Abstract **2023 Materials Research Society Conference**
November 26 - Decamber 1, 2023, Boston, MA

The role of hyaluronic acid in the organization of aggrecan in the extracellular matrix

Ferenc Horkay[1], Emilios Dimitriadis[2], Iren Horkayne-Szakaly[1], Peter J. Basser[1]

[1]Section on Quantitative Imaging and Tissue Sciences, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, 13 South Drive, Bethesda, MD 20892, USA

[2]Laboratory of Bioengineering and Physical Science, National Institute of Biomedical Imaging and Bioengineering, National Institutes of Health, 13 South Drive, Bethesda, MD 20892, USA

Aggrecan is a negatively charged bottlebrush shaped biopolymer molecule. Bottlebrush structures provide excellent lubrication in living systems. Inspired by the lubrication properties of biological systems (e.g., synovial fluid), synthetic bottlebrush polymers have been designed and synthesized. In the extracellular matrix (ECM) aggrecan exists as an aggregate where aggrecan molecules are noncovalently attached to long hyaluronic acid (HA) chains. Aggrecan-HA complexes are important for the mechanical response of cartilage. They exhibit high osmotic modulus, which defines the resistance of the tissue to compressive stress. We studied the hierarchical organization and the scattering properties of hyaluronic acid solutions and aggrecan-hyaluronic acid complexes. Small angle neutron scattering (SANS) and static and dynamic light scatting (SLS and DLS) measurements reveal a domain structure of size greater than several hundred nanometers. At higher values of wave vector, the SANS response corresponds to rod-like structures, of length consistent with the hydrodynamic correlation length associated with the fast diffusion coefficient. Calcium ions do not affect the geometric properties of these domains. DLS is used to investigate the effect of charge valence on the relaxation rates of the concentration fluctuations. The fast diffusive mode in the autocorrelation function becomes slower in the presence of calcium relative to sodium counter-ions. The slow mode, however, becomes faster with calcium ions. Reasonable agreement is found between the scattering intensity of the osmotic concentration fluctuations obtained from DLS and from the SANS response. Atomic Force Microscopy is used to determine the morphology of the aggrecan-HA complexes.