In optical absorption spectroscopy, an analyte can be detected by the variation of light intensity due to absorption in analyte. The PhC parameters should be designed to create a mode whose wavelength matches the absorption peak of analyte and has high elecric field in the region filled by the analyte. In this work we present a design to enhance absorption of light by a fluid analyte being in contact with PCRRs. For this purpose, we propose a new PCRR with higher interaction between guided mode and analyte. This will be done in a PCRR consisting of dielectric silicon rods surrounded by air. The entire air space will replaced by the analyte when performing sensor tasks. The lattice constant and radius of the rods is tuned to obtain a resonance peak in desired frequency range. The band diagram gives the propagation modes and photonic band gap (PBG) of the photonic crystal structure, which supports TE polarized modes (electric field dominantly aligned along the silicon rods). The guided modes inside PBG region are related to the PCRR cavity. The Plane Wave Expansion (PWE) method is used to calculate the photonic band gap and propagating modes of structure.

Photonic crystal parameters should be designed to create a mode that has a high electric field in the region filled by the analyte. Achieving strong confinement of light intensity in the low index region is the advantage of this PCRR. In that manner, the interaction of light and analyte, which can be a liquid or a gas, will be enhanced. Structure optimization is performed by Finite Difference Time Domain (FDTD) simulations to maximize the Q-factor of the cavity mode at 0.2357μm-1. In our design, the radius of the twelve silicon rods at the corners of the outer and inner photonic crystal, is tuned to obtain the higher Q factor. The changes in the radii are ?r2 and ?r1 for outer and inner photonic crystals, respectively. The Q factor reaches a maximum of about 390000 for ?r1=0.22μm and ?r2=0.18μm. However, it decreases when the PCRR is coupled to waveguide.

The corresponding electric field profile of the mode at 0.2357μm-1 confirms that the cavity mode is strongly confined within the PCRR, having an effective mode volume equal to Veff =4.36μm3 and the ?, filling factor of optical field in the gas medium, is 0.759. Knowing the mode field overlap ?, the sensitivity of the device S to the refractive index change ?n can be estimated to 1700nm per refractive index unit (RIU).

10242-5, Session 1

Temperature-drift-secure wavelength meter based on an integrated micro ring resonator

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Wavelength meters are central for many applications such as in telecommunication systems [1] or laser monitoring [2]. The primary function of a wavelength meter is to provide an output signal that changes sensitively with the wavelength of the input light. Of central importance is the reproducibility of the output signal even in the presence of external perturbations, e.g., temperature changes causing thermal drift. Various different methods are usually applied to improve reproducibility, e.g., thermal stabilization or repeated calibration with an additional reference light source of well-known and stable wavelength.

We present an integrated optical wavelength meter that is safe against thermal drift, requiring no thermal stabilization or repeated calibration with additional light sources. Our approach is based on an optically integrated waveguide micro ring resonator (MRR) together with a neural network-based readout and optimization algorithm that is able to detect temperature changes and reduce the effect of these on the displayed output wavelength. We implement this readout

method in an experimental setup comprising a tunable laser coupled into a Si3N4 waveguide MRR and a detector that measures the transmitted power. Via a applying a set of different heating voltages as a thermo-optical control parameter, the resonant wavelengths of the MRR are tuned to a set of different values. For measuring a single unknown input wavelength, the transmitted power is measured for the entire set of control parameters, i.e., an entire set of output powers is obtained per unknown wavelength from which the neural network determines the displayed wavelength.

We observe that this wavelength determination becomes increasingly more precise when increasing the number of heating voltages applied. We also observe that during the initial calibration of the MRR with a set of known input wavelengths, the readout precision increases with the number of known input wavelengths, and even with unknown input wavelengths.

We demonstrate for the first time the full working of such wavelength meter in that we observe long-term reproducibility (one week). We also observe that the displayed output wavelength does not change with ambient temperature up to several degrees. This shows that the readout provides temperature-drift secure operation of the wavelength meter, which makes a precise temperature stabilization or re-calibration after temperature change obsolete. The current wavelength range of operation spans one free spectral range (FSR) of the MRR (~2.7 nm) with a high spectral resolution of ~50 pm. An extension of the FSR is possible via exploiting waveguide birefringence of the MRR or using sequential resonators, e.g., in a Vernier fashion.

1. Fangfei Liu, Qiang Li et al. “Optically tunable delay line in silicon microring resonator based on thermal nonlinear effect”, IEEE Journal of Selected Topics in Quantum Electronics 14, 3, 706-712 (2008).

2. Saakyan, S. A. et al. “Frequency control of tunable lasers using a frequency-calibrated lambda-meter in an experiment on preparation of Rydberg atoms in a magneto-optical trap”, Quantum Electronics 45, 9, 828-832 (2015).

10242-6, Session 2

Reconfigurable silicon photonics: devices and circuits *(Invited Paper)*

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As the link capacity increases dramatically, it is also becoming more and more important to develop smart photonic networks-on-chip so that the bandwidth/channels can be utilized optimally and flexible. One of the keys for realizing smart (reconfigurable) photonic networks is reconfigurable photonic integrated devices and circuits. As silicon has a large thermo-optic (TO) coefficient as well as the large heat conductivity (~149W/m?K), it is promising to realize efficient thermally-reconfigurable silicon photonic integrated devices and circuits with reduced power consumption and simple fabrication processes. This paper gives a review of our recent work on reconfigurable photonic integrated devices and circuits on silicon, including: (1) Ultra-broad band optical switches; (2) switchable/tunable silicon photonic integrated devices with transparent graphene nano-heaters; (3) Monolithically-integrated reconfigurable optical add-drop multiplexers (ROADMs) for wavelength-division-multiplexing (WDM) systems; (4) Multi-channel ROADMs mode-division-multiplexing (WDM) systems.

10242-7, Session 2

Automated tuning, control and stabilization of photonic integrated circuits *(Invited Paper)*

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The complexity scaling of silicon photonics circuits is raising novel needs related to control. Reconfigurable architectures need fast, accurate and robust procedures for the tuning and stabilization of their working point, counteracting temperature drifts originated by environmental fluctuations and mutual thermal crosstalk from surrounding integrated devices.

In this contribution, we report on our recent achievements on the automated tuning, control and stabilization of silicon photonics architectures. The proposed control strategy exploits transparent