Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Nonlinear response and crack propagation in Articular Cartilage modeled as a biopolymer double network[1] ANDREW SINDERMANN, Rochester Institute of Technology, LENA BARTELL, LAWRENCE BONASSAR, ITAI COHEN, Cornell University, MOUMITA DAS, Rochester Institute of Technology — Articular cartilage (AC) is a soft tissue that covers the ends of bones to distribute mechanical load in joints. It is primarily composed of water, type II collagen, and large aggregating proteoglycans called aggrecan. Its fracture toughness is extremely high compared to synthetic materials, but the underlying physical mechanism is not well understood. Here we investigate how the toughness of AC depends on its microscale composition and structure by modeling it as a double network made of collagen and aggrecan embedded in a background gel, and by using rigidity percolation theory to characterize its mechanical response to shear and compressive (or tensile) strains. Our calculations of the mechanical moduli, as well as network-wide heat maps of local strains and energy show shear-stiffening and compression-softening with increasing applied strain, in good qualitative agreement with known experimental results. Notches are then introduced in the network to study crack propagation under shear and tensile strains for various applied loads. Preliminary results indicate a loading threshold above which the network will undergo catastrophic failure by fracturing. Our results may help to formulate a Griffith-like criterion for crack propagation and fracture in soft tissues.

[1]This work was partially supported by a Cottrell College Science Award from the Research Corporation for Science Advancement

Moumita Das
Rochester Institute of Technology

Date submitted: 11 Nov 2016 Electronic form version 1.4