Effects of Light Attenuation on Local and Bulk Mechanical Properties of Photopolymerized PEG Hydrogels

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Abstract

Cell experiments investigating cell behavior as a function of material stiffness are often carried out on the surface of hydrogels. An assumption that the bulk hydrogel mechanical properties represent the surface properties is often employed but in many cases is not valid. In photo-initiated radical polymerization, photons are absorbed by initiator chromophores generating high energy electrons. As photons progress through the prepolymer solution, the intensity of light that reaches the distal end of the solution is decreased through this attenuation. This work aims to determine whether light attenuation plays a significant role in local stiffness within a poly(ethylene glycol) diacrylate (PEGDA) hydrogel, compared to its bulk stiffness.

Differences in bulk properties were tested by varying the polymerization parameters of hydrogel cylindrical plugs, including sample thickness (0.7mm – 1.2mm), photoinitiator type (EosinY vs LAP), PEGDA weight percent, and exposure time. Mechanical loading data of the plugs was analyzed to reveal the relationships between the physical properties (e.g. thickness, surface area, volume) and chemical properties (e.g. monomer and initiator concentrations, exposure settings). Preliminary data suggests that an appreciable difference in physical properties exists between gels of differing thickness (1.0mm vs 0.3mm based on gel point). The goals of this work are to quantify the extent of this difference based on sample thickness, and to compare the bulk stiffness data with local surface stiffness measurements obtained using an AFM nano-indentation technique and determine whether changes in bulk properties carry over to changes in surface properties.

Keywords

hydrogel; photoinitiator; light attenuation; poly(ethylene glycol); LAP

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ABSTRACT

Cell experiments investigating cell behavior as a function of material stiffness are often carried out on the surface of hydrogels. An assumption that the bulk hydrogel mechanical properties represent the surface properties is often employed but in many cases is not valid. In photo-initiated radical polymerization, photons are absorbed by initiator chromophores generating high energy electrons. As photons progress through the prepolymer solution, the intensity of light that reaches the distal end of the solution is decreased through this attenuation. This work aims to determine whether light attenuation plays a significant role in local stiffness within a poly(ethylene glycol) diacrylate (PEGDA) hydrogel, compared to its bulk stiffness.

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