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# TENCEL® FIBER REINFORCED PLA COMPOSITES

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**Summary:** Today, Poly(lactic acid) (PLA) is the most commercially relevant biobased polymer, particularly in packaging applications. Due to its relatively high modulus and ultimate strength, PLA is also promising as a technical polymer. However, low impact strength and heat deflection temperature (HDT) still limit its application range. To overcome this shortage, one way is reinforcement with fibers. Of course, employing conventional reinforcement fibers like glass or carbon fibers defeats the purpose of a biobased polymer. Thus, fibers from renewable sources would be the logical choice for PLA reinforcement, yielding a 100 % bio-composite. However, typical natural fibers like hemp or flax have well known disadvantages like seasonal change of quality, emission of odorous compounds, and problematic processing. Man-made cellulose fibers produced from wood, like Tencel® by Lenzing AG, avoid these issues. Thus, the focus of this research was the production of PLA-Tencel® composites, and the exploration and optimization of their property profile.

Two Ingeo injection molding grades by Natureworks LLC were tested. While 3251D is a standard type, 3260HP is modified for accelerated crystallization with 1 wt% of a biobased lubricant. Tencel® FCP 10/300/M by Lenzing AG was used for reinforcement. Those fibers have a mean length of 300 µm, a diameter of appr. 10 µm, and are surface-modified to allow continuous dosing. Compounding was performed on a parallel, co-rotating twin screw extruder Brabender DSE20. Specimens were prepared on a Wittmann Battenfeld HM 1300/350 injection molding machine. The composites prepared were then tested for mechanical properties (tensile, impact, HDT), and characterized in terms of the melting and crystallization behavior (DSC and hot stage microscopy).

The results achieved show that tensile modulus and notched impact strength of PLA can be improved significantly by reinforcement with Tencel® FCP. However, heat deflection temperature cannot be increased as long as the matrix polymer stays amorphous. FCP acts as a nucleating agent, and allows PLA 3260HP to crystallize when cooled from the melt at 10 K/min. However, under processing conditions, cooling rates are usually much higher. Two different ways to still achieve crystallization were tested, namely 1) injection molding with high tool temperature and 2) annealing after injection molding. Both approaches have distinct effects on the mechanical and thermal properties of PLA composites, and allow a significant increase in heat deflection temperature.