Integrated wave-meter in silicon photonics, a case study: DFB stability and under direct modulation

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We present an application of an integrated high-resolution wave-meter where a DFB laser directly modulated is characterized in terms of wavelength position as a function of time and confronted to a commercial spectrometer.
Keywords: Wave-meter; silicon photonics; DFB laser, integrated optics.

1. Introduction

Silicon photonics opens the opportunity to process optical signals on a tiny footprint with very low energy consumption [1-4]. In this case study, a precise wave-meter is used in order to track and characterize a distributed feedback (DFB) laser. A DFB is a specific type of single frequency laser where the active region of the device contains a periodically structured element, which provides optical feedback for the laser, which sets a specific resonance and therefore the resonant wavelength. This type of laser is used in many applications like in telecommunications in the C-band or in sensing as they are relatively inexpensive, narrow linewidth (below 5 MHz) and good coherence and have a good stability over time.

2. Experiment

A Koheron LD100 low-noise DFB laser with integrated current driver emitting around 1550 nm was characterized using a wave-meter in integrated optics as shown in [4-5].

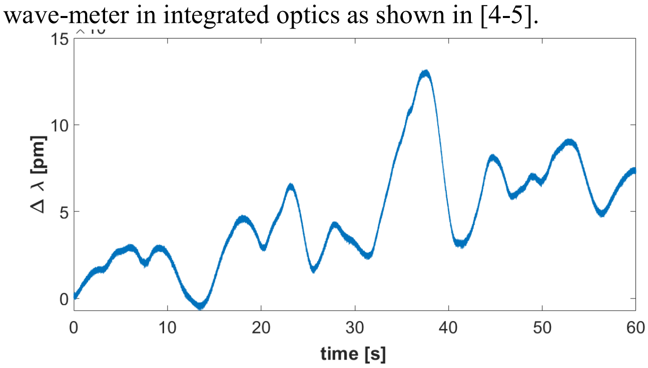

Figure 1 - Stability measurement of the emitted wavelength.

The sensing system is an integrated unbalanced Mach-Zehnder interferometer (iUMZI) with an active phase demodulation scheme using a thermo-optic heater is modulated at 5 kHz. The phase dithering allows the extraction of the phase with no responsivity fading associated to the quadrature point; the wavelength is finally extracted from phase multiplying by the free-spectral range, which in our case was 600 pm. In *Figure 1* is shown the measured spectral shift as a function of time. The stability measurement exemplifies a small and slow drift, which can ascribe to thermal effects. Such small drifts can be compensated for stabilizing the laser with a Peltier cell. In an application where low power consumption is needed, a solution without active temperature control of the laser but with the real-time monitoring of the wavelength is an interesting power saving alternative.

In a second time, the DFB was directly modulated using function generator, which tends to create a chirped emission of the light. Using the iUMZI it is possible to follow the wavelength and intensity of the DFB. As shown in *Figure 2* the spectral shift is only of +/- 25 pm but is easily tracked. We compared the measured shift using a high-speed spectrometer (I-MON from IBSEN photonics) and the spectral shift measured with the iUMZI appears equivalent if not less noisy.

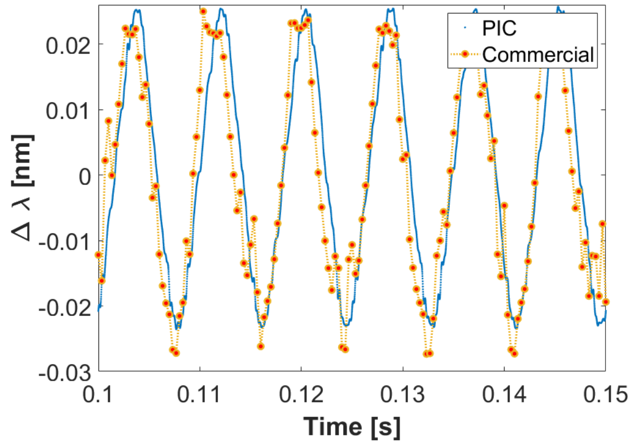

Figure 2 – spectral shift measured with both the integrated wave-meter (PIC) and a commercial spectrometer (IBSEN) as a function of time under sinusoidal modulation.

Other different types of modulations and speed have been tested and the complete results will be presented in order to show the performances and full characteristics of the iUMZI.

3. Conclusions

The presented case study validates our integrated wave-meter in terms of resolution and low noise. A directly modulated DFB was used as a moving monochromatic source and characterized in wavelength and intensity.

Acknowledgements

This research was partially funded by Tuscany Region through a POR FESR Toscana 2014–2020 grant in the context of the project SENSOR.

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