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Living Interfaces: Fluid-Solid Interactions in Engineered Living Materials

Żywe interfejsy: oddziaływania cieczy i ciał stałych w inżynierskich materiałach ożywionych

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Abstract

Engineered living materials (ELMs) represent a new class of biohybrid systems in which living cells are embedded within structured matrices to deliver adaptive and long-lasting functionality. Unlike conventional materials, these systems actively exchange matter and energy with their surroundings, evolve, and respond to environmental stimuli. As a result, they behave less like passive solids and more like dynamic interfaces between biological activity, material structure, and surrounding fluids. This keynote will explore how bioinspiration from natural living interfaces can guide the design of next-generation functional materials. In nature, systems such as microbial biofilms, plant surfaces, and biological tissues operate as integrated fluid-solid environments in which transport, structure, and biological function are tightly coupled. These systems achieve remarkable capabilities, including self-regulation, self-repair, and adaptive transport of nutrients and metabolites. Translating such principles into engineered materials opens opportunities to design surfaces and porous structures that maintain functionality over long timescales while adapting to changing conditions. Examples from living coatings and biohybrid functional surfaces in architecture will illustrate how embedding living microorganisms within designed matrices enables materials to sense, respond, and regenerate. By outlining ELMs as bioinspired, adaptive interfaces, this contribution aims to highlight how lessons from natural systems can inform the development of sustainable materials with built-in functionality, resilience, and long-term performance.

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