CHARACTERIZATION OF DNA IMMOBILIZATION AND HYBRIDIZATION COMBINING NANOMECHANICAL AND ELECTROCHEMICAL BIOSENSORS

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The development of highly sensitivity and inexpensive DNA biosensors is of great interest for medical analysis, forensics, genomics etc. While conventional methods achieve most of the requirements, sample labelling has some disadvantages: it is time-consuming, there is interference with the molecular recognition process and an unspecific background signal. On the other hand, nanomechanical[1,2] and electrochemical[3,4] biosensors are label free detection schemes that can be combined to characterize the mechanisms involved in the immobilization of thiolated ss-DNA onto gold surfaces. The sensitivity of a DNA biosensor depends on the hybridization efficiency, which is in turn related to the DNA orientation and the surface coverage, and on the detection signal. Local measurements of the displacement along the cantilever position give information about the homogeneity of the DNA adsorption and about the surface stress induced by DNA adsorption and hybridization. The electrochemical measurements give information about the electron transfer through the monolayers. This is relevant to accurately determine the molecule sites involved in the interaction with the gold surface and with other molecules: 5´-thiolated end, the phosphate backbone (negative charge) or the amines on the bases (positive charges). The dynamics of the absorption mechanism and the resulting coverage pattern depend on the chemical environment, the deposited species, and presumably on the charge state of the metallic surface on which the DNA strands deposit.

Cantilever deflexion measurements show a clear relation between the gold surface charge and the mechanism of DNA adsorption and intermolecular interactions at the nanometer scale. The experiments show how the cantilever bending is modified drastically depending on the initial surface charge state. Remarkably, the cantilever bends downward or upwards after DNA immobilization (figure 1) depending on the initial charge state. This is probably related to differential population of DNA strands standing up and laying down on the gold surface.. (Further support of this assumption comes from white light reflectivity measurements that show a different DNA apparent thickness depending on the surface charge.

In situ measurements of the electric currents during both immobilization and hybridization processes in an electrochemical cell allow to optimize the conditions for nanomechanical translation of hybridization events. Moreover it allows a deeper understanding of the mechanism of surface stress generation under self-assembly of DNA on gold and subsequent hybridization.

References:

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Figures:

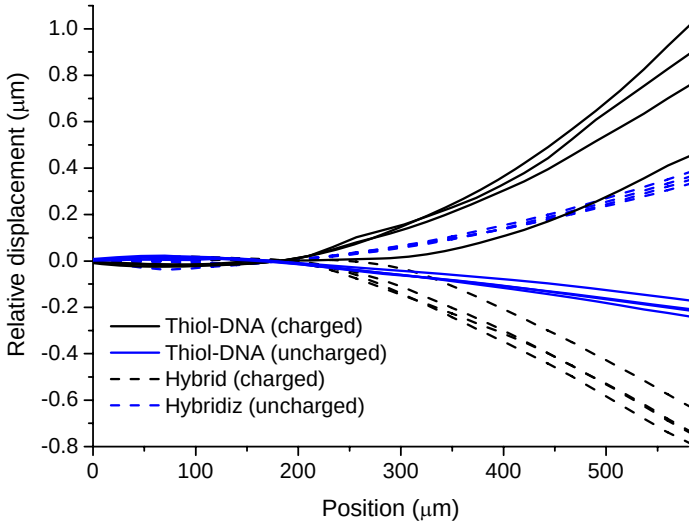

Figure 1: Cantilever profile measurements of two arrays of cantilevers DNA coated with charged (black lines) and uncharged (blue lines) gold. The cantilever displacement was measured after thiolated-DNA immobilization (solid lines) and hybridization with complementary DNA (dotted lines).