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Ultrasonic characterization and beyond: How to select a hydrogel for tissue engineering

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Hydrogels have emerged as a crucial class of materials within the field of tissue engineering. There is growing interest in matching the mechanical properties of hydrogel scaffolds to tissues in the human body and optimizing these properties for cell growth and differentiation. Gelatin methacrylate (GelMA) is a well-accepted, biocompatible hydrogel with tunable mechanical properties. However, the effects of various formulation parameters on its mechanical properties are not well understood. In this study, an array of GelMA scaffold fabrication parameters is evaluated by varying GelMA concentration and ultraviolet light exposure time. Our overarching goal is to characterize the mechanical properties through ultrasound and rheological measurements, providing a framework for GelMA scaffold selection. Pulse-echo ultrasound techniques were used to non-invasively determine the sound speed and attenuation of the scaffolds, revealing significant dependence on GelMA concentration. Steady shear rate and strain- and frequency-controlled oscillatory shear tests using a rotational rheometer (Model: DHR-2, TA Instruments) revealed a range in the levels of shear-thinning as well as viscoelasticity and showed moduli-dependence on both GelMA concentration and light exposure time. Together, this acoustic and rheological characterization can be used to inform the selection of GelMA scaffolds in tissue engineering applications.