

ELECTRONIC SUPPLEMENTARY INFORMATION

Rate-independent hysteretic energy dissipation in collagen fibrils

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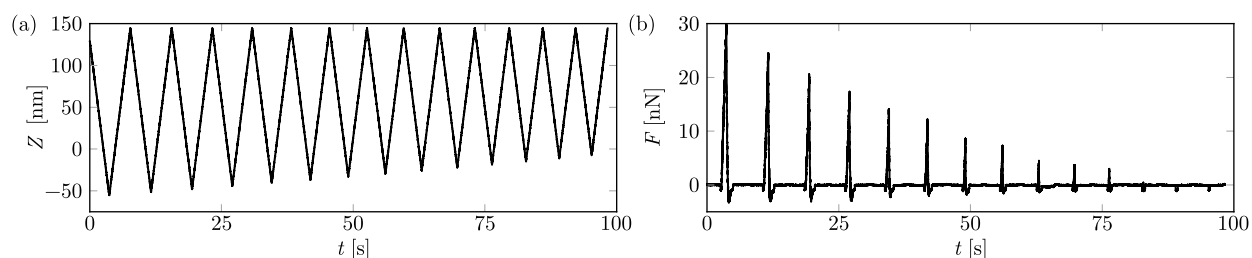


FIG. S1. Experimental protocol for measuring a force trajectory with multiple approach-retract cycles. (a) Piezo displacement Z and (b) measured force F as a function of time t . The data shown are measured on a hydrated collagen fibril at 90% RH using $v_{\text{tip}} = 0.05 \mu\text{m/s}$.

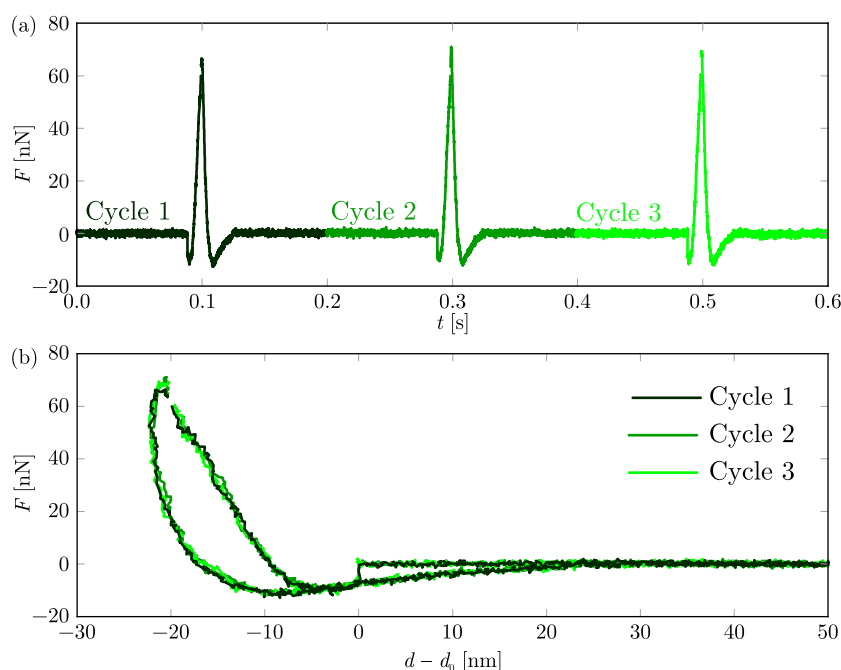


FIG. S2. (a) Force trajectory with three approach-retract cycles measured on a hydrated collagen fibril using $v_{\text{tip}} = 2 \mu\text{m/s}$, the same approach setpoint, and a type I AFM tip. (b) The perfect overlap of the corresponding FD cycles demonstrates the steady-state hysteresis and the surface leveling after tip retraction beyond d_{off} . The d_0 position was determined from the first FD cycle. Note that due to the large opening angle of the Type I AFM tip, the maximal indentation is smaller than with Type II AFM tips.

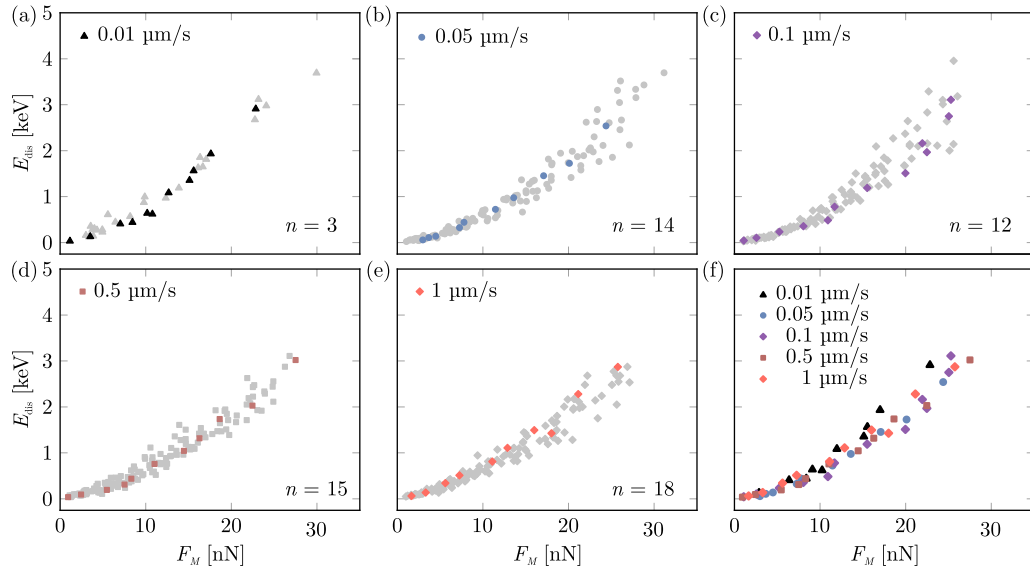


FIG. S3. (a–e) E_{dis} as a function of F_M measured with different v_{tip} in cyclic indentation experiments at n individual positions on the overlap region of the collagen fibril. Colored points are data sets shown in Fig. 2b, which is reproduced in panel (f).