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Optical Nanofluidic Piston: Assay for Dynamic Force-Compression of Single Confined Polymer Chains AHMED KHORSHID, PHILIP ZIMNY, PATRICK MACOS, GEREMIA MASSARELLI, DAVID TÉTREAULT-LA ROCHE, WALTER REISNER, McGill University — While single-molecule approaches now have a long-history in polymer physics, past methodology has a key limitation *: it is not currently possible to apply well-defined forces to a precise number of chains in a well-defined volume. To this end,* we have developed a nanofluidic assay for the study of DNA compression in vitro, the *optical nanofluidic piston.* The optical nanofluidic piston is a nanofluidic analog of a macroscopic piston-cylinder apparatus based on a nanosphere ("the piston") optically trapped inside a 200-400nm nanochannel with embedded barrier (the "cylinder"). The nanofluidic piston enables quantification of force required to compress single or multiple chains within a defined volume. We present combined fluorescence and force-measurements for the compression of T4 DNA under a variety of compression rates. Surprisingly, we find that compression occurs on a force-scale roughly 100x higher than that predicted by equilibrium theories, suggesting that the DNA is present in highly entangled states during the compression. Moreover, we observe that compression at high rates induces a "shock-wave" of high-polymer concentration near the bead, suggesting that our setup can quantitatively access novel non-equilibrium polymer phenomena.

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