Surface modification of natural fibers using bacteria

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Considering the current environmental, societal and political issues especially in the way we use materials, a pressing need for innovative, sustainable and recyclable materials can be identified. Industry and consumers need to move to greener materials to divert materials from waste streams. However, materials made from renewable resources should have the performance of conventional engineering materials we aim to replace. Our aim is to produce composites, which combine nano- and micrometer-sized reinforcements within a polymeric matrix to obtain hierarchical composite structures. This will allow us to create a new class of materials with both superior mechanical, environmental and chemical performance, as well as significantly reduced through-life costs.

The design, optimization and control of composite interfaces is the most crucial issue in composite engineering and more so in composites made from renewable resources, because of the known incompatibility of the natural fibers and many polymers used as matrix. Here we will present a novel route to tailor interfaces in natural fiber reinforced polymers. We have developed a truly green technique of modifying a variety of natural fiber surfaces to improve the interaction between the fibers and matrix by attaching nano-scale bacterial cellulose to the fiber surfaces. Bacterial cellulose was successfully attached to the fibers by culturing cellulose-producing bacteria, *Gluconacetobacter xylinus* BPR 2001, in presence of natural fibers. This natural fiber modification method does not affect the fiber tensile properties significantly; however, it results in a massive improvement of the interfacial shear strength, a measure of practical adhesion, between the modified fibers and renewable polymer matrices. These modified natural fibers were incorporated into cellulose acetate butyrate (CAB) and poly-L-lactic acid (PLLA) to create an entirely renewable hierarchical structure. Unidirectional natural fiber reinforced composites were manufactured to investigate the impact of the surface modification on the fiber and interface dominated composite properties. Both the tensile strength parallel as well as perpendicular to the fibers of the composites reinforced by bacterial cellulose modified natural fibers were found to increase dramatically, especially in the case of the PLLA matrix.