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Nonlinear microrheology and molecular imaging to map microscale deformations of entangled DNA networks TSAI-CHIN WU, RAE ANDERSON, University of San Diego — We use active microrheology coupled to single-molecule fluorescence imaging to elucidate the microscale dynamics of entangled DNA. DNA naturally exists in a wide range of lengths and topologies, and is often confined in cell nucleui, forming highly concentrated and entangled biopolymer networks. Thus, DNA is the model polymer for understanding entangled polymer dynamics as well as the crowded environment of cells. These networks display complex viscoelastic properties that are not well understood, especially at the molecular-level and in response to nonlinear perturbations. Specifically, how microscopic stresses and strains propagate through entangled networks, and what molecular deformations lead to the network stress responses are unknown. To answer these important questions, we optically drive a microsphere through entangled DNA, perturbing the system far from equilibrium, while measuring the resistive force the DNA exerts on the bead during and after bead motion. We simultaneously image single fluorescent-labeled DNA molecules throughout the network to directly link the microscale stress response to molecular deformations. We characterize the deformation of the network from the molecular-level to the mesoscale, and map the stress propagation throughout the network. We further study the impact of DNA length (11 – 115 kbp) and topology (linear vs ring DNA) on deformation and propagation dynamics, exploring key nonlinear features such as tube dilation and power-law relaxation.

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