UTILIZING BIOMATTER TO ENGINEER SUSTAINABLE HIERARCHICAL MATERIALS

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Abstract: In response to the pressing environmental challenges posed by non-degradable plastics and the substantial greenhouse gas emissions associated with traditional infrastructure materials, urgent action is imperative. Current approaches to clean energy materials often rely on unsustainable supply chains, exacerbating the sustainability dilemma. Recent studies propose a paradigm shift towards harnessing whole biological matter, or biomatter, as a foundational resource for sustainable materials. Biomatter, sourced from algal, bacterial, and fungal cells, has proved to be a versatile building block for hierarchical polymer nanocomposites. In its deceased state, biomatter exhibits tunable structural properties, while preserving viability unlocks living and responsive functions. Drawing inspiration from our recent breakthroughs in converting photosynthetic algal biomatter into thermoplastics through conventional thermoforming, and our initial explorations of integrating unprocessed biomatter into cement, we embark on pioneering a circular material design. This endeavor aims to establish a regenerative framework, moving beyond traditional linear material life cycles. In this holistic design, materials and systems aim to restore, renew, or replenish resources, minimizing waste and environmental impact. Furthermore, we outline prospects for in-situ resource utilization, envisioning locally grown biomatter tailored for specific material performances. This innovative approach holds the potential to bolster local communities and disrupt conventional supply chains.

Bio: Eleftheria Roumeli is an Assistant Professor in the Materials Science & Engineering department of the University of Washington. With a focus on developing and understanding sustainable materials, her research group explores new families of bioplastics, biocomposites, and environmentally friendly structural materials derived from biological building blocks, and specifically from biopolymers. The group investigates the relationships between structure, processing, mechanical properties and life cycle impacts in these novel classes of sustainable materials. Prior to joining UW, Eleftheria completed her postdoctoral work at the California Institute of Technology (2017-2020) and ETH Zurich (2015-2017) – both in Departments of Mechanical Engineering. She earned her B.S. (2009) and Ph.D. in Physics (2014) from the Aristotle University of Thessaloniki in Greece, where her research focused on understanding the structure-property relationships in synthetic polymer nanocomposite materials.