DETECTING ON-CHIP DNA HYBRIDIZATION USING SILICON BASED MICRORING RESONATORS

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We report an experimental demonstration of single-strand DNA (ssDNA) detection using a micro-ring resonator based optical sensor. Our experiments show that it is possible to quantitatively detect hybridization events when flowing different concentrations of complementary ssDNA over the sensors.

The race-track shaped micro-ring resonators used in this experiment were fabricated within the ePIXfab facilities at IMEC (Belgium). Each micro-ring is coupled to a straight waveguide with input and output grating couplers, which allow light coupling to and from the structure. The sensor surface preparation is simpler than those published elsewhere [1-2], as it does not involve the use of cross-linkers or streptavidin/biotin to immobilize the DNA probes on the sensor surface. After a piranha cleaning, the chips are silanized by chemical vapor deposition and then biofunctionalized with aminated double strand DNA (dsDNA) which covalently bind to the silane. By using dsDNA, an optimum coverage is achieved, and the last step in the sample preparation consists in flowing a dehybridization buffer in order to separate the DNA strands and only leave ssDNA probes on the sensor.

In figure 1 we show the overlay of the temporal evolution of the resonance wavelength shift of a sensing micro-ring for two different concentration of complementary ssDNA. After introducing the buffer solution back into the system, upon stabilization we can clearly see a permanent shift, indicating that the target ssDNA has hybridized with the DNA probes on the sensor's surface. This binding between the complementary DNA strands is disrupted using a dehybridization buffer, in order to regenerate the sensor surface between the flow of 100nM ssDNA and 200nM ssDNA and achieve binding curves for different ssDNA concentrations. Note that the net shift for the concentrations used in this experiment is between 130pm and 140pm, while the maximum shift obtained in [1] is 20pm. The proposed sensor should thus allow us to achieve a detection limit of the order of nM or even below for the direct detection of hybridization events.

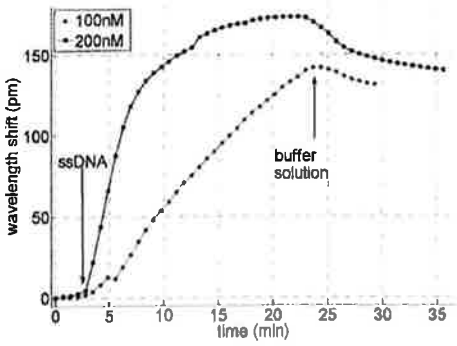

Figure 1. Wavelength shift for the tracked resonance during the flow of the complementary ssDNA and subsequent buffer solution.

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[1] A. J. Qavi and R. C. Bailey, "Multiplexed detection and label-free quantitation of microRNAs using arrays of silicon photonic microring resonators", Angewandte Chemie (2010), Vol. 49, pp. 4608-4611.
[2] V. Toccafondo, et al., "Single-strand DNA detection using a planar photonic-crystal-waveguide-based sensor", Optics Letters (2010), Vol. 35, pp. 3673-3675.