# BIOMECHANICAL PROPERTIES OF COLLAGENS STUDIED BY BRILLOUIN LIGHT SCATTERING SPECTROSCOPY AND ATOMIC FORCE MICROSCOPY

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**Introduction**: Collagen is the most abundant protein in the human body and the main component of highly organized tissue structures. Its fibrillar structure is responsible for biomechanical anisotropies in the tissues and their exceptional elastic properties. In the present work we use Brillouin light scattering (BLS) spectroscopy and atomic force microscopy (AFM) for probing elastic properties of collagen fibers harvested from different tissues. While BLS spectroscopy is non-invasive and label-free modality for probing mechanical properties of fibrous tissues that can give information on structure-function properties of normal and pathological tissues on micrometer scale, AFM provides elastic property information in contact manner on nanometer scale

**Methods:** Fresh cut samples of bovine flexor tendon and collagen fibers from the rat's tails were used in the study. Tendon was cut along and across of the fiber axis. Collagen fibers from the rat's tail were collected from the tail of Sprague-Dawley rats that were euthanized for other purposes. Before the experiments fibers were hydrated in phosphate buffered saline (PBS). 6-pass scanning tandem Fabry-Perot interferometer equipped with single photon counter was used to collect BLS spectra in backscattering geometry. BLS was recorded for different tilting angles of collagen fibers in the sample plane. Elastic (Young's) moduli of collagen samples were determined from the position of Brillouin spectral peaks fitted with Lorentzian. From AFM measurements different indentation (force) curves were obtained at various points on collagen samples and fitted with Hertz-Sneddon model to find Young's modulus.

**Results:** There is a distinct difference between elastic modulus of collagen fibers measured across or along the cut of the tendon (≈1.5 fold). Significantly higher difference was measured with AFM with ≈3 fold difference between the samples. The difference is due to various lateral spatial scales accessed in both techniques. Elastic modulus of the single fiber of collagen from rat-tail was found to be 2.815 ± 0.016 Gpa, which is in agreement with earlier results. We were able to see a shift of elastic modulus with tilting angle of collagen fiber and found a negative correlation between these two parameters. Elastic modulus of the collagen fiber decreased with a rotation of this fiber from 0° to 90° angle. Numerical simulations showed consistency with the experimental results.

**Conclusion:** BLS has proven to be non-contact, non-invasive, and label-free laser technique that can be combined with other optical methods and with AFM to assess elasticity and collagen fibers orientation in cancer tissues and tissue engineering applications. We ere able to see correlation between biomechanical properties measured with BLS and AFM.