Transcription in DNA Brush

(Talk #7)

Tetsuya Yamamoto*, S. A. Safran

Department of Materials and Interfaces, Weizmann Institute of Science, Israel

***Email of Presenting Author: tetsujava@hotmail.com**

The first step in expressing the genetic information encoded in the sequence of bases of DNA is the synthesis of RNA (transcription). The rate of transcription (TX rate) is regulated by both the chemical states and local packing density of the DNA molecules. DNA brushes are simple synthetic systems that enable one to quantitatively study the role played by the local packing of DNA in TX rates [1]. Experiments have shown that the TX rates of DNA brushes are sensitive to the grafting density of DNA molecules and the orientations of transcription (TX) units (that are the regions of DNA between promoters – that initiate TX – and terminators – that terminate TX). It is thus of interest to theoretically predict the TX rates of DNA brushes as functions of their grafting density and the orientations of TX units.
RNA polymerases (RNAP) that synthesize RNA based on the base sequence of DNA are bound to promoters and are released from terminators; TX units are thus treated as sources and drains of RNAPs. In a coarse-grained picture, at scales much larger than the distance between promoters and terminators, the pairs of promoters and terminators can be viewed as dipoles that account for the active transports of RNAPs due to transcription (TX dipoles). The concept of TX dipoles enables us to simplify the active transports of RNAPs due to transcription in a manner that can be put in the context of diffusion equations. We thus take into account TX dipoles and the osmotic pressures of polymer brushes in the diffusion equations of RNAPs and use a scaling theory and a mean field theory of polymer brushes to predict TX rates in DNA brushes [2]. This theory predicts that DNA brushes, in which the promoters are closer to the substrate than the terminators, show smaller transcription rates than DNA brushes with opposite promoter–terminator orientations because DNA transcription actively transports RNA polymerases to the outside of DNA brushes (and thus decreases the number of RNA polymerases in the brushes).

References:

[1] S. S. Daube, D. Bracha, A. Buxboim, R. H. Bar-Ziv, *Proc. Nat. Acad. Sci.*, **107** (7), 2836 (2010).
[2] T. Yamamoto and S. A. Safran, *in preparation*.