Semi-flexible polymer translocation through a nanopore

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We study the translocation of a semi-flexible polymer through a nanopore under an external driving force by means of both modified version of the iso-flux tension propagation theory (IFTP), and extensive molecular dynamics (MD) simulations. To properly describe the translocation process, we show that for semi-flexible polymers with a finite persistence length $\tilde{\ell}_p$ the *trans* side friction must be explicitly taken into account. In addition, knowing R_N (the scaling of the end-to-end distance as a function of the polymer length N) is vital to construct the modified IFTP theory. Therefore, we first derive a semi-analytic scaling form for R_N, which reproduces all three different regimes of rod, ideal chain, and excluded volume chain in the appropriate limits. We then quantitatively characterize the nature of the *trans* side friction based on MD simulations of semi-flexible chains. By taking into account these two factors, the modified IFTP theory shows that there are three main regimes for the scaling of translocation time $\tau \propto N^{\alpha}$. In the stiff chain (rod) limit $N/\tilde{\ell}_p \ll 1$, $\alpha = 2$, which continuously crosses over in the regime $1 < N/\tilde{\ell}_p < 4$ towards the ideal chain behavior with $\alpha = 3/2$, which is reached in the regime $N/\tilde{\ell}_p \sim 10^2$. Finally, in the limit $N/\tilde{\ell}_p \gg 10^6$ the translocation exponent approaches its asymptotic value $1 + \nu$, where ν is the Flory exponent. Our results are in good agreement with available simulations and experimental data.