Diffusion and electrophoretic transport of DNA Polymers in Microfluidic Channels made of PDMS

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Confinement effects on conformation

Cartoon of a λ-phage DNA molecule (a) unconfined in free solution ($R_G$: radius of gyration), (b) confined in one dimension as in a nanoslit (depth of slit $< R_G$), (c) confined in a nanochannel (diameter $< R_G$). The three DNA contours have been drawn roughly to scale relative to one another. The small scale bar represents the spatial resolution limit.
Scaling behavior of DNA under confinement

Bonthuis, D. J.; Meyer, C.; Stein, D. & Dekker, C.
Conformation and dynamics of DNA confined in slitlike nanofluidic channels. *Phys Rev Lett*, **2008**, *101*

\[ R_g = \frac{1}{2N^2} \sum_{i,j=0}^{N} \langle |\vec{r}_i - \vec{r}_j|^2 \rangle \]

\[ R_\parallel = \sqrt{\left( R_M^2 + R_m^2 \right)/2} \]

\[ R_\parallel \sim aN^{3/5} \left( R_{bulk}/h \right)^{1/4} \]
Circulation of DNA in channels

Velocity of a molecule depends on its height, \( z \), in the channel.

The transport of a polymer is predicted to become \( z \)-independent in the nano-confined regime.

Simulated voltage profile

\[ v_{\text{DNA}}(x) \approx \left( \mu - \frac{\varepsilon \varepsilon_0 \xi}{\eta} \right) E_0 \]
PDMS stamp

Gradual entropy gradient
Filling procedure
Accumulation of molecules due to the electric field
Accumulation of DNA molecules due to electric field
Diffusion of DNA molecules in equilibrium
Stretching of DNA in flow
Stretching of DNA in Flow (switch off)
Stretching of DNA in Flow (switch on)
Thank you for your kind attention.
DNA conjugated with quantum dots
DNA conjugated with quantum dots
Fluctuation of DNA conjugated quantum dots