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To Knot or Not-That is the Question: A Nanofluidic Knot Factory based on Compression of Single DNA Molecules against Slit Barriers in Nanochannels SUSAN AMIN, AHMED KHORSHID, LILI ZENG, Department of Physics- McGill University, PHILIP ZIMNY, Department of Biomedical Engineering- McGill University, WALTER REISNER, Department of Physics- McGill University — Knots can form during DNA packaging in chromosome and obstruct mapping of DNA in nanochannels. Studies have focused on theoretical and numerical studies of knots, but an efficient and fully controlled means of knotting has not yet been explored. Here, we introduce a knot factory on chip based on pneumatic compression of single T4 DNA against a slit barrier in a nanochannel. The DNA are compressed to a well-defined fraction of their initial equilibrium extension. The pressure is then released and the DNA molecules relax back to their equilibrium extension; knots are present along the relaxed DNA, visualized as sharply localized regions of high intensity. Via repeated compression and relaxation, we can measure the probabilities of forming single and multiple knot states and the distribution of knot sizes as a function of fractional compression and waiting time in the compressed state. We show that the total probability of knot formation increases with greater compression and waiting time.These findings are well described via a knot formation free energy derived from scaling arguments, suggesting that the enhanced knotting probability at high compression arises from avoiding the free energy cost due to self-exclusion interactions that would arise from contour stored in the knot.

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