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Determining local mechanical properties of biological scaffolds

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ABSTRACT

The last decade has shown great progress in developing increasingly sophisticated 3D extracellular scaffolds closely mimicking in-vivo environments, yet our understanding of material properties of these scaffolds is still in its infancy. This is in large part due to the lack of available experimental techniques capable of mechanically characterizing these networks at the microscale. Traditional material testing procedures including shear and uniaxial characterization protocols have not been able to resolve details at the microscale due to their intrinsic macroscale nature. Yet, this information is critically important not only to understand how cells function within their surroundings in 3D, but also to lay a quantitative foundation of cellular mechanosensing and mechanotransduction in 3D. To address these challenges, we present a noninvasive 3D experimental apparatus for measuring the force–displacement response in soft biological scaffolds. By mapping the local 3D material deformations under the application of well-calibrated forces and loading rates, we are able to extract the time-dependent mechanical properties of these scaffolds at the microscale.