Active microrheology of entangled biopolymer composites link polymer flexibility and length to molecular force response

ROBERT FITZPATRICK, COLE HAUER, University of San Diego, CARL KYRILLOS, Georgetown University, RYAN MCGORTY, RAE ROBERTSON-ANDERSON, University of San Diego — Entangled polymers have complex viscoelastic properties that are tuned by polymer lengths and flexibilities. Entangled composites of distinct polymers offer added versatility and display nonlinear mechanics, serving as a platform for multifunctional materials. To determine the role of flexibility and length in polymer composites we use optical tweezers and confocal microscopy to measure mechanical and structural properties of co-entangled actin and DNA. Actin filaments have lengths of 5-20 μm, comparable to their persistence length, while DNA of similar lengths have hundreds of persistence lengths per chain. To characterize the nonlinear mechanics of actin-DNA composites, we optically drive a microsphere through the composite and measure the induced force during and following strain. We characterize viscoelasticity and relaxation timescales; and determine the dependence of these quantities on the actin:DNA ratio (0:1-1:0) and DNA length (4-100 μm). We use confocal microscopy to image distinctly labeled co-entangled actin and DNA and characterize network homogeneity and fluctuations. Initial results show actin and DNA are well-integrated and form structurally homogenous networks that exhibit stiffness and relaxation times that increase nonlinearly with increased actin.

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