**Durability of PLA – Modified Wood Composites**

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The commercial production of modified wood has increased over the last decade. This production and further processing also renders modified wood residuals in the form of shavings and sawdust that currently goes to energy production. One way to gain value of these residuals would be to further process them into fibers and flour to be used for production of new durable biocomposites. By combining the modified residuals with a biobased thermoplastic polymer, new durable biocomposites can be processed. In this study acetylated fiber and flour, thermally modified flour and unmodified fiber reference have been compounded with poly lactic acid (PLA) and injection molded into 80 mm long test bars with a cross section of 4 x 10 $mm^2$. The objective was to study these composites regarding the biological durability in a modified soil block test according to ASTM D1413. The specimens were also mechanically tested in three-point bending after the decay test.

The modified soil block test involved preconditioning specimens with a 2 week water soak at 22 °C, followed by placing horizontally in the soil bottles to facilitate the longer specimens. The brown rot fungus, *Gloeophyllum trabeum,* was used as the test fungi. The specimens were dried after decay testing to determine the weight loss. The mechanical evaluation in three-point bending was performed with a span length of 64 mm and the crosshead speed was 2 mm/min. The strength and modulus of the composites were calculated.

Results show that the resulting mass loss values are very low for all the composites tested, however the unmodified fiber reference composite showed the highest mass loss, see Table 1 for the mass loss from the soil block test.

**Table 1.** Corrected mass loss (%) from the soil block test.

| Material | Weight loss % |
|---|---|
| Pine sapwood control | 27.3 |
| | |
| PLA - Unmodified MDF fiber | 1.6 |
| PLA - Acetylated MDF fiber | 0.2 |
| PLA - Acetylated particles | 0.1 |
| PLA - Thermally modified particles | 0.0 |
| Pure PLA | 0.1 |

The mechanical evaluation showed an increase in modulus and a decrease in strength for all composites after preconditioning with water. The mechanical properties after decay have changed to a small extent except for the composites with unmodified wood fiber, which

show much lower strength and stiffness. See Figure 1 and 2 for the strength and stiffness before and after decay testing in the soil block test.

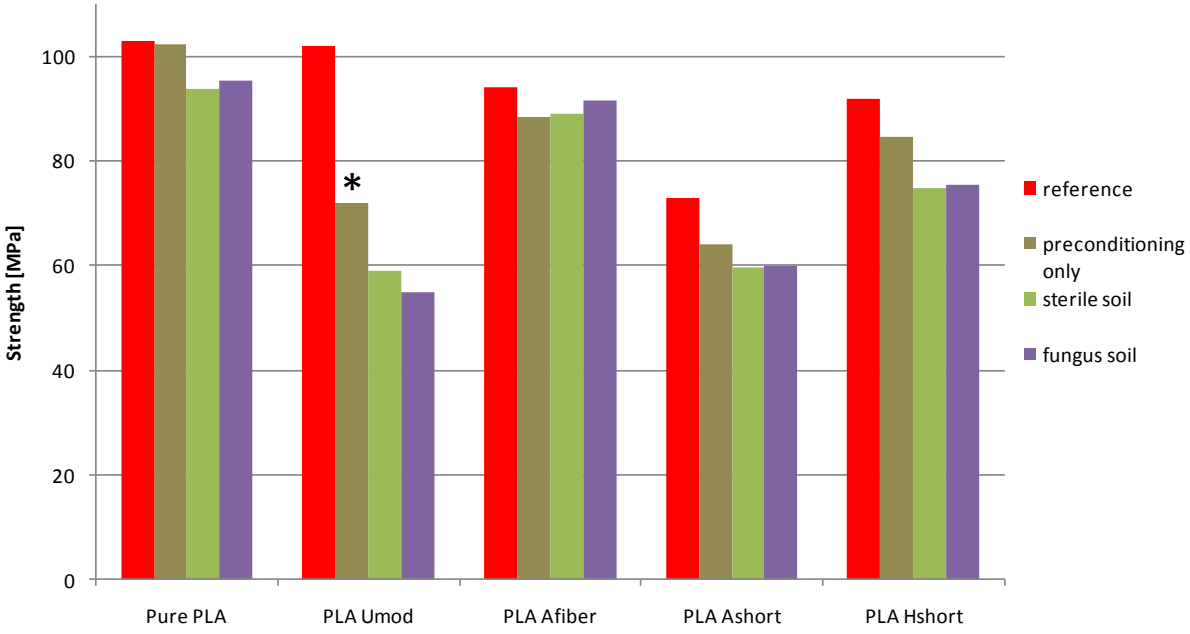


**Figure 1.** Strength (MPa) from three-point bending of specimens from soil block test. (Umod=Unmodified MDF fiber, Afiber=Acetylated MDF fiber, Ashort=Acetylated particles, Hshort=Heat treated particles) *Data for PLA Umod and preconditioning only have been obtained from another study on the same material and the same preconditioning.

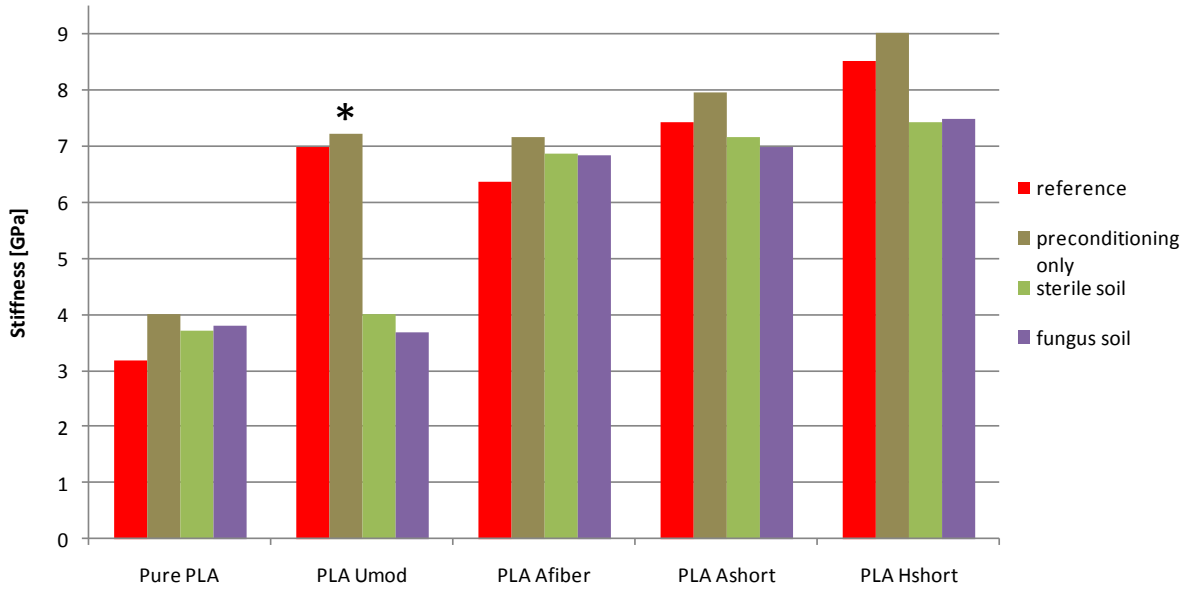


**Figure 2.** Stiffness (MPa) from three-point bending of specimens from soil block test. (Umod=Unmodified MDF fiber, Afiber=Acetylated MDF fiber, Ashort=Acetylated particles, Hshort=Heat treated particles). *Data for PLA Umod with preconditioning only have been obtained from another study on the same material and the same preconditioning.

Scanning electron microscope analysis of the surfaces of the tested materials show that the composites with unmodified fiber have formed surface cracks after decay test but not after preconditioning alone (see Figure 3). Cracks have also been found for the composites with acetylated and heat treated particles, but to a smaller extent than the composites with unmodified wood. Pure PLA and composites with acetylated fiber show no cracks at the surface.

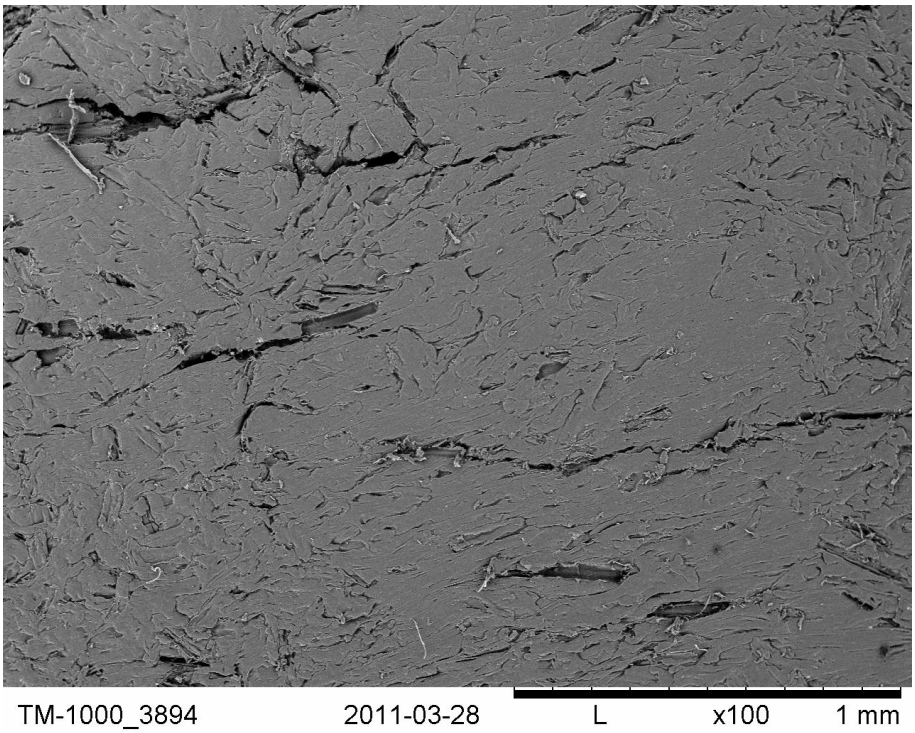


**Figure 3.** PLA-unmodified fiber after testing in compost soil

The biological durability of PLA – wood composites, according to the method used in this study, seems to be highly dependent on the wood component used. The pure PLA samples were not affected regarding weight loss and loss in mechanical performance after decay testing. The composites with acetylated fiber or particles or thermally modified particles also sustained the biological testing fairly well with only minor losses in strength and stiffness, whereas the composites with unmodified fiber had small weight losses from the durability tests but major losses in mechanical performance.

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