Title

Tunable Viscoelasticity and Gelation Kinetics in Squaramide/PEG based Supramolecular-Covalent Double Network Hydrogels

Authors

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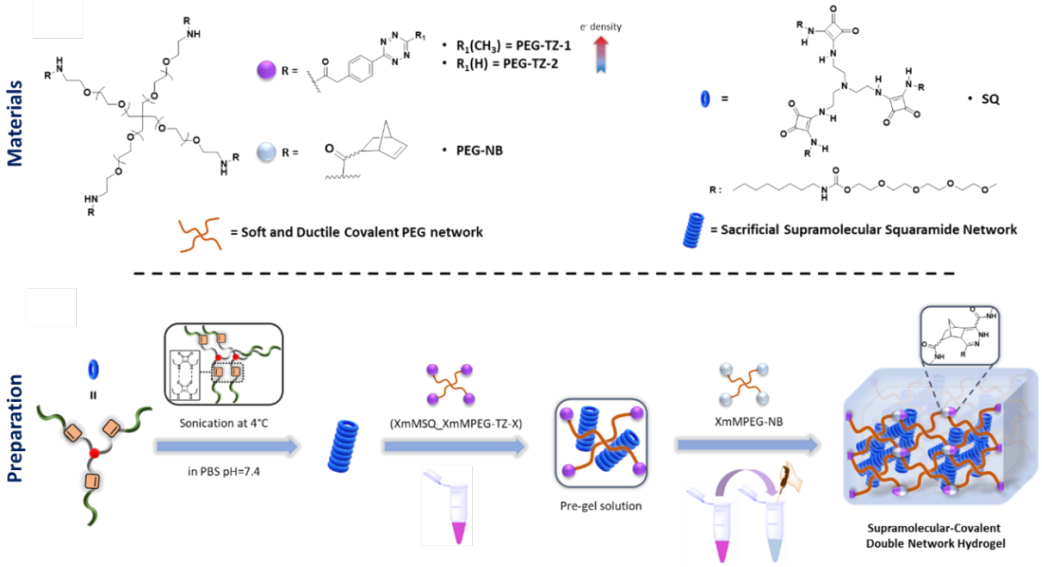
Abstract poster presentation

Traditional two-dimensional cell culture models often fail to replicate the three-dimensional nature of native cell environments, potentially altering cell behavior and differentiation. To address these limitations, there is a growing need to develop synthetic hydrogels mimicking the native behaviour of both structure and spatiotemporally developing mechanics (i.e. viscoelasticity) of the extracellular matrix.[1] The integration of bioorthogonal click chemistries into hydrogel systems has significantly advanced the field of dynamic and adaptable hydrogels for 3D cell culture applications.[2] Specifically, the inverse electron demand Diels–Alder (iEDDA) reaction, most notably, the tetrazine–norbornene (Tz-NB) click reaction, is an innovative cross-linking strategy for creating multifunctional hydrogels.[3]

In this study, the preparation of tetrazine monomers and their reaction with tetra-arm PEG macromonomers to obtain PEG-tetrazine/norbornene decoration enables the rapid formation of self-standing hydrogels within seconds to minutes, showcasing the time-dependent material properties and versatility of this reaction. The rheological characterization further reveals the unique mechanical properties and tunable kinetics of the resulting hydrogels.

Beyond the well-studied iEDDA reaction, this study particularly explores squaramide-based supramolecular cross-linking to engineer double network hydrogels with tunable stress relaxation and gelation kinetics. The results indicate that the desired tissue-specific elastic modulus, or 'stiffness,' and sol-gel transition kinetics can be achieved by adjusting the tetrazine moieties and total macromonomer concentration. Additionally, different stress-relaxation profiles can be obtained depending on the type of tetrazine moiety and the concentration of the incorporated squaramide network. These results provide a basis for mimicking the temporal stiffness change in the maturation of certain cell types such as cardiomyocytes.

Together with advances in cross-linking chemistry and supramolecular-covalent double network hydrogel design, our study offers promising tools for the development of sophisticated, cell-relevant materials with precise control over complex mechanics for 3D cell culture, tissue engineering, and other biomedical applications.



References (*max 3*)

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