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University of Wisconsin-Madison
Genomic Sciences Training Program

Fostering new paradigms for the biological sciences

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Room 1408, Genetics/Biotechnology Center, 425 Henry Mall

Single DNA Simulation in Microchannel Confinement

Abstract:

It is generally perceived that the microfluidic environment considerably facilitates controlled manipulation of *long* strands of DNA, which remains one of the major bottlenecks in the development of functional genomic analysis. As an example, restriction mapping using adsorbed DNA on microchannel walls has been shown to be highly successful. The confined geometries could be three dimensional (e.g. microchannels), pseudo-two dimensional (e.g. lipid bilayers), or even one-dimensional (e.g. nanoscale channels). Predictive models for the structure and properties of DNA in nano-geometries would be of considerable value for the design of efficient DNA-manipulation nanodevices.

The main difficulties encountered when modeling such systems are that hydrodynamic interactions, conformational transitions in the macromolecule itself, and interactions between the DNA segments and the confining surfaces must all be captured over length scales ranging from nanometers to hundreds of microns. To address these issues, a multi-scale modeling approach is developed in a collaborative effort with experiments. The simulation model has been shown to successfully capture the conformation and diffusivity of highly confined single DNA molecules under different channel geometries and flow conditions. We have also shown that DNA molecules migrate towards the channel center in pressure-driven flow, and the predictions agree well with experiments.
