The Hebrew University of Jerusalem , Colloquium

Prof. Amit Meller

Department of Biomedical Engineering, Technion and Department of Biomedical Engineering, Boston University, Massachusetts

Levin building, Lecture Hall No. 8

"Sensing Single Biomolecules using Solid-State Nanopores"

Nanopores are nano-scale pores fabricated in synthetic thin films, used to detect and characterize unlabeled biomolecules by electrophoretically threading them through the pore.[1] Nanopores are widely believed to be a main future platform for direct, single molecule sequencing of DNA, RNA and perhaps proteins. Controlling and tuning the capture rate and the translocation speed of biomolecules through nanopores remains to be a main challenge for this technology, limiting their wider application.

In this lecture I will discuss two physical methods to: (i) enhance the capture rate of DNA molecules into solid-state using salt gradients, and (ii) Slowing down the translocation speed of DNA through nanopores using a novel optoelectronic effect. We found that a salt concentration gradient applied across the pore can be used to electrostatically attract charged biopolymers into the nanopore overcoming thermal diffusion.[2] This process results in a highly efficient capture of DNA, and is used to detect minute DNA copy numbers, at the scale of an attomole. For control of translocation, we have recently shown that low-power visible light focused at the nanopore can be used to modulate its surface charge and thus induce a counter electro-osmotic flow in the pore that in turn slows down the translocation of biomolecules.[3] The optoelectronic effect is analogically tunable on sub-millisecond timescales by simply adjusting the photon density. Specifically, a few mW of green light reduces by more than two orders of magnitude the translocation of small globular proteins such as ubiquitin, allowing their characterization at the single molecule level.

1. Wanunu, M. & Meller, A. in Laboratory Manual on Single Molecules Vol. 395-420 (eds T. Ha & P. Selvin) (Cold Spring Harbor Press, 2008).

2. Wanunu, M., Morrison, W., Rabin, Y., Grosberg, A. Y. & Meller, A. Electrostatic Focusing of Unlabeled DNA into Nanoscale Pores using a Salt Gradient. Nature Nanotechnology 5, 160-165 (2010).

3. Di Fiori, N., Squires, A., Bar, D., Gilboa, T., Moustakas, T. and A. Meller. Optoelectronic control of surface charge and translocation dynamics in solid-state nanopores. Nature Nanotechnology 8, 946–951 (2013).