

Nanoneedle Biosensor Array for High-Throughput DNA Sequencing

Hesaam Esfandyarpour^{1,2}, Rahim Esfandyarpour^{1,2}, Ron W. Davis^{2,3}

¹Department of Electrical Engineering, Stanford University
Center for Integrated Systems, CISX B103, Stanford, CA, 94305
hesaam@stanford.edu, tel: (650) 723.4566 fax: (650) 723.4659

² Stanford Genome Technology Center

Impedance biosensors are a class of electrical biosensors that show promise for point-of-care and other applications due to low cost, ease of miniaturization and label-free operation. We have previously introduced the Nanoneedle [3-7], a label-free biosensor, which has the potential of measuring single molecule interactions useful for protein biomarker detection and DNA sequencing through single molecule or bead-based system.

Here we report the improvement in device operation, through a modification in the design and fabrication procedure of nanoneedle array device; we discuss the fabrication process for an array of needles in a microchannel and show images of successfully fabricated devices.

Fabrication of on-chip amplifiers near to the tip of the sensor improves the signal to noise ratio in the detection; we optimized the sensor performance for high throughput DNA sequencing and protein detection. We fabricated few thousands nanoneedle array in microfluidic channels as it is shown in the Fig. 1.

The device has been experimentally tested for the detection of Bovine Serum Albumin (BSA) at different concentrations. The results of binding experiment are shown in the Fig. 2. In addition, for sequencing of the DNA molecules, after the PCR step, millions of similar DNA strands are attached to small few-micron magnetic beads (e.g. M270 Dynal beads) and then the DNA-coated beads are injected to the channel with nanoneedle array with on-chip amplification. Then sequential injection of nucleotides into the channel results to a change in the ionic charge concentration for practical pH sequencing [1,2].

The device geometry and the frequency regime of operation are optimized for achieving high sensitivity and low concentration detection. The geometry helps to localize fringing field effects therefore increasing sensor sensitivity. We also performed finite element modeling of impedance modulation in the nanoneedle during the capture of the target biomolecule or detecting a biochemical event.

References:

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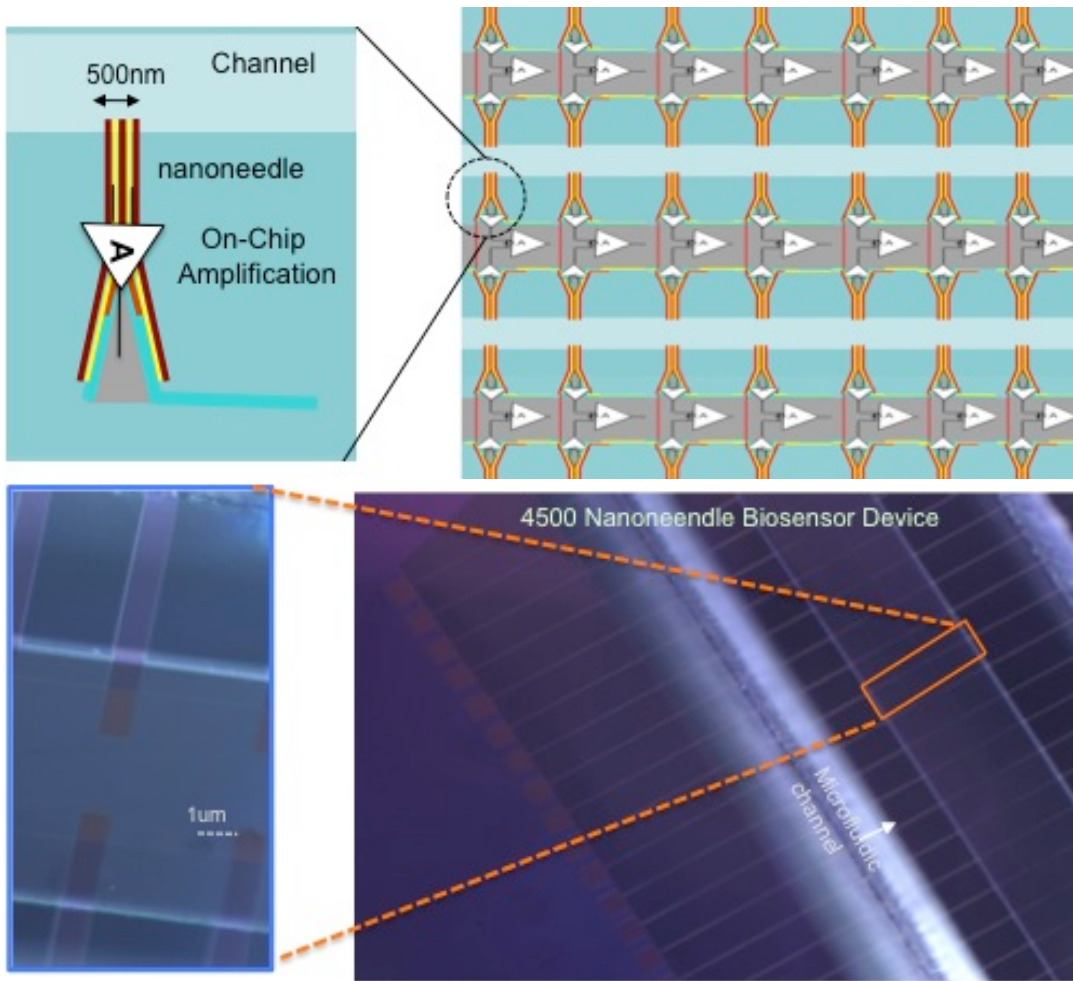


Fig. 1 Schematic and Micrograph of nanoneedle array in microfluidic for high throughput bio-detection of Nanoneedle array biosensors with 10um PDMS channel on top

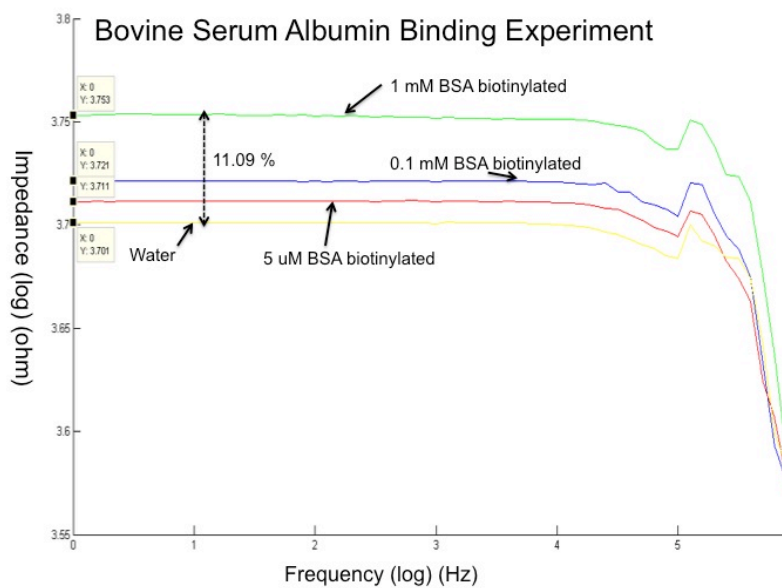


Fig. 2. Detection of Bovine Serum Albumin (BSA) binding experiment with nanoneedles