Interactions at material-biofilm interfaces: preliminary synchrotron-based studies for next-generation living coating systems

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Abstract

Developing new sustainable materials often involves integrating biological systems into conventional material structures. Engineered Living Materials (ELMs), incorporating microorganisms represent a promising strategy for designing adaptive, self-healing, and environmentally responsive surface technologies. A critical aspect of this approach involves understanding how biofilms interact with material interfaces, especially in architectural contexts.

This study explores the potential of synchrotron-based X-ray microtomography (µCT) for investigating material-biofilm interfaces. Using *Aureobasidium pullulans* biofilms grown on wood samples (*Pinus sylvestris* L.), we conducted preliminary high-resolution 3D imaging at the POLYX beamline of the SOLARIS Synchrotron facility. Initial scans demonstrated the feasibility of capturing high-resolution 3D images, providing insights into hyphal network formation, substrate penetration, and biofilm integrity without compromising the natural state of the samples.

This advanced imaging technique provides a deeper understanding of fungal interactions with architectural materials, highlighting their interface and revealing their impact on structural integrity. Such insights are particularly relevant for the development of sustainable coating systems. This foundational work establishes a basis for future research on biofilm interactions across various materials and surfaces.

By focusing on material–biofilm interactions, this study supports the integration of microbial systems into sustainable coating design. The results offer valuable insight for developing next-generation, adaptive, self-healing surfaces that contribute to SDG13 (Climate Action) and promote environmentally responsible material innovation.

Keywords: biointerfaces, material–biofilm interactions, synchrotron imaging, Engineered Living Materials, sustainability

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