

PROCEEDINGS

Engineering Tough Bioadhesives for Precision Biointerfaces: From Interfacial Mechanics to Therapeutic Functions

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ABSTRACT

Seamless biointegration between synthetic materials and living tissues remains a central challenge in biointerface engineering, particularly in dynamic, wet, and mechanically demanding pathophysiological environments in the human body [1]. Conventional devices are often limited by weak adhesion, mechanical mismatch, and lack of adaptability, leading to failure under cyclic loading and complex biological conditions. There is a critical need for biointerfacing strategies that enable robust, stable, and functional integration while supporting precise therapeutic interactions [2].

By synergizing bioinspired design, supramolecular chemistry, and additive manufacturing technologies, we establish robust biointerfaces with programmable spatiotemporal control, enabling patterned adhesion and on demand detachment across complex biological and engineered surfaces [3-7]. These advances are supported by integrated computational and experimental approaches that elucidate fundamental multiphasic mechanisms governing interfacial behavior [3,8].

Beyond mechanical integration, we further develop hybrid medical devices that merge functional hydrogels with conventional biomedical materials, transforming traditional sutures and implants into multifunctional systems adaptable to diverse biomedical and clinical applications [4,6]. The resulting precision biointerfaces have been demonstrated to enhance tissue repair and cancer therapy, validated through in vitro, ex vivo, and in vivo models [7,9-12].

Collectively, this work positions multifunctional tough bioadhesives as a versatile platform for next-generation biointerfacing devices, bridging computational and experimental engineering to enable dynamic and therapeutic interactions with complex biological systems.

KEYWORDS

Adhesive; tough; biointerface; mechanics

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