Design and synthesis of light activated biomimetic peptide-based soft materials

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Naturally derived biomaterials offer biocompatibility but may lack batch-to-batch consistency and precise chemical tunability, limiting their use in advanced applications like drug delivery and tissue repair (1). Synthetic biomimetic peptides can address these limitations by producing consistent, peptide-only hydrogels that are both biocompatible and tunable in their properties at the atomic level (2).

Using optimized solid-phase peptide synthesis, we produced high-purity biomimetic peptides engineered with light responsive functional groups for rapid, light-triggered crosslinking. The peptides were purified by RP-HPLC, with identify verified by mass spectrometry, and analyzed for stable conformation and supramolecular assembly through circular dichroism. To leverage the spatial and temporal control offered by light activation, we introduced alkene and thiol moieties, enabling rapid thiol-ene reactions that allow for controlled material assembly (3). By systematically varying the peptide structure, we investigated how functional group configuration impacts the physical properties of hydrogels.

Our custom-designed biomimetic peptides formed strong hydrogels with finely tunable mechanical properties. Rheometry demonstrated that increasing reactive group density enhanced gel elastic modulus (G') up to the solubility limit. Allowing time for peptide folding of 1 hour before activation further strengthened the hydrogels, especially at lower concentrations.

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