Séminaire

INSTITUT Charles SADRON
UPR 22 - CNRS - STRASBOURG

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Amphithéâtre Henri Benoît

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Multiscale Engineering & Additive Manufacturing of Sustainable Lignocellulosic Biomaterials

Global challenges of pollution and climate change underscore the need to tackle materials science from cradle to grave. As the most abundant CO2-neutral polymers available on Earth, forest-based biopolymers have a key role to play in this contest. Whereas the late nineteenth century has advanced the technology and value of paper and fiber production, the past ½ generation has expanded biomass valorisation to include biorefining. Yet, as much as 45% of the energy value of biomass continues to be ignored. Lignin, in particular, has the potential of contributing more value to the biorefinery than the other (carbohydrate-rich) components. Just as polysaccharides can become textiles, pharmaceuticals and nano-structures, lignin can become adhesives, epoxies, modulus-building and biodegradable thermoplastics. With lignocellulosic biorefineries coming to reality, exciting opportunities arise to diversify materials from biomass and replace undegradable, fossil-carbon based plastics. The scientific challenges then reside in endowing processability to lignocellulosic biomaterials and engineering their structure- processing-property relationships towards desirable functionalities.

Nature relies on simple materials design principles, including a recurrent use of molecular constituents, an orientation of structural elements, the design of durable interfaces between hard and soft segments, and the engineering of lightweight structures1. Bouligands2 and other hierarchical structures are also ubiquitous in Nature. These design principles and multi-level architectures confer processability and unique material functionalities such as high fatigue resistance, resiliency and complex shapes. Using Nature design principles, can we likewise shape lignocellulosic biomaterials and engineer their multi-level architectures towards desirable functionalities? Most inspiringly, using light as energy source and simple compounds as feedstocks, Nature cyclically biosynthesizes the major families of biomacromolecules and assembles them into highly-engineered biocomposites. These biocomposites, in turn, disassemble naturally into simple compounds and feedstocks at the end of their service life. Likewise, using light, can we molecularly program sustainable lignocellulosic biomaterials for a sustainable end of life?

Over the past 20 years, my group has strived to advance the use of lignocellulosic biopolymers and composites from the fundamental and technological perspectives. Inspired by the plant cell wall biosynthesis and shaping, we have more recently brought our attention to liquid crystalline lignin / polysaccharidic multiphase systems and their processability and engineering by additive manufacturing towards desirable shape, multi-scale structure and functionalities. This seminar will highlight the main findings and ongoing challenges for designing and 3D printing such liquid crystalline lignin / polysaccharidic multiphase systems. At the crossroads between macromolecular design, surface and interfacial science, polymer processing and physics, these complex systems provide unique opportunities for interdisciplinary and international collaborations in the Upper Rhine region. Prospects for such collaborations within the European Campus Eucor and particularly with research groups at the ICS will be highlighted in this seminar.

Les personnes souhaitant rencontrer M.-P. Laborie sont priées de prendre contact avec C. Serra.