Persistence length strongly contributes to network mechanics of entangled semiflexible filaments

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The mechanics of complex soft matter such as cells or tightly-entangled biopolymer networks cannot be understood in the classical physical frame of flexible polymers or rigid rods. Instead, the underlying constituent filaments are semiflexible, with their finite bending stiffness ( ) leading to non-trivial bulk mechanical responses [1]. A natural model for such polymers is the protein actin [2–5]. Experimental studies of actin networks, however, are limited since the persistence length ( ) cannot be readily tuned [2,4].

Here, we experimentally investigate this parameter for the first time through bulk rheological and single-filament measurements of entangled networks formed by structurally tunable DNA nanotubes [6,7]. This de novo model system enabled the validation of numerous characteristic properties inherent to semiflexible polymers and networks thereof, i.e. persistence length, inextensibility, reptation, and mesh size scaling. While the scaling of the elastic plateau modulus with concentration is consistent with previous measurements [4] and established theories [3–5], the emerging persistence length scaling is opposing predominant theoretical predictions [3–5].

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