Integrated High-resolution Photonic Spectrometer

S. N. Zheng[1,2], H Cai[2] , Y. D. Gu[2] and A. Q. Liu[1]
[1]School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore 639798
*[2]Institute of Microelectronics, A*STAR (Agency for Science, Technology and Research), 2 Fusionopolis Way, #08-02 Innovis Tower, Singapore 138634*

Abstract: An integrated high-resolution on-chip spectrometer is designed, fabricated and experimentally tested. A thermally tunable microring resonator is adopted to function as a tunable filter so as to retrieve the input spectrum. The robust integrated spectrometer is quite compact, low cost and CMOS-compatible. It has high potential to be used in on-chip sensing and spectroscopy systems.

1. Introduction

On-chip spectrometer has been a hot topic with the development of CMOS fabrication technology. The development of the integrated photonic circuits has given the high possibility to integrate sensing system including active and passive devices all on a single chip. Spectrum analysis is very important especially in various sensing and substance analysis systems. Many approaches have been tried to achieve an on-chip spectrometer. Here, an on-chip spectrometer using a tunable microring resonator (MRR) integrated with a Ge-on-Si photodetector is demonstrated.

2. Results and Discussions

The working principle of the spectrometer is shown in Figure 1(a). A microheater is used to thermally tune the resonance wavelength of the MRR. Only light components on resonance will pass through the drop port. With resonance wavelength modulated, all corresponding light components will be finally retrieve by detecting the light intensity change with time in the drop port. Figure 1(b) shows the fabricated integrated spectrometer. The photodetectors as through and drop port are used to detect light instead of an off-chip photodetector

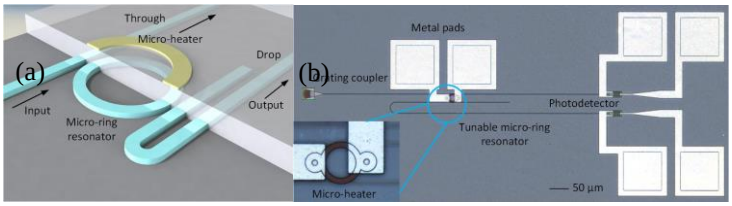

Fig.1. (a) Schematic illustration of the cross-section view of an on-chip spectrometer. (b) Microscopic picture of a spectrometer chip and the micro-heater (inset).

Figure 2(a) shows the retrieved spectra with 1558 nm and 1558.2 nm input with power variation for 1558.2 nm. Figure 2(b) shows the retrieved spectra with 1558 nm and 1559 nm input with power variation for both. Figure 2(c) shows the responsivity of the Ge-on-Si photodetector at 0 voltage bias.

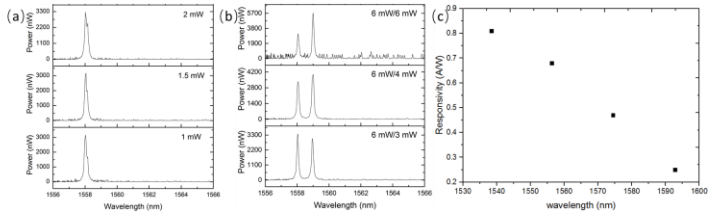

Fig.2. Retrieved spectrum (a) with 1558 nm and 1558.2 nm input with power variation for 1558.2 nm. (b) with 1558 nm and 1559 nm input with power variation for both. (c) Responsivity at 0 voltage bias.

3. Summary

An integrated high-resolution on-chip spectrometer is demonstrated. Thanks to the microring resonator cavity, the resolution can achieve up to 0.2 nm. The responsivity of the photodetector at 0 bias is up to 0.8 A/W at around 1540 nm. The bandwidth covers the whole FSR (19 nm). It is promising for application in on-chip spectrum analysis.