On-chip optical pulse analyzer using silicon photonics

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Conventionally, short-pulse lasers have been used only in research laboratories or factories whose environment is clean and stable. In such a case, a pulse measurement equipment used for development of the pulse generators can also be used in the clean and stable environment. Recently, the short-pulse laser begins to be used for some applications such as bioimaging, cataract surgery, and time-of-flight LiDAR operated in usual environment where vibration, temperature change, and human's eyes exist. To monitor the pulses in such environment, a compact, solid-state, and high-sensitive pulse analyzer is desired. Such a demand will not be achieved by conventional pulse analyzers like a frequency resolved optical gating (FROG). In this paper, we demonstrate a fully integrated pulse analyzer fabricated using silicon photonics. This is ultracompact and solid state, and highly sensitive compared to the conventional ones.

Figure 1 shows the schematic of the proposed pulse analyze. A pulse under test is split and launched from both ends of the SiPh chip at the same timing. One pulse is filtered by a micro-ring filter and propagates into the two-photon absorption photodiode (TPA-PD) array embedded on the silicon waveguide. The other pulse propagates into the TPA-PD array from the other side. The cross-correlation of the filtered pulse and the original pulse is obtained by the TPA-PD array [1]. By acquiring the cross-correlation with scanning the filtering frequency over the entire range of pulse spectrum, the spectrogram of the pulse is obtained. Then, pulse waveform is retrieved from the spectrogram.

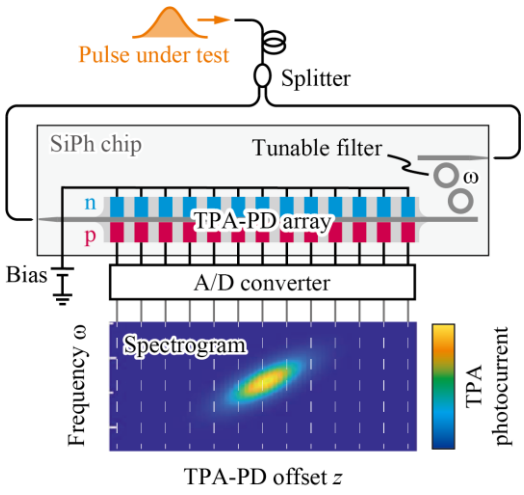

Fig. 1. Schematic of the pulse analyzed integrated on a SiPh chip, and a spectrogram obtained by the analyzer.

[1] K. Kondo and T. Baba, Optica **4**, 1109 (2017).

Keisuke Kondo received the B.E., M.E, and Ph.D. degrees all from the Department of Electrical and Computer Engineering, Yokohama National University, Yokohama, Japan, in 2012, 2013, and 2016, respectively. During his Ph.D., he studied co- and counter-propagating slow-light systems. At present, he is an assistant professor in Utsunomiya University, Graduate Program in Optical Engineering. He is currently working toward silicon photonic optical measurement devices. He is a Member of JSAP.