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Solvent-induced changes in the structure and rheology of polyelectrolyte solutions.

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By integrating microfluidics and particle tracking microrheology, we have constructed a dialysis cell for microrheology, which provides unique opportunities for studying the dynamics of microstructural changes induced by changes in solvent composition. Such experiments are virtually impossible with mechanical rheometers. The concept and design of the microdialysis cell will be discussed, and data will be presented on the structural and rheological response of polyelectrolyte solutions to changes in ionic strength. Sulphonated polystyrene is a water-soluble polymer and its molecular conformation in solution strongly depends on ionic strength of the solution. It will be shown that quantitative measurements of transient solution viscosity during solvent exchange can be performed with the new dialysis cell. Experiments were also performed on amphiphilic block copolypeptide (BCP) hydrogels, which self-assemble into fibrillar structures due to a subtle balance between attractive and repulsive intermolecular forces. Electrostatic repulsion between the hydrophilic L-lysine blocks plays a key role. Therefore, changes in ionic strength have a significant effect on the self-assembled local structure and mechanical properties of the BCP gels, as was previously observed in rheometer experiments. Microrheology in the dialysis cell provided a much more complete picture, revealing the occurrence of microscopic phase separation upon the addition of salt. For example, in a K160L40 lysine-leucine block copolypeptide, the motion of tracer particles in the hydrogel is homogeneous in DI water. After the addition of salt, microrheology reveals the co-existence of populations of freely moving and immobilized particles. The changes in local microstructure were found to be reversible when the ionic strength of the solution was lowered again. Data will be presented on the dynamics of the morphological and rheological changes of various block copolypeptide hydrogels.