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Using hydrodynamics to control DNA conformation for genotyping, sorting, and analysis

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Understanding the dynamics of biopolymers in complex flows is critical for the successful design of lab-on-a-chip devices. Work by Chu, Shaqfeh, and others using both Brownian dynamics simulations and direct, single molecule visualization methods have yielded unprecedented insights into DNA dynamics in simple shear, planar extension, and a range of linear mixed flows. Here, we focus on two flows designed to stretch and manipulate DNA conformation for single molecule genotyping and analysis; that is, flows designed to produce specific conformation fields. First, we present results on DNA in pressure-driven flow through a post array, and discuss insights from direct comparisons with Brownian Dynamics simulations by Shaqfeh and co-workers. Second, we consider stagnation point flows and, through the use of sequence-specific probes, demonstrate the potential of these flows for target sequence identification, single molecule studies of enzyme kinetics, and sorting.