Simulation of DNA motion with hydrodynamic interactions in a microfluidic channel

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マイクロチャネル内におけるDNA分子の運動のシミュレーションを流体相互作用を考慮に入れて行った。シミュレーションはSRD法（Stochastic Rotation Dynamics）を用いた。スリットが周期的に並んだチャネルのジオメトリーを設定した上で、圧力勾配によって流れる溶媒中に置かれたDNA分子の運動を計算した。この結果、DNA分子の長さによって分子のチャネル通過速度が異なることが分かった。

Several types of microfluidic channel devices have been proposed for separation of DNA by length [1, 2, 3]. Although they are regarded as new and efficient methods for separation of DNA, the mechanism of separation in the channel is complicated and not clear enough to design the optimized geometry of the channel for separation. One of the reasons for the difficulty of the theoretical understanding of the motion of DNA is that hydrodynamic interaction(HI) gives complicated effects on the motion of DNA molecules.

We investigate the motion of DNA molecules in a microfluidic channel using SRD(Stochastic Rotation Dynamics) method [4]. With this method, the effects of intramolecular HI of DNA and HI between the molecule and the boundary wall of the channel are taken into account. In the channel, slits are placed periodically and DNA molecules migrate in the flow of solvent induced by a pressure gradient.

The simulation results show that velocity for a DNA molecule to migrate in the channel depends on the length of the molecule. This suggests the possibility to separate DNA molecules by length in the channel.

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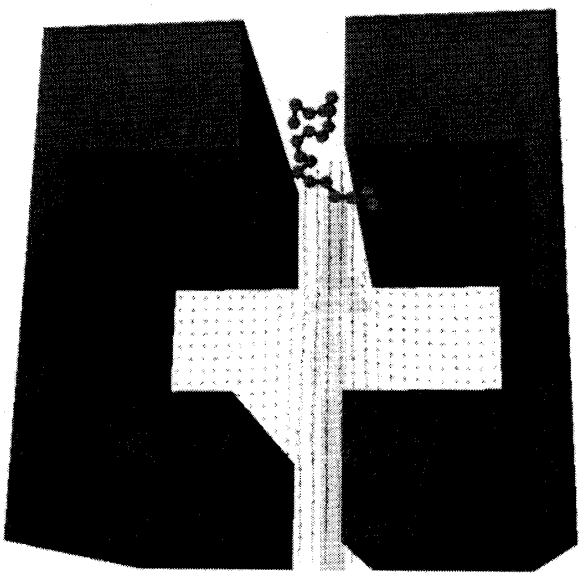

Figure 1: A snapshot of the simulation of DNA molecule in a microchannel. Periodic boundary conditions are imposed.

References

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