

Abstract Submitted
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Characterize and Control the Motion of DNA in a Solid-State Nanopore¹ BINQUAN LUAN, GUSTAVO STOLOVITZKY, GLENN MARTYNA, IBM T. J. Watson Research Center, P.O. Box 218, Yorktown Heights, New York 10598, USA — Controlling the motion of a single-stranded DNA (ssDNA) at a single-base resolution is critical to all nanopore based DNA sequencing technologies. Experimental studies till now demonstrated that the overall translocation speed of DNA driven by a biasing electric field could be affected by ion concentration, solvent viscosity or temperature. Although the DNA translocation could be slowed down, the instant motion of DNA is too diffusive to allow each DNA base to be measured. Using extensive all-atom molecular dynamics simulations, we studied the diffusion constant, friction coefficient, electrophoretic mobility, and effective charge of ssDNA in a solid state nanopore. Simulation results showed that the spatial fluctuation of ssDNA in one nano-second is comparable to the spacing between neighboring DNA bases, which makes the sensing of a DNA base very difficult. The recently proposed DNA transistor (Appl. Phys. Lett. 91, 153103 (2007)) could potentially solve this problem by electrically trapping ssDNA inside a nanopore. Our simulations demonstrated that the DNA transistor could achieve base-by-base ratcheting of ssDNA when ssDNA is either pulled by an optical tweezer or driven by a biasing electric field. Using the Fokker-Planck equation, simulated motion of ssDNA in the DNA transistor was theoretically characterized.

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Binquan Luan
IBM T. J. Watson Research Center, P.O. Box 218,
Yorktown Heights, New York 10598, USA

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