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K02: ENGINEERED LIVING MATERIALS AS INTEGRATED BIOPROCESSING SYSTEMS: FROM LIVING CELLS TO RESILIENT CITIES

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The convergence of biotechnology, materials science, and bioprocess engineering is opening new pathways for the creation of a new class of sustainable, high-performance materials. By organising living cells within structured matrices, Engineered Living Materials (ELMs) blur the traditional boundaries between upstream production, downstream purification, and final material functionality, enabling systems that grow, self-heal, and dynamically respond to their environment. Many natural systems, from microbial biofilms to biological tissues, already function as highly integrated living structures in which production, transport, and functional performance occur simultaneously. These natural systems provide powerful sources of bioinspiration for the design of materials that combine biological activity with structural functionality. This keynote will explore ELMs from the perspective of integrated bioprocessing processes. The talk will focus on engineered fungal biofilms and microbial consortia that can be organised within materials to form living coatings, printable inks, or composite materials. In these systems, microorganisms grow and produce their own structural matrices, creating functional materials directly during cultivation. By controlling growth conditions, formulation, and spatial organisation, living cells can be retained within the material, where they continue to perform useful functions such as sensing, regeneration, or bioremediation. This approach reduces the need for extensive downstream processing while enabling materials that remain active over time.

Beyond laboratory-scale design, the talk will address key challenges associated with scaling and deploying ELMs for the built environment. These include manufacturability, robustness and reproducibility, integration within existing bioprocess workflows, and the implications for techno-economic analysis and long-term performance. Regulatory classification, safety considerations, and public perception will also be discussed, as ELMs challenge established distinctions between materials and biological systems. By connecting bioinspired design, advances in bioseparation, process integration, and material design, this contribution aims to stimulate discussion within the BPP community on how engineered living materials can redefine sustainable manufacturing - from cells to cities.

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