Novel ring resonator based biosensors
(invited)

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Label-free photonic biosensors can perform sensitive and quantitative multiparameter measurements on biological systems and can therefore contribute to major advances in medical analyses, food quality control, drug development and environmental monitoring. Additionally they offer the prospect of being incorporated in laboratories-on-a-chip that are capable of doing measurements at the point-of-care at an affordable cost. A crucial component in most of these photonic biosensors is a transducer that can transform a refractive index change in its environment to a measurable change in its optical transmission. Silicon-on-insulator is a material system with many assets for such transducers. First, it has a high refractive index contrast permitting very compact sensors of which many can be incorporated on a single chip, enabling multiplexed sensing. Second, silicon-on-insulator photonic chips can be made with CMOS-compatible process steps, allowing for a strong reduction of the chip cost by high volume fabrication. By using ring resonators with high quality factors that have very narrow resonance peaks, the smallest detectable spectral shift can be minimized.

Here, we present two novel concepts based on this ring resonator platform: the use of a Vernier ring resonator cascade to improve sensitivity and the transfer of silicon sensor chips to the facet of an optical fibre.

In order to exploit the **Vernier concept**, two ring resonators with slightly different optical roundtrip lengths are cascaded. The complete chip is covered with a thick cladding, with only an opening for one of the two resonators. This sensor ring resonator will be exposed to refractive index changes in its environment, while the other resonator, the filter ring resonator, is shielded from these refractive index changes by the cladding. By making these reonators long and the path length difference between them small, we obtain a sensor that can work in a continuous regime. We implemented the sensor in silicon-on-insulator and experimentally determined its sensitivity to be as high as 2169nm/RIU in aqueous environment, as compared to only 70 nm/RIU for a single ring.

While a lot of progress has been made to mplementsensors in small and easy to use cartridges, many applications require a sensor probe that can perform measurements at locations that are hard to reach. We introduce a method to integrate a silicon-on-insulator photonic **sensor on the facet of a single-mode optical fiber**, and apply this method to a well-known ring resonator refractive index sensor without deteriorating its sensitivity. We thus combined the good performance of silicon-on-insulator sensors with the high mobility of optical fibers.

References

[1] T. Claes, W. Bogaerts, P. Bienstman, “Experimental characterization of a silicon photonic biosensor consisting of two cascaded ring resonators based on the Vernier-effect and introduction of a curve fitting method for an improved detection limit”, Optics Express, vol 18, no 22, pp. 22747-22761, 2010