Silicon nitride ring resonator for biosensing fabricated on 300 mm SOI industrial environment

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Abstract—This paper reports on the experimental characterizations of photonic ring resonators used for biosensing. The devices were realized on a 300 nm photonic R&D platform in an industrial environment. This is a key point to manufacture performing photonic devices close to a final marketable product.

Keywords— SiN waveguides; industrial manufacturing; biosensing; photonics; ring resonators.

I. INTRODUCTION

In the last decade, many designs for integrated photonics biosensors have been published. New fascinating and elaborate structures often require fabrication steps that are not compatible with industrial platforms. The SiN ring resonator sensor discussed in this paper was manufactured on the STMicroelectronics DAPHNE 300 mm Photonic R&D platform [1] and has performances comparable to the state-of-the-art.

II. MATERIALS AND METHODS

The device structure, based on a silicon nitride (SiN) ring resonator fabricated on a SOI wafer, is shown in Fig. 1(a). Subject to the DAPHNE platform design rules, simulations with the commercial software Lumerical determined the optimal geometry for the device (600 nm thick SiN waveguides). For characterization, a PolyDiMéthylSiloxane (PDMS) fluidic reservoir was bonded on top of the device, as shown in Fig. 1(b). TE polarized light from a 1.55 μm fiber pigtailed laser was injected into the bus waveguide by butt coupling. Output light from the bus waveguide was characterized with a spectrometer. Liquids of different optical indices were introduced in the PDMS reservoir to induce a shift in the resonance wavelength.

Fig. 1. (a) SEM picture of the ring resonator. The inset shows the coupling area of the access waveguide and the ring. (b) Measurement setup.

III. RESULTS

The bulk sensitivity of the device was calculated from measurements of the transmission spectra for 4 fluids with distinct refractive indices. Fig. 2(c) plots the dependence of resonance wavelength on the refractive index of the fluid. The slope of the fitted line defines bulk sensitivity of the device in nm per refractive index unit (nm/RIU). In the present case, the device has a 300 nm/RIU bulk sensitivity which is comparable to state-of-the-art ring resonator sensors[2]. Fig. 2(d) shows transmission spectrum measurements for H2O and ethanol with the corresponding numerical simulations. Complementary experiments to characterize the response to add-layers are ongoing (for instance Bovine Serum Albumin (BSA) and Biotin-Streptavidin interactions).

IV. CONCLUSION AND DISCUSSION

This paper shows that integrated photonics sensors can be manufactured with the same industrial process as other microelectronics devices: a single deep UV lithography and a well-known deposition and etching processes. In particular, a biosensing ring resonator with state-of-the-art bulk sensitivity (300 nm/RIU) can be realized with this platform.

V. REFERENCES