

## **Microrheological characterization for biological applications and soft material design**

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Synthetic scaffolds are designed to be remodeled and degraded by migrating cells for applications in tissue engineering, wound healing and stem cell culture. Although the starting material properties can be meticulously designed, as cells interact with the scaffold little is known about how the rheological properties and microenvironments evolve. The development of techniques that are sensitive to the evolution of the rheological material properties during gelation and degradation and spatial changes in the microenvironment will fully characterize the pericellular region. To meet this end, I have developed techniques that measure the equilibrated scaffolds and transient rheological properties, such as those occurring during gelation and degradation, using multiple particle tracking microrheology (MPT).

My work has focused on the development of a high-throughput characterization technique that combines MPT with sample preparation in a microfluidic device,  $\mu^2$ rheology, to rapidly measure material rheological properties. MPT is a passive microrheological technique that captures the Brownian motion of embedded probe particles.  $\mu^2$ rheology is used to screen equilibrated scaffold material properties over a large composition space yielding a high information density, but requiring only small volumetric amounts. From the data collected, gelation state diagrams are created identifying compositions where hydrogels form.

Secondly, my work has focused on the application of MPT to characterize complex, cell-laden hydrogelators to better understand how cells degrade and remodel their local environment. A model hydrogel system is first characterized, measuring the enzymatic degradation of the scaffold as the amount of a matrix metalloproteinases (MMP) degradable peptide cross-links (KCGPQG\*IWGQCK) is varied. The gel-sol transition and spatial heterogeneity are quantitatively measured. These results are used to understand remodeling and degradation of the scaffold in the pericellular region of encapsulated cells, enabling the identification of the rheological properties and spatial variations that are required to enhance and control cell motility.