopic effects on the polymers caused by the degradation process.[3]

We assessed the thermal and morphological changes that the pure polymeric matrix and the reinforced biocomposite undergo through degradation in soil. We used thermogravimetry (TGA), differential scanning calorimetry (DSC), and scanning electron microscopy (SEM). In derivative thermogravimetric curves (see Figure 1), pure Mater-Bi KE and its reinforced biocomposite both display a complex thermal decomposition with two main mass-loss regions: the first one related to the thermal decomposition of the starch and the second one associated with the thermal decomposition of the synthetic component present in the Mater-Bi KE. However, the reinforced biocomposite displays a slight increase in the temperature peak of the first mass-loss region.

During the degradation process in soil, the thermal stability of the synthetic component in pure Mater-Bi KE changes as the starch component degrades. The cotton fibers in the reinforced biocomposites enhance this effect, so the degradation rate increases. In the cooling and heating scans of pure Mater-Bi KE and its reinforced biocomposite, there is a slight increase in the areas associated with the crystallization and melting of the crystalline phase of the synthetic component of the pure Mater-Bi KE (see Figure 2).

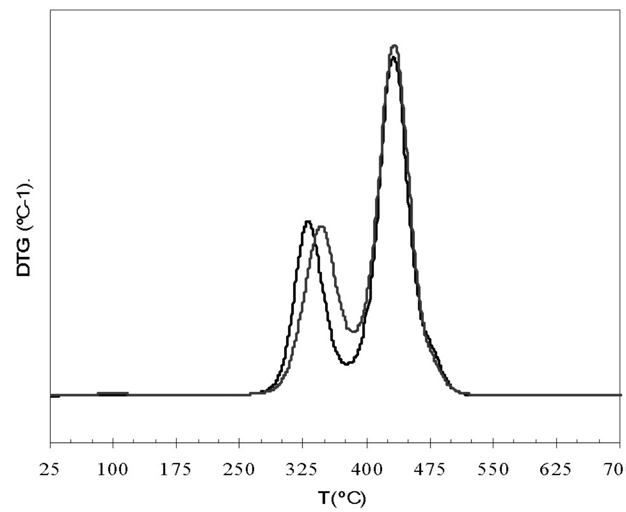


***Figure 1.*** *Derivative thermogravimetric (DTG) curves of (black) pure Mater-Bi KE and (gray) its reinforced biocomposite.*

Due to the degradation process in soil, there is a decrease in the crystallinity index for the pure and reinforced materials. This decrease is more significant for the reinforced biocomposite. Cotton fiber seems to hinder the crystallization of the synthetic component during the degradation process. SEM micrographs from cryogenic sectioned samples of degraded pure Mater-Bi KE and degraded reinforced biocomposite can be seen in Figure 3. The reinforced biocomposite shows the rougher surface, confirming that the presence of the cotton fiber enhances the degradation of the synthetic component, in accordance to the calorimetric results.

When cotton fibers are incorporated into pure Mater-Bi KE, the degradation of the synthetic component is assured. The available surface produced by the degradation of cotton promotes attack by microorganisms. As a consequence, the crystalline structure and the superficial morphology of the reinforced biocomposites are more damaged by the soil burial test than the pure Mater-Bi KE. Our next step will be to

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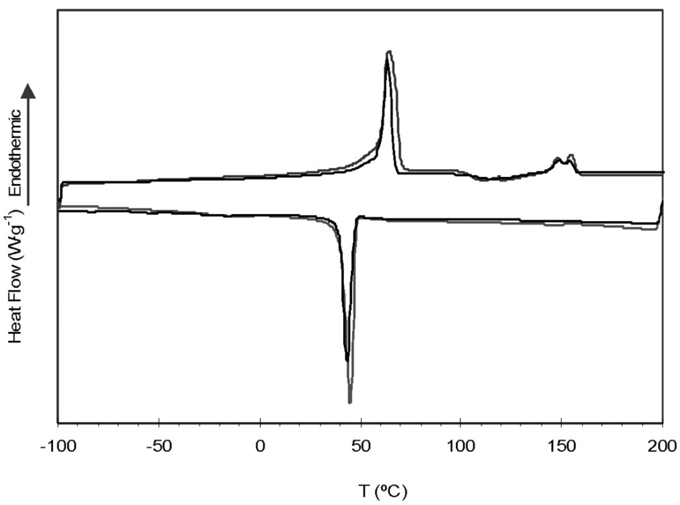


***Figure 2.*** *DSC thermograms of (black) pure Mater-Bi KE and (gray) its reinforced biocomposite.*

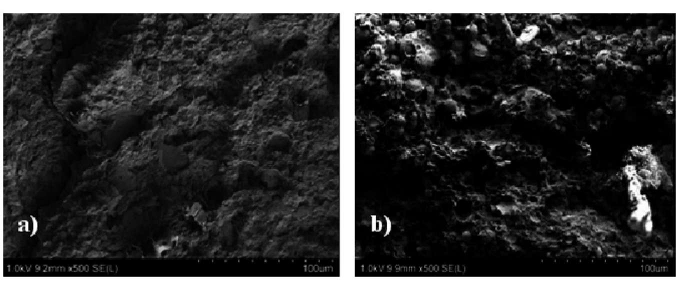


***Figure 3.*** *SEM micrographs of the sectioned surfaces of the a) pure Mater-Bi KE at 535 days of degradation and b) reinforced biocomposite after 535 days of degradation in soil.*

assess the degradation in soil of different biocomposites formed from the same polymeric matrix and different natural fibers in order to study the influence of each natural fiber, considering their different chemical composition.

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