Characterization of the chirp properties of a monolithically-integrated widely-tunable all-optical wavelength converter (TAO-WC)

Milan L. Mašanović, Vikrant Lal, Leif A. Johansson, Jonathon S. Barton[1]
Larry A. Coldren, Daniel J. Blumenthal
Electrical and Computer Engineering ([1]Materials) Department, University of California Santa Barbara
Santa Barbara, CA 93106-9560, USA
Email: mashan@ece.ucsb.edu, Phone: 805-893-5282, Fax: 805-893-5705

Abstract - Characterization of time resolved chirp for first monolithically-integrated InP widely-tunable wavelength converter is reported. Average chirp parameter was measured to be -2 in non-inverting and 1-3 in inverting mode of operation for 40nm input - 22 nm output wavelength range.

1. Introduction

Monolithically-integrated tunable all-optical wavelength converters (TAO-WC) are key components for deployment of all optical networks, particularly for functions like WDM optical switching, and optical add/drop multiplexing. TAO-WCs allow data to be transferred from an input wavelength to a tunable output wavelength without passing the signal through electronics [1,2]. Recently, we reported the first monolithic integration of a widely tunable laser and a semiconductor optical amplifier Mach-Zehnder Interferometer (SOA-MZI) wavelength converter that performs both up and down wavelength conversion and 2R signal regeneration [1,2]. An important parameter for any type of optical regenerator is the output chirp as it will dictate the dispersion limited transmission distance and/or number of regenerator spans. It has been shown that the chirp of SOA-MZIs has little dependence on the chirp of the input signal [3]. Therefore, the chirp of the wavelength converter introduced in the process of data transcription will ultimately determine its performance in transmission systems. In this paper, we are reporting on characterization of time resolved chirp for the first monolithically-integrated widely-tunable wavelength converter [1,2]. Results obtained (low negative and positive chirp parameter for inverting/non-inverting mode of operation) indicate favorable device characteristics for deployment in all-optical networks.

2. Device

The TAO-WC consists of an InP SGDBR laser integrated with a SOA-MZI (Fig. 1) [1]. The interferometer branches are defined by two S-bends and 1mm long SOAs. The laser and the interferometer are connected via a multimode

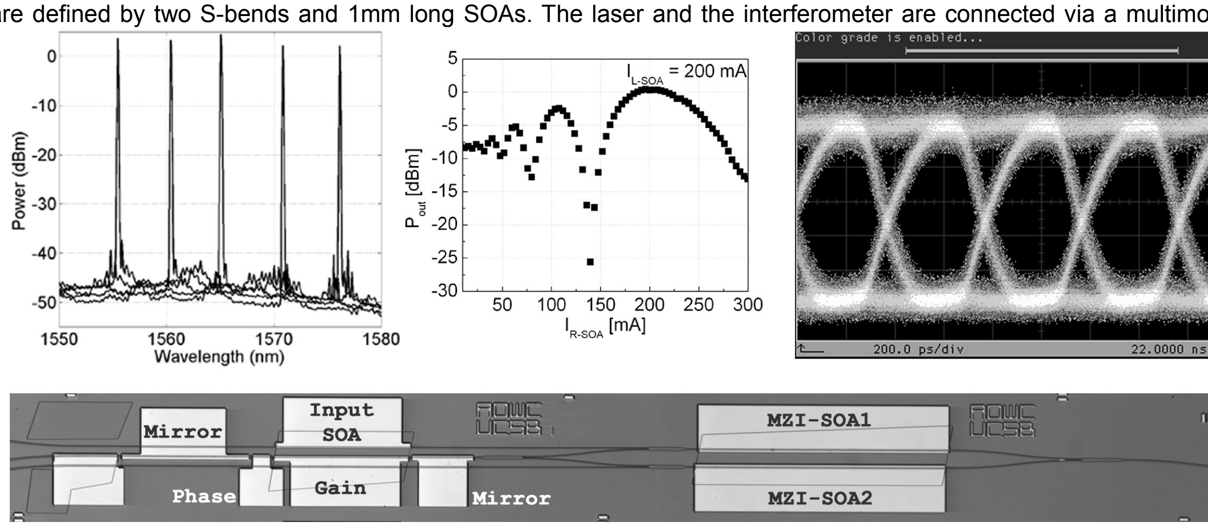

Figure 1 – Overlapped spectra, interferometer electrical transfer curve, typical eye diagram at 2.5Gb/s and TAO-WC micrograph

interference (MMI) splitter. The input signal is coupled onto the chip through a tapered, angled input waveguide, and amplified by an input SOA. The total device length is 4.8mm (Fig. 1). TAO-WC is fabricated using our offset quantum well integration platform, and the process requires a single MOCVD regrowth of InP.

The device used for these measurements had a tuning range of 22nm set by the on-chip laser (Fig. 1), and operated with >12dB RF extinction at 2.5GB/s. Typical interferometer electrical transfer curve and eye diagram of converted data are shown in Fig. 1. Details about the device design, fabrication process and operation can be found in [1,2].

3. Results and discussion

For time resolved chirp measurements, the TAO-WC MZI's bias currents were optimized for maximum extinction ration in either inverting or non-inverting mode of operation at 2.5Gb/s. Device test setup used is similar to the one described in [1,2]. The output of the device was optically filtered and then led into an optical chirp test instrument. The interferometric method used for chirp measurement is based frequency and amplitude change measurements on two different slopes of the interferometer in order to obtain time resolved frequency change [4]. The optical output from this instrument was connected to a high-speed digital oscilloscope, which is used in combination to perform measurements on the data pattern.
Time-resolved chirp was measured as a function of the input wavelength, output wavelength (set by the integrated on-chip laser) and interferometer bias point (inverting, non-inverting and in between). Example of results measured for non-inverting and inverting mode of operation is shown in Fig. 2.

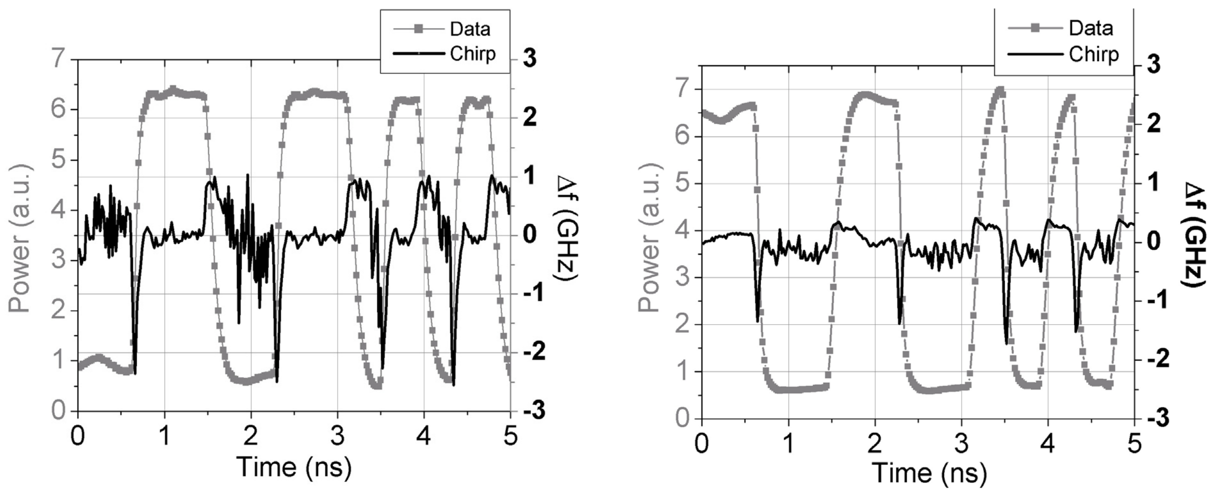

Figure 2 – Example of time-resolved chirp data for non-inverting and inverting mode of operation

Little input-output wavelength dependence of chirp parameter values was observed across the entire data set. The chirp parameter value and sign depend on the slope of the transfer function of the wavelength converter in the selected regime of operation (Fig. 1). For non-inverting operation, the average chirp parameter was measured to be -2 for 40nm input and 22 nm output wavelength range. For inverting mode of operation, the average chirp parameter was measured to be 1-3 for the same output wavelength range. Thus, the performance of the wavelength converter in transmission should consistently reduce the dispersion power penalty if operated in the suitable mode of operation (based on the fiber dispersion parameter). The chirp parameter sign measured is consistent with theory and previous results for an XPM-SOA based wavelength converter [3].

4. Conclusion

We have performed characterization of the time resolved chirp for the first monolithically-integrated widely-tunable wavelength converter in InP. The average chirp parameter was measured to be -2 in the non-inverting and 1-3 in the inverting mode of operation for 40nm input and 22 nm output wavelength range. Output chirp is one of the key parameters that dictate the dispersion limited transmission distance and/or number of regenerator spans, therefore results obtained indicate favorable device characteristics for its application in real optical networks.

5. Acknowledgments

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6. References

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