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A single-frequency integrated ring laser for gyro applications

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Inertial measurement unit (IMU) is an essential part of modern aircrafts, drones spacecrafts, ships, missiles and others. A typical IMU comprises a set of accelerometers and gyroscopes providing signals which enable accurate and reliable navigation. The application determines detailed requirements, however in any case high speed and accuracy, compact and robust design combined with low power consumption are strongly demanded. Optical gyroscopes, either interferometric or ring laser based devices, seem to be the most suitable for these applications. However, so far an integrated optical gyroscope has not been implemented on the market [1]. In our previous paper [2] we demonstrated the initial results of our research on multi-mode integrated ring lasers for gyro application, while in this work we present a system, based on a single-frequency integrated ring laser, which could be used as an optical gyro sensor.

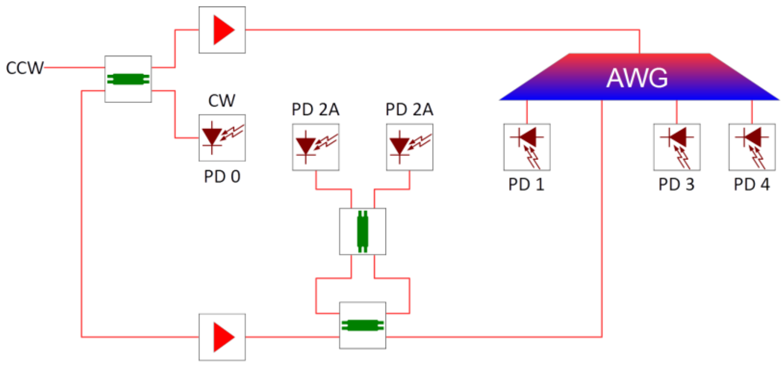

Fig. 1. Schematic diagram of the single-frequency integrated ring laser.

The scheme of the integrated ring laser is shown in Fig. 1. It comprises two semiconductor optical amplifiers (SOA, l = 750 µm) connected with each other by deeply etched waveguides forming a ring. A 1×4 arrayed waveguide grating (AWG, λ_c = 1550 nm, $\Delta\lambda$ = 1.6 nm, FSR = 12.8 nm) is used as an intra-cavity wavelength filter in order to force the laser to operate on a single frequency. The top-left coupler (an 85:15 MMI) is used to tap the signal out of the laser cavity for characterization purposes. The two lower MMI couplers and two photodiodes (PD 2A and 2B) are used for detection of the wavelength split under rotation of the sensor. Fig. 2. presents the mask layout of the designed photonic circuit. The chip was fabricated in the generic process of SMART Photonics [3].

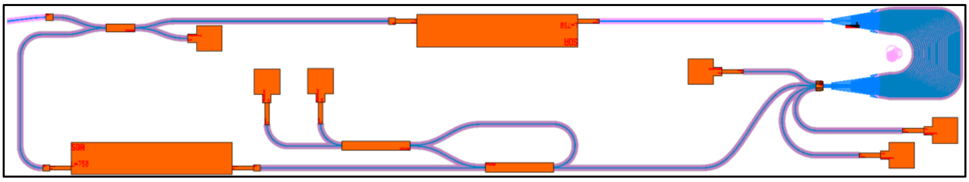

Fig. 2. The mask layout of the photonic chip (dimensions 4.6 × 0.8 mm).

The fabricated chip was initially characterized. Fig. 3. presents LI characteristics of the ring laser measured with a power meter at the chip output (counter-clockwise, CCW) and on-chip by reading the photocurrent on PD 0 (clockwise, CW). The threshold current is around 24 mA. The power of the CW and CCW modes is similar up to around 30 mA. For higher currents the CCW mode dominates. This phenomenon is similar to the results obtained in [4] for an AlGaAs ring laser, where also domination of one mode for higher supply currents was reported.

Fig. 3. presents also the output spectrum of the laser, measured while powering the SOAs with 70 mA, with a clearly visible singly frequency. The side mode corresponds to an adjacent AWG free spectral range, the side mode suppression ratio is as good as 52 dB.

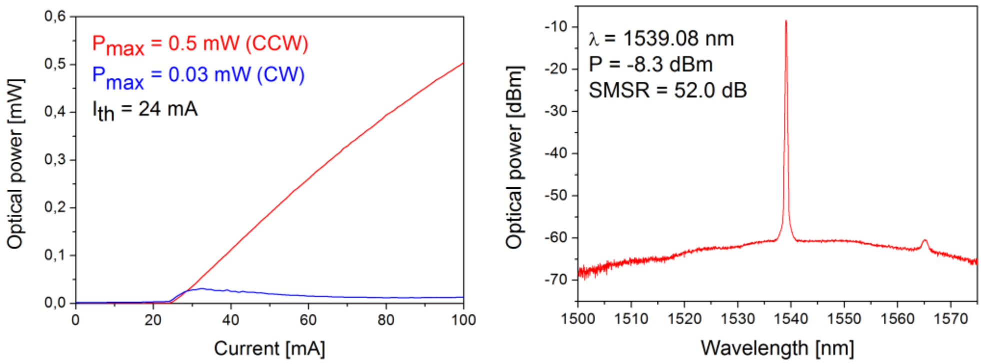

Fig. 3. Measured LI characteristics of CW and CCW signals and recorded output spectrum of the CCW signal.

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