SILICON NANOPHOTONICS SENSORS INCORPORATED IN A DIGITAL MICROFLUIDIC SYSTEM

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Label free techniques such as silicon nanophotonic microring resonator sensors attempt to overcome the stability and reliability problems of biosensors relying on the detection of labeled molecules [1]. However, these typically require microfluidics to function, which adds cost and complexity to the system.

An alternative to this could be the use of microdroplets ("digital" microfluidics) [2] instead of continuous flows. This is one of the recent trends in microfluidics, where micro- to picoliter-sized droplets are generated, transported, mixed and split, thereby creating miniaturized reaction chambers which can be controlled individually in time and space. This technique allows fluid plugs to be manipulated on reconfigurable paths without any complex microfluidic structures such as channels or valves, and has great potential for high-throughput liquid handling, while avoiding on-chip cross contamination.

We present the combination of both technologies, label free silicon nanophotonics microring resonators sensors [1] and digital microfluidics. Our silicon photonic chip is incorporated upside down into the electrowetting-based digital microfluidic platform using a compatible holder that sandwiches the microdroplets against a plate of electrodes which are all controlled individually or in parallel by using software-controlled electrical signals. The chip contains an array of well-known microring resonators sensors [1]. We first deposit and micropattern a Teflon layer to guarantee the hydrophobicity of the chip surface which facilitates the free movement of the droplets and to allow direct contact between the ring resonators and the fluid under analysis (Figure 1).

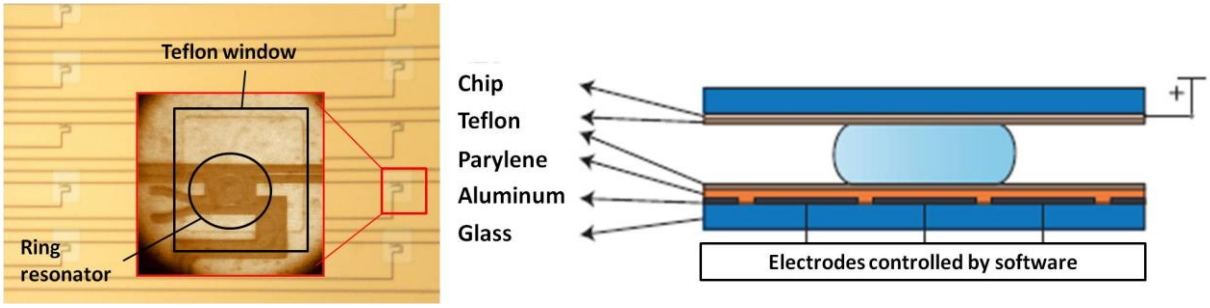

Figure 1. Left: Teflon pattern of the array of silicon photonic microring resonator sensors. Right: Cross-section of the system.The microdroplet is sandwiched between the chip and the plate of electrodes controlled by software [2].

In this system the measurements are performed from the back side of the chip, i.e. light from a tunable laser is coupled into the microring resonator through the chip substrate, instead of from the top of the sample as in our previous approach [1]. To avoid the scattering of the rough substrate surface and to optimize the coupling, few simple processing steps must be done in advance, like the thinning and polishing of the chip substrate. A shift in the resonance wavelength of the ring is measured when the binding of the specific antibody to the antigen (previously coated on the sensor surface) is produced. This shift is monitored by an infrared CCD camera that reads out the signal from the back side of the chip.

This system allows real time detection and analysis. Its great flexibility and portability make it ideal for easy and fast use in any laboratory.

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[2] N Vergauwe, "A versatile electrowetting-based digital microfluidic platform for quantitative homogeneous and heterogeneous bio-assays" J. Micromech. Microeng. 2011, vol 21 pp 11.