Compact Interferometer Devices for Chip-Based Chem-Bio Sensing

(Invited)

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(100-word limit, 89 words)

Changes in the real and imaginary parts of the waveguide effective index in the presence of analytes have been used in various microcavity and slow light devices for on-chip sensing and absorption spectroscopy respectively in diverse applications. Periodically patterned waveguide sensors in interferometer configurations can lead to small interferometer sizes comparable in dimensions to microcavity resonator sensors, and/or significantly higher sensitivities compared to resonator type sensors. We show our work with compact silicon photonic interferometer devices for on-chip biosensing and absorbance sensing, overcoming fabrication tolerances with post-fabrication phase trimming.

(250-word limit, 248 words)

During the past two decades, devices utilizing microcavity resonators, slow light devices, interferometric devices have been studied on the silicon photonics platform for detection of various analytes of interest in healthcare, environment and other toxin detection. Changes in the real and imaginary parts of the waveguide effective index in the presence of analytes have been used for on-chip sensing and absorption spectroscopy applications respectively. Although interferometer devices have the highest sensitivities, the relatively smaller size of microcavity resonator type sensors make them more attractive for multiplexed high-throughput sensing of multiple analytes on a chip. We have shown that periodically patterned waveguide sensors in interferometer configurations can lead to small interferometer sizes comparable in dimensions to microcavity resonator sensors, and/or significantly higher sensitivities compared to resonator type sensors. An impediment towards the demonstration of fully packaged photonic chip-based sensors has been the lack of a low-cost on-chip light source. In measurements with a fixed wavelength laser and integrated photodetector, resonator resonances and interferometer fringes seldom occur exactly at the designed absolute wavelength of the source laser due to fabrication imperfections. Compared to thermal heaters requiring active power consumption, we overcome this problem with phase change materials to trim optical phase permanently post-fabrication thus requiring no active power consumption during sensing measurements. Compact interferometers are important components for wavelength discrimination in Fourier transform (FT) spectroscopy for on-chip absorbance sensing. We experimentally demonstrate FT spectroscopy with Michelson interferometers that effectively double the wavelength resolution compared to Mach-Zehnder interferometers of equal dimensions.

Keywords: Michelson Interferometer, subwavelength waveguide, silicon photonics, slow light, photonic crystal, biosensor, absorption sensor