Numerical Study on the Effect of Nanopore Length on the Translocation Process of a Biopolymer

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Abstract: In this study, we simulate the electrophoretic motion of a bio-polymer through a synthetic nanopore in the presence of an external bias voltage by considering the hydrodynamic interactions between the polymer and the fluid explicitly. The motion of the polymer is simulated by 3D Langevin dynamics technique by modeling the polymer as a worm-like-chain, while the hydrodynamic interactions are incorporated by the lattice Boltzmann equation. We report the simulation results for three different lengths of the nanopore. The translocation time increases with the pore length even though the electrophoretic force on the polymer is the same irrespective of the pore length. This is attributed to the fact that the translocation velocity of each bead inside the nanopore decreases with the pore length due to the increased fluid resistance force caused by the increase in the straightened portion of the polymer. We confirmed this using a theoretical formula.

References

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Figures

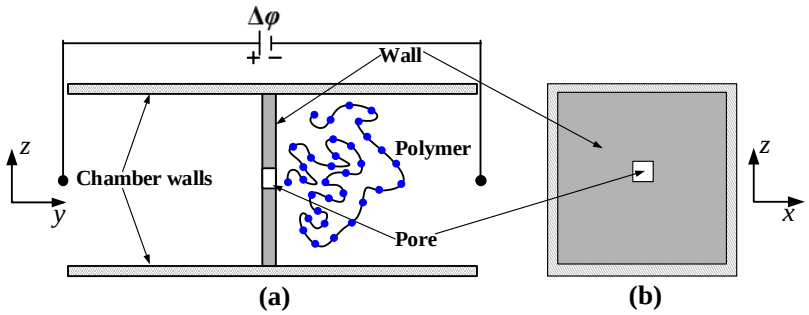

Fig. 1: Sectional view illustrating the simulation set-up used in the present work: (**a**) *yz*-plane and (**b**) *xz*-plane

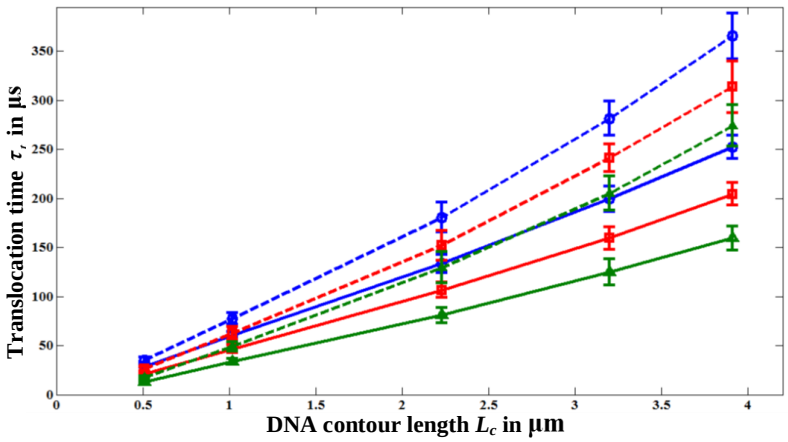

Fig. 2: Variation of the translocation time with polymer length for different nanopore lengths; L_p = 100 nm (○), L_p = 60 nm (□), and for L_p = 20 nm (Δ).