Biomaterials are commonly used to encapsulate cells, generating 3D structures for tissue engineering applications and the fundamental study of cellular behavior. Mechanical properties, such as elasticity and porosity, are critical design parameters for these scaffolds due to their known influences on cell behavior. However, the exact cellular response varies based on the cell type, the chemical structure of the biomaterial, and any change in the mechanical properties over time. In this work, a new technique, cavitation microrheology, was used to understand how mechanical properties within 3D materials change over both time and position in alginate scaffolds. Alginate is a natural biopolymer that crosslinks based on the local calcium concentration in the gel. We have taken advantage of this ionic gelation to quantify the precision, accuracy, and resolution afforded by cavitation microrheology in application to natural polymers. We went on to characterize the degradation of alginate hydrogels in phosphate-buffered saline and cell culture medium, as well as fibroblast-seeded scaffolds. This new technique is able to correlate local mechanical microenvironments with neighboring cell function, providing new insights into cell-matrix interactions as well as heterogeneities observed in device function. Future work is aimed at understanding cellular remodeling and extracellular matrix production in response to stimuli (mechanical or chemical) over both time and space in 3D biomaterial scaffolds.

Figure 1: Cavitation microrheology instrumentation for the analyses and quantification of microscale mechanical properties within 3D materials.