Mechanical Properties of DNA Nanografted Monolayers

P. Parisse[1,2], M. D. Nkoua Ngavouka[2,3], A. Bosco[2,4], C. Micheletti[4], A. Vindigni[5], G. Scoles[2,6], L. Casalis[1,2]

[1]INSTM – ST Unit, Trieste, Italy [2] Sincrotrone Trieste S.C.p.A., Trieste, Italy, [3] University of Trieste, Doctorate School in Nanotechnology, Trieste, [4] International School of Advanced Studies (SISSA), Italy [5]Department of Biochemistry and Molecular Biology, St. Louis University School of Medicine, USA [6] University of Udine, Department of Medical and Biological Sciences, Italy

pietro.parisse@elettra.trieste.it

Abstract (Arial 10)

Nanografted monolayers (NAMs) of short oligonucleotides sequences (18-60 bps) show novel properties that make them ideally suited for advanced biosensing applications [1,2]. Due to their small size and the high homogeneity of the DNA surface coverage, they allow for extreme miniaturization and for ultrasensitivity. In order to optimize the performances of NAM-based devices, however, a thorough understanding of the physical-chemical properties of these systems is required.
Analyzing the mechanical response of DNA NAMs to the force exerted by an AFM (Atomic Force Microscope) tip by means of differential topographic height profiles in buffer solution and parallel coarse-grain modeling of the DNA nanostructures, we were able to estimate the NAM surface coverage and correlate it to the hybridization efficiency [3]. Also, we studied the dependence of the NAM height on the ionic strength of the solution, in order to optimize the responsiveness to hybridization events.
The different mechanical response of ss- and ds-DNA NAMs, connected to their different flexibility, has been further exploited to investigate the reaction mechanism of helicases, which are accounted for strand separation in ds-DNA. We monitored the differential height variation of engineered dsDNA NAMs as a function of the enzyme incubation time, for two different, homologous helicases, the bacterial RecQ and the human RecQ1, highlighting different kinetic behaviors for these enzymes, and providing the first estimate of RecQ1 unwinding rate [4].

References

[1] E. Mirmontaz, M. Castronovo, C. Grunwald, F. Bano, D. Scaini, A.A. Ensafi, G. Scoles, L. Casalis, Nanoletters 8, 4134 (2008) 4134
[2] F. Bano, L. Fruk, B. Sanavio, M. Glettenberg, L. Casalis, C.M. Niemeyer, G. Scoles, Nanoletters 9, 2614 (2009)
[3] A. Bosco, F. Bano, P. Parisse, L. Casalis, A. DeSimone, and C. Micheletti, Nanoscale 4, 1734 (2012)
[4] P. Parisse, A. Vindigni, G. Scoles and L. Casalis, The Journal of Physical Chemistry Letters, 3, 3532 (2012)