Tailoring the Physico-Chemical and Biological Interface of Gelatin-Based Hydrogels: The Role of Lactic Acid in Network Stability and Cell Viability

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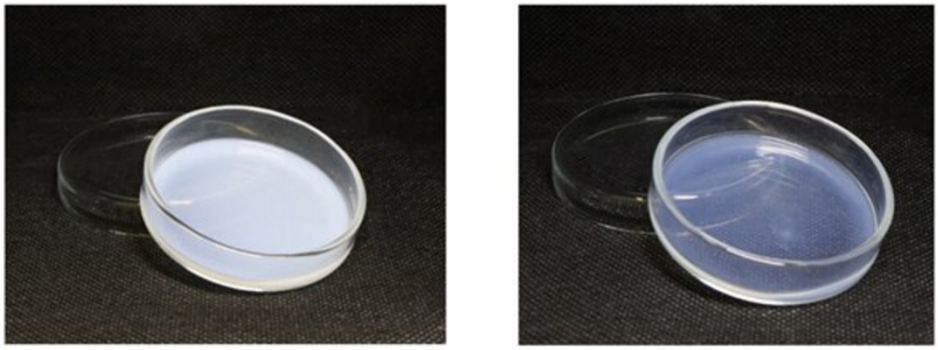
Hybrid hydrogels based on natural and synthetic polymers are key materials in modern bioengineering, yet achieving a balance between pre-polymerization stability, mechanical integrity, and biological activity remains a challenge [1-2]. This study investigates the influence of lactic acid (LA) and photoinitiator concentration on the structural and interfacial properties of gelatin-poly(ethylene glycol) diacrylate (PEGDA) networks synthesized via UV-induced photopolymerization A critical aspect of our research was the analysis of the stability of pre-polymerization mixtures using the Multiscan MS20 system. We demonstrate that the incorporation of LA significantly enhances the homogeneity of the system, preventing phase separation and ensuring a high light transmission (over 90%), which is crucial for uniform network formation. Rheological studies revealed thixotropic behavior and a pseudoplastic flow character, where LA concentration acts as a precise modulator of dynamic viscosity and final gel hardness. Furthermore, we show that LA content systematically reduces the swelling capacity in physiological fluids, providing better structural stability. Surface characterization (SEM and contact angle measurements) confirmed that LA increases surface free energy and hydrophilicity, directly impacting the bio-interface. Most importantly, cytotoxicity assays (HaCaT and P388D1 lines) revealed a dramatic shift in biocompatibility: while LA-free gels showed significant cytotoxicity (<15% viability), the optimized LA-modified networks achieved cell viability up to 88%. These findings position these tunable hydrogel platforms as promising candidates for bioactive implant coatings and advanced wound dressings with controlled mechanical and biological interfaces.

Keywords:
hydrogels; lactic acid, photopolymerization, colloid stability, bio-interface, cell viability, soft matter rheology



Photograph of the hydrogel material immediately after synthesis in the UV radiation field without and with the addition of lactic acid.

References:

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