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Dielectric fluctuations and the origins of non-contact friction
SEPPE KUEHN, ROGER F. LORING, JOHN A. MAROHN, Department of Chemistry and Chemical Biology, Cornell University, Ithaca, NY 14853 — Dielectric fluctuations underlie a wide variety of physical phenomena, from ion mobility in electrolyte solutions and decoherence in quantum systems, to dynamics in glass-forming materials and conformational changes in proteins. Here we show that dielectric fluctuations also lead to non-contact friction. A detailed understanding of non-contact friction is essential to micromechanical systems and the continued success of high sensitivity scanned probe microcopies such as magnetic resonance force microscopy. We study non-contact friction by using high sensitivity, custom fabricated, single crystal silicon cantilevers to measure energy losses over poly(methyl methacrylate), poly(vinyl acetate), and polystyrene thin films. We present a new theoretical analysis, relating non-contact friction to the dielectric response of the film, which is consistent with our experimental observations. We believe this constitutes the first direct, mechanical detection of friction due to dielectric fluctuations, and establishes a new route to the measurement of these fluctuations at the nanoscale.

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