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Photo-patternable, Mechanically Adaptive Polymers for Neural Interfaces

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Stimuli-responsive polymer that undergo a stiff-to-soft transition upon absorption of water are particularly useful as substrates for brain-machine interfaces. In the dry state, the substrate's stiffness facilitates the implantation of the device in the brain, but once inserted, the substrate softens as a result of water absorption. This reduces the mechanical mismatch between the device and the surrounding soft tissue that promotes a foreign-body response and ultimately contributes to the limitations of the lifetime of brain-machine interfaces.
The processing capabilities of mechanically adaptive polymers has generally been limited and their shaping has often relied on laser ablation, which has hindered their adoption in the field. Patterning these materials using a photolithographic process would facilitate their integration into the fabrication process and enable the development of complex structure. However, these changes would also require a significant revision of the materials' design. Thus, the work presented in this thesis aimed to develop new materials that combine mechanical adaptiveness and photo-patternability.
In this context, several systems were investigated, improving each iteration while taking the precedent results into account. A careful study of the materials allowed us to understand the structure-properties and process-properties relationships and enabled us to fully tailor the final properties of the materials to a targeted application. Importantly, spatial control over not only the mechanical- but also the optical properties, enabled the fabrication of mechanically adaptive optical waveguides and optogenetic probes.

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