1. Introduction and Motivation

DNA-binding proteins perform a variety of important functions in cells: transcriptional regulation, chromosome maintenance, replication and DNA repair. The interactions between proteins such as transcriptional factors (TFs) and DNA are of particular interest, as these control crucial steps in cell development and responses to environmental stresses.

Need of a new generation technique

Nanobase length polymers (genomic DNA) can be identified and characterized without amplification and labeling, a unique analytical capability that makes inexpensive, protein-DNA identification a better understanding would require an ideal technology capable to probe unmodified DNA, thus allowing whole genome coverage and providing direct readings.

2. Working Principle

Schematic Layout of electronic barcode detection in a nanogap

The use of an embedded nanogap detector inside the nanochannel offers the possibility to measure the electrical conduction perpendicularly to the DNA backbone and observe electrical signals characteristic of the DNA protein complex translocation events.

3. Fabrication of device

1. Two different ways for bridging the micro and the nanoworld

Gradعاش in chip (TFs)

Smallest electrode gap achieved: ~4 nm

2. Electrode nanogap fabrication

Non trapping event

E-beam lithography, RIE transfer, e-beam metal evaporation of Ti/Au in layers and lift-off

Characteristics of I-V curves of deposited structures in the trapping event cases, linear and nonlinear curves characteristic of tubes across nanochannel termini

3. E-beam lithography of nanochannels

2nd alignment, exposure and RIE etching transfer

Nanochannel (TFs)

Dielectric constant material, e-beam evaporation of Ti/Au in layers and lift-off

4. Nanoimprint conformable channel sealing

Nanogap between electrodes same in tube dimension

Nanogap between electrodes same in tube dimension

Reservoir bonding for ink device

4. Further miniaturization of nanogaps

DEP Trapping of individual CNT on nanoelectrodes assisted by integrated system on board, to be used as a mask for electrode nanogap creation

5. Some conclusions and further work

E-beam lithography assisted fabrication of detection nanostucture in combination with world-to-nano microfluidic structure successfully integrated on a chip provides the road ahead to start biological experiments. By itself, it is already a nano-engineering achievement.

Preparatory studies with the biophysics and in-house developed amplifier focus on the characterization of the devices with solid state nanomaterials to later conduct different studies with DNA-protein complexes.

DEP assisted trapping of carbon nanotubes to be used as metal deposition masks is prototyped with the use of a real time electronic monitoring system of the trapping events. Further investigation needs to be performed in order to achieve single nanotube trapping. Smaller nanogaps have potential for single base sequencing applications.

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