New Impedimetric DNA Sensors based on Alumina Nanopores.

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We describe new types of DNA sensors (A,B) based on impedance measurements. Two realizations of the basic concept of the sensor are shown in Fig. 1

Alumina membranes prepared by anodization of aluminum (Fig. 2) are modified with ss-DNA via covalent attachment using aminosilane-glutaraldehyde chemistry.

The first approach employed in this work relies on decreasing of ionic conductivity through the modified nanopores upon hybridization with complementary target ss-DNA analyte and resulting in enhanced hinderance for ion flow through nanopores (Fig 1, A). This method does not require Faradeic current (no need for Red/Ox pairs in a solution). The signal is measured either in time domain as a voltage variation across the membrane in response to stepwise voltage changes of small amplitude or as a frequency dependent impedance at low alternating potentials. Fig. 3 demonstrates increase of membrane resistance upon DNA immobilization square form potential (±100mV, 1ms) in 0.1M NaCl solution. To make the membrane resistance much bigger then resistance of a solution, gold polished electrodes were brought in contact with membrane.

In the second approach, shown in Fig 1 B, conductance modulation in nanopores is achieved by blocking them with nanoparticles. Nanoparticles with a diameter close to that of nanopores and modified with another ss-DNA provide together a “sticky-end” sequence complementary to a target ss-DNA. Upon presence of the target ss-DNA in solution, due to hybridization, nanoparticles stick at the mouth of nanopores blocking the ion flow, which is observed by impedance increase.

Applicability of this technique is investigated on the example of Sickle Cell Anemia Disease linked to one-base mutation in the human hemoglobin B gene. DNA fragments (40–mer sequences) mimicking the normal and mutated genes are used as analytes in the sensor design.

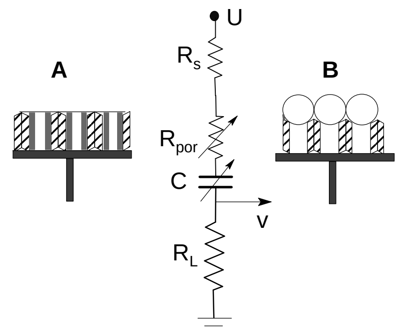

Figure 1.
Schematic representation of a proposed DNA sensor. **A**. Due to partial blockage of a nanopore upon DNA hybridization inside pore ionic conductance decreased. **B**. Nanopore is blocked by a nanoparticle which is linked to the membare by hybridization with a target DNA.

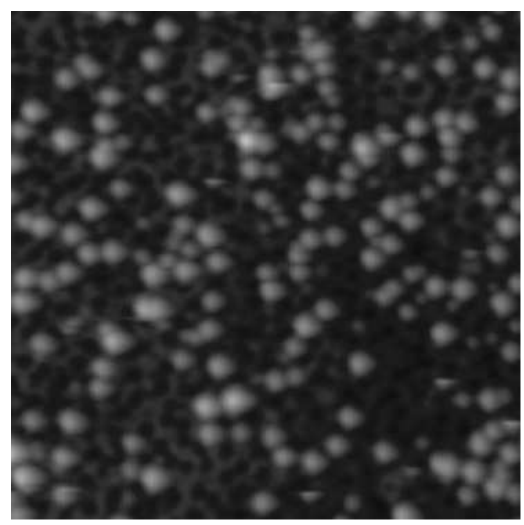

Figure 2.
AFM image of an aluminum oxide membrane partially covered with silica nanoparticles (ca. 50 nm in diameter).

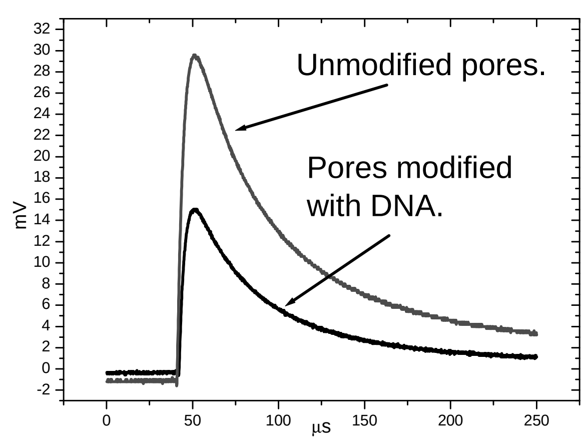

Figure 3
Voltage drop across bare and modified with DNA membranes. An alternating square form potential (±100mV, 1ms) was applied across membrane in 0.1 M NaCl.