

*250th American Chemical Society National Meeting
August 16-20, 2015, Boston, MA*

Division of Polymer Chemistry, Abstracts

Biological function and osmotic properties of cartilage polymers

Ferenc Horkay and Peter J. Bassler

Section on Tissue Biophysics and Biomimetics, Program in Pediatric Imaging and Tissue Sciences, Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health

Aggrecan, an anionic polyelectrolyte, is one of the major polymeric components of cartilage extracellular matrix. Like many biological macromolecules, the structure of aggrecan is uniquely tailored for its biological function: it exhibits a bottlebrush architecture consisting of an extended protein core to which many chondroitin sulfate and keratan sulfate chains are attached. In cartilage extracellular matrix, aggrecan molecules form a complex with hyaluronic acid and link protein. In the aggrecan-hyaluronic acid complex as many as hundred aggrecan molecules are associated with a hyaluronic acid chain. The micro-gel like complexes enmeshed within a network of collagen fibers exert a high osmotic swelling pressure that resists compressive loads.

We investigate aggrecan and aggrecan-hyaluronic acid solutions using an array of complementary experimental techniques probing the structure and interactions over a broad range of length scales from the molecular to the macroscopic scales. Osmotic pressure measurements and rheological measurements are reported for solutions of aggrecan-hyaluronic complexes with different ratios of aggrecan to hyaluronic acid. Small-angle neutron scattering and small-angle x-ray scattering is used to reveal the organization of aggrecan molecules in solutions. The effect of ionic strength and counterion valence is studied by osmotic pressure measurements and scattering measurements. Ionic effects are of great importance because aggrecan assemblies participate in cartilage skeletal metabolism by binding calcium ions. It is demonstrated that aggrecan exhibits polyelectrolyte behavior that is remarkably different from that of typical linear polyelectrolytes in solution.