In-flow and in-continuum refractive index sensing using a highly sensitive porous silicon ring resonator

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Traditional planar photonic sensing structures based on a high index contrast configuration present a limitation affecting their sensitivity: only the evanescent field propagating outside the photonic structure is used for sensing purposes, while the majority of the optical field is confined within the structure itself. To overcome such limitation, we developed a highly sensitive photonic sensor based on a porous silicon ring resonator (PSRR). The porous silicon platform allows the infiltration of the target substance directly into the pores in order to obtain an increased sensitivity [1,2]. The photonic sensing structure was fabricated by using a high index contrast nanoporous silicon platform, consisting of a porous silicon double layer. A low porosity top layer was used to form the PSRR by e-beam lithography, whereas a high porosity bottom layer was used to confine light in the vertical direction (Fig. 1). The sensing performance of the PSRR was characterized by means of several refractive index sensing experiment. An opto-fluidic setup was developed to flow several solutions with different refractive indices over the photonic sensor and, at the same time, to monitor in-continuum the evolution of the PSRR spectrum (Fig. 2). PSRR presented a sensitivity of up to 439 nm/RIU (Refractive Index Unit). The average value of the noise observed in the experiments was 0.1 pm, leading to a limit of detection of only $2.2 \cdot 10^{-7}$ RIU.

References

[1] F. A. Harraz, Sensors and Actuators B, 202 (2014) 897–912
[2] O. Bisi, S. Ossicini, and L. Pavesi, Surface Science Reports, 38(1) (2000) 1–126

Figures

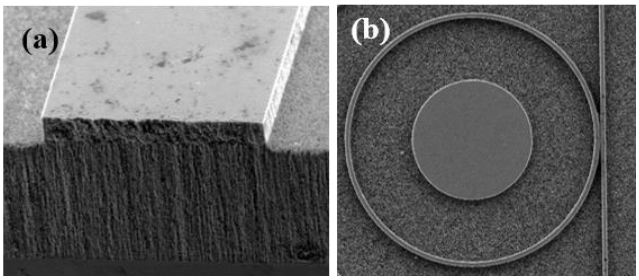

Figure 1: (a) 60°-sectional FE-SEM image of the 10µm-wide access waveguide. (b) Top-view image of the RR and the coupling waveguide.

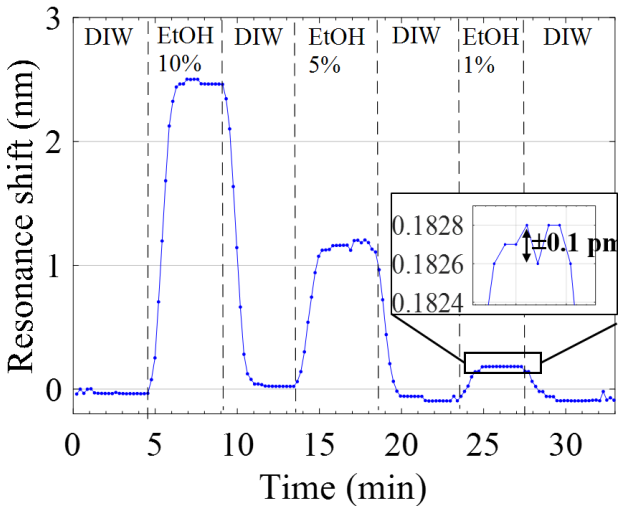

Figure 2: PSRR resonance wavelength shift time evolution.