Two-Photon Absorption Avalanche Photodiode Array for Ultra-Compact Pulse Analyzer

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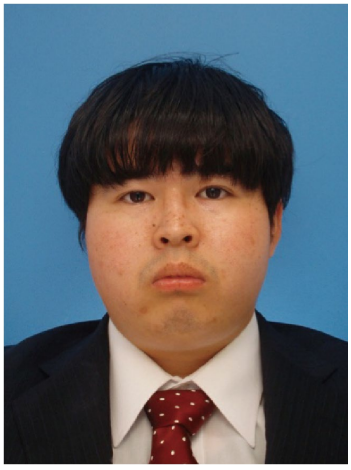
We have studied an ultra-compact pulse analyzer consisting of an on-chip optical correlator and a tunable filter. The on-chip optical correlator is comprised of a silicon waveguide embedded with a two-photon absorption photodiode (TPA-PD) array. The pulse analyzer has advantages of high sensitivity, ultra-compact, and solid-state. If an avalanche amplification is applied to the TPA-PD, our pulse analyzer would achieve further high sensitivity. In the TPA-PD waveguide, the photo-absorption region is just the waveguide core. To achieve an efficient avalanche amplification, it is preferred that the amplification region, which is intrinsic region sandwiched by the p- and n-doped region, is separated from the photo-absorption region. As a result, the waveguide is formed on the p-doped region and the TPA-PD' responsivity is degraded by free carrier absorption (FCA) loss.

In this study, we investigate a *p-i-n* junction structure that can simultaneously achieves the suppression of FCA and the efficient avalanche amplification. We propose a *p-i-n* junction with latticed p-doped region formed on the waveguide and compare the performance of it to a TPA-PD which has conventional *p-i-n* junction or a simply offset *p-i-n* junction. The photocurrent and dark-current characteristics of the *p-i-n* junctions were analyzed using a charge transport simulation, and the FCA loss was numerically estimated. It was revealed that the proposed structure can sufficiently suppress the dark current compared with the conventional *p-i-n* junction, and its FCA loss was 16 dB/cm lower than that of the simply offset p-i-n junction.



Short biography

Nozomi Koyama graduated from the University of Utsunomioya in March 2024. He went on to pursue a master's degree at the same university. He is a member of the The Japan Society of Applied Physics. His research topic is Silicon Photonics.