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Pressure-driven polymer dynamics in nanofluidic channels
DEREK STEIN, Delft University of Technology, WIEPKE KOOPMANS, Delft University of Technology, CEES DEKKER, Delft University of Technology — The pressure-driven transport of different lengths of DNA molecules in flat, rectangular nanofluidic channels was studied using fluorescence microscopy. The molecular speeds were observed to fall between the maximum fluid velocity in the parabolic flow profile and the average fluid velocity. The dependence of polymer speed on channel height was characterized by two distinct transport regimes: In channels larger than $\sim$1 μm, 21 μm-long molecules traveled faster than 3.8 mm-long molecules. In channels smaller than $\sim$1 μm, the observed speeds coincided. This behavior reflects the dynamical properties of polymer coils in solution, whose statistical size is characterized by the radius of gyration, R_g. In large channels, DNA coils can explore all regions of the channel cross section up to a distance $\sim R_g$ from the walls. The center of mass of large molecules is therefore confined to regions of higher fluid velocity than small molecules, and travel faster in a pressure-driven flow. In thin channels, molecular conformations are confined in height, leading to cross-sectional profiles that are independent of length, and that travel at the same speed.

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