

Plenary Talk

PV VIII Tue 16:30 Audimax 1

The Structural Origins of Wood Cell Wall Toughness —

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Properties that are determined by structure - rather than by composition - are the basis of synthetic architected and meta-materials and of almost all natural materials. One remarkable example is wood. Despite being composed of only polymers, its hierarchical structure leads to specific strengths and stiffnesses that compete with those of high-performance engineering alloys.

The study presented here relates cellulose microfibril arrangements

to splitting fracture toughness in pine wood cell walls using in-situ electron microscopy and reveals a previously unknown toughening mechanism [1]. The splitting cracks propagate along the direction of the microfibrils, and are steered to and trapped at highly tough interfaces, where the microfibrils change direction. This previously unexplained arrangement of the microfibrils can now be understood as a natural adaptation of living wood to enhance its toughness.

The microfibril structure can be mimicked to provide a powerful, new tactic for designing tough engineering composites by arranging fibers and layers to introduce tough interfaces that attract and trap delamination cracks. Perspectives for the application of this tactic to several technological problems will be discussed.

[1] M.-C. Maaß et al. Adv. Mater. 2020, 32, 1907693