Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Alignment and Stiffening of Liquid Crystal Elastomers under Dynamic Compression ADITYA AGRAWAL, Rice University, PRABIR PATRA, University of Bridgeport, PULICKEL AJAYAN, WALTER CHAPMAN, RAFAEL VERDUZCO, Rice University — Biological tissues have the remarkable ability to remodel and repair in response to disease, injury, and mechanical stresses, a phenomenon known "functional adaptation" or "remodeling". Herein, we report similar behavior in polydomain liquid crystal elastomers. Liquid crystal elastomers dramatically increase in stiffness by up to 90 % under low-amplitude, repetitive (dynamic) compression. By studying a systematic series of materials, we demonstrate that the stiffness increase is directly influenced by the liquid crystal content of the elastomers, the presence of a nematic liquid crystal phase and the use of a dynamic as opposed to static deformation. Through a combination of rheological measurements, polarizing optical microscopy and 2-D X-ray diffraction, we demonstrate that self-stiffening arises due to rotations of the nematic director in response to dynamic compression, and show that the behavior is consistent with the theory for nematic rubber elasticity. Previous work with liquid crystal elastomers has focused primarily on 'soft elastic' deformations at large strains, but our findings indicate rich behavior at previously overlooked low-strain, dynamic deformations.

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Date submitted: 18 Nov 2012 Electronic form version 1.4