Linear signal processing using silicon micro-ring resonators

Christophe Peucheret[1], Yunhong Ding[1], Haiyan Ou[1], Meng Xiong[2,1], Yi An[1], Abel Lorences Riesgo[1], Jing Xu[1], Oskars Ozolins[3,1], Hao Hu[1], Michael Galili[1], Bo Huang[2,1], Minhao Pu[1], Hua Ji[1], Jorge Seoane[1], Liu Liu[4] and Xinliang Zhang[2]

[1] *DTU Fotonik, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark*
[2] *Wuhan National Laboratory for Optoelectronics, 430074 Wuhan, China*
[3] *Telecommunications Institute, Riga Technical University, LV-1048 Riga, Latvia*
[4] *South China Normal University, 510006 Guangzhou, China*
cpeu@fotonik.dtu.dk

Abstract: We review our recent achievements on the use of silicon micro-ring resonators for linear optical signal processing applications, including modulation format conversion, phase-to-intensity modulation conversion and waveform shaping.

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Silicon micro-ring resonators (MRRs) are compact and versatile devices whose periodic frequency response can be exploited for a wide range of applications, the most straightforward being periodic filters, add-drop multiplexers or wavelength selective switches [1]. Recently, we have exploited the design flexibility of MRRs in order to demonstrate spectral and temporal signal shaping. In particular, MRRs can be used for optical modulation format conversion from return-to-zero (RZ) on-off keying (OOK) to non-return-to-zero (NRZ) OOK [2]. This technique has been used for multi-channel format conversion, but also for the first ever demonstration of NRZ signal generation at 640 Gb/s by conversion of an optical time division multiplexed (OTDM) signal [3]. It has also been extended to format conversion from RZ differential phase-shift keying (DPSK) to NRZ-DPSK [4]. Another application of MRRs is for the demodulation of DPSK signals [5]. Other temporal shaping demonstrations include the generation of ultra-wideband monocycle pulses [6] as well as the enhancement of the modulation speed of directly modulated lasers [7].

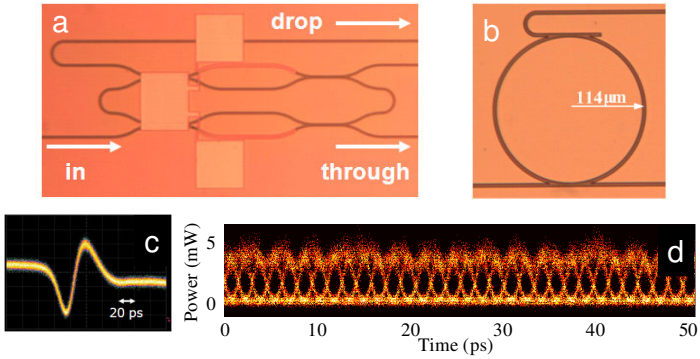

Fig. 1. Microscope pictures of (a) micro-ring resonator with tunable coupling coefficients for UWB signal generation and (b) add-drop micro-ring resonator used for multi-channel DPSK demodulation at 40 Gb/s. (c) Synthesised Gaussian monocycle pulse. (d) Eye diagram of a 640 Gbit/s NRZ-OOK signal obtained by modulation format conversion of an OTDM RZ-OOK signal.

Even though silicon MRRs are promising devices, they suffer from inherent polarization sensitivity, which is a critical impediment to their practical use. We will show how polarization diversity circuits based on polarization splitters and rotators can be engineered to significantly reduce their polarization sensitivity and illustrate the benefit of such circuits with the example of an MRR-based DPSK demodulator [8].

References

1. W. Bogaerts et al., Laser Photonics Rev. **6**, 47–73 (2012).
2. Y. Ding, et al, Opt. Express **18**, 21121–21130 (2010).
3. Y. Ding et al., Opt. Express **19**, 6471–6477 (2011).
4. M. Xiong et al., *OECC* (2012), paper SC2-1085.
5. Y. Ding et al., J. Lightwave Technol. **29**, 677–684 (2011).
6. Y. Ding, et al., *IPC* (2011), paper TuI2.
7. Y. An et al., *OECC* (2012), paper SC2-1086.
8. Y. Ding et al., IEEE Photon. Technol. Lett. **23**, 1808–1810 (2011).