"Design of Smart High-Performance Cellulose Materials based on Wood"

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Abstract

The development of high performance sustainable materials based on renewable resources is one of the key challenges in materials science. Wood is a prominent example for an abundant, CO_2 storing, green resource that possesses enormous potential to play an important role in future materials advancement. Particularly, functional materials fabrication in bottom-up approaches using wood inherent cellulosic building blocks has attracted increasing attention over the last 20 years. Their vast amount of reaction sites, large surface area and superb mechanical properties make them a very promising raw material.
However, the need for energy intense disassembly processes and limitations in terms of reassembly, raise questions regarding scalability and the potential to transfer their excellent mechanical properties on the micro- and nanoscale to the bulk material level. Hence, the presentation covers recent developments regarding alternative manufacturing and functionalization processes that are based on a top-down approach utilizing the hierarchical structure of native wood or the wood inherent cellulose scaffolds. Structure retaining delignification of wood, optional matrix infiltration and a subsequent densification result in high performance cellulose materials characterized by excellent tensile properties with elastic moduli of up to 70 GPa and 600 MPa strength. Wet cellulose scaffolds can also be easily shaped which provides elements with high curvatures and cellulose fibres perfectly adapting to the shape. Smart lay-up manufacturing enables elements with mechanical gradients that facilitate force transfer.
In addition, cellulose scaffold functionalization strategies are highlighted, such as the in situ formation of Metal Organic Frameworks or Stimuli Responsive Polymers, to develop novel functional cellulose materials.

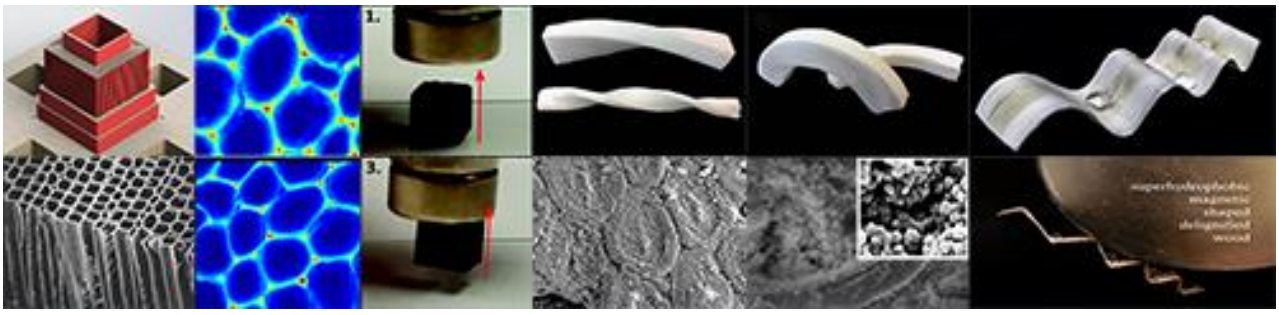

Figure: hierarchical wood structure; high resolution Raman imaging of wood cell walls; magnetic wood; shapeable cellulose scaffolds and wood-metal organic framework composites

Short Bio

Dr. Tobias Keplinger is group leader of the “Functional Wood Materials Characterization Group” at the Institute of Building Materials/Wood Materials Science at ETH Zürich. Before he has worked as PostDoc and completed his PhD with a thesis on versatile strategies for wood cell wall functionalization in 2016 at the same institute. By profession he is a chemist and studied at the Johannes Kepler University Linz, Austria. His current research interests are the development of novel hybrid wood based materials, the nano-structural and chemical analysis of wood functionalization processes by Confocal Raman Spectroscopy and Atomic Force Microscopy, and the fabrication of new types of wood based composite materials equipped with excellent mechanical properties, functionality and formability.