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Mechanical Property measurements of Single Nanofibers

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Mechanical properties of biological materials play an important role in physiology. Specifically, mechanical properties of nanofibers are important to the extracellular matrix as well as in blood coagulation. Previous studies measured mechanical and structural properties such as creep, storage modulus, G', and loss modulus, G" of nanofiber mats or bundles however, individual fiber properties were not measured due to measurement limitations because of the size of the fibers. However, advances in technologies, instrumentations and techniques now allow us to probe the properties of individual nanofibers. The mechanical properties of individual fibers help us to understand and model the properties of the bulk fiber network. Our research focuses on the mechanical properties of fibrin fibers and electrospun fibrinogen. Studies on electrospun fibers have determined their bending modulus and extensibility and elastic limit. We have worked in concert with these efforts to expand the knowledge of single fiber mechanical properties using a combined atomic force microscope (AFM) and inverted optical microscope. We found fibrin fiber have a modulus of 4 +/- 3 MPa when uncrosslinked and 15 +/- 7 MPa when crosslinked. When we measured a variant fibrinogen molecule, which eliminates gamma-gamma crosslinking, the modulus was 10 +/- 12 MPa. We also measured the extensibility of the fibers, the extensibilities were 221 +/- 44 %, 177 +/- 58 % and 236 +/- 96 % for uncrosslinked, crosslinked and variant fibrin, respectively. In addition we measured the modulus (17.6 +/- 1.5 MPa) and extensibility (130 +/- 10 %) for electrospun fibrinogen fibers. These studies provide insight into the similarities and differences between native and electrospun fibrin/fibrinogen fibers as well as, provide insight in to the role of crosslinking on the mechanical properties of fibrin fibers.