

Abstract Submitted
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DNA Dynamics in a Microfluidic Device PATRICK DOYLE, MIT, GREG RANDALL, MIT — We present a general analysis and experimental study of DNA deformation in complex electric field gradients created inside microfluidic devices. Double-stranded DNA, free of its native proteins, is a “model polyelectrolyte” because reliably monodisperse samples can be attained with a uniform negative charge. Furthermore, the molecules can be stained with fluorescent probes and their motion directly observed by single-molecule microscopy. Large DNA coils move at a size-independent velocity in uniform electric fields and can significantly deform in electric field gradients. Because the electrophoretic velocity field is a potential field, local deformation of DNA in any electric field gradient is pure elongation, quantified by a strain rate and axes of extension and compression. From this analysis we construct the electrophoretic Deborah number, the non-dimensionless parameter that governs deformation of a polyelectrolyte in an electric field gradient. Over a range of Deborah numbers, we experimentally study single-molecule DNA deformation dynamics in model geometries such as a sharp contraction and a non-conducting cylinder. Analogous to deformation in hydrodynamic velocity gradients, we report both critical coil-stretch behavior and a strong dependence on the zero-strain DNA configuration. Furthermore, we apply these results to DNA mapping and DNA sequencing innovations.

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