Numerical Simulation on Wavelength Characteristics of an Optically Amplified Feedback Circuit for Multi-Wavelength Sensing Applications

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Introduction:

High-precision sensing of optical power is an important technology in photonics applications such as optical measurement and optical communication [1-2]. We have proposed an optical amplifier feedback circuit (OAFC) method as a new method of photodetectors that can achieve remarkably high precision, that is, high resolution of optical power sensing [1-7]. Then, we are studying for clarifying the performance of the OAFC. In this study, we report that the proposed method achieves about 142 times higher accuracy (about 1/142 of the resolution) compared with the conventional method without OAFC using numerical simulation.

Numerical Simulation:

Figure 1 shows the configuration of the OAFC. The pump light of the erbium-doped fiber (EDF) from the pump light source (PLS) was used as the input light (Input) of this method. The OAFC consists of a gain medium (EDF), an optical isolator (ISO) installed on both sides of the EDF, a multiplexer (CP) for introducing the pump light, and a pump light remover (PR). The OAFC also has an optical attenuator (ATT) for adjusting the loss and a splitter (BR) for extracting the output light (Output) out of the ring. The optical input/output characteristics of the OAFC have been investigated when an optical narrowband filter (OBPF) is installed. The transmission bandwidth of the OBPF was 0.87 nm. The wavelength of the PLS was about 1470 nm. The PLS was driven with a constant current, and a variable optical attenuator (VOA) was installed after the PLS to change the input optical power of the EDF input.

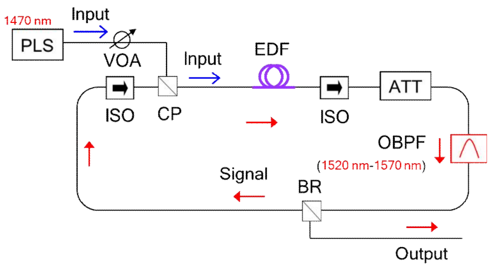

Fig. 1 System configuration

The input optical power at the input port of the CP is P_{in}, and the output optical power is P_{out}. Figure 2 shows the dependence of P_{out} against P_{in}. Let the slope (S) be $S = \Delta P_{out} / \Delta P_{in}$ [1-2]. Figure 3 shows the dependence of S on the wavelength of the OBPF. Also it shows the comparison between the experimental result and the simulated result. This slope shows the improvement of the optical power detection accuracy (optical power resolution: OPR) of the proposed method when compared with the conventional technology. The OPR value is $1/S$ times the OPR of the conventional technology. The maximum value of S was about 142 at the wavelength of 1555 nm and value of S was about 418 at the wavelength of 1553 nm in our experimental data. As shown in Fig. 3, the S values obtained by the experiment are much higher than those obtained by the numerical simulation. The reason for the differences between the two series of data is a future issue.

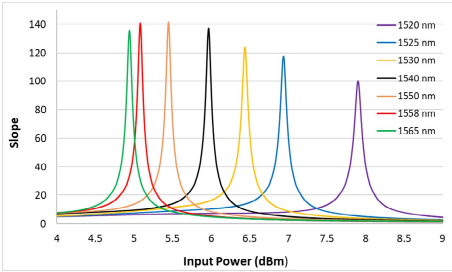

Fig. 2 Slope characteristics

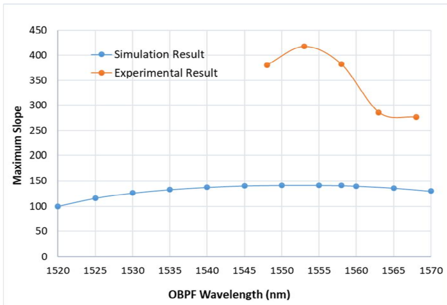

Fig. 3 Slope as a function OBPF wavelength

Conclusion:

We clarified the characteristics of the improvement factors S in the OPR with the OAFC method as a function of the wavelength of the output light by the numerical simulation for the first time. The maximum value of slope S obtained by the numerical simulation was about 142 at wavelength of OBPF 1555 nm.

References:

[1] H. Masuda and K. Kitamura, (APOS), Wed-6 (2018).
[2] K. Kitamura and H. Masuda, (OECC), 3C1-3 (2018).
[3] K. Kitamura and H. Masuda, (MOC), P.26 (2018).
[4] H. Masuda, K. Kitamura, MD S. Islam, and B. Biswas, MC2-5, OECC (2019)
[5] H. Masuda and K. Kitamura, B13-1, IEICE Society Conference (2019)
[6] B. Biswajit, MD S. Islam, K. Kitamura, and H. Masuda, B13-2, IEICE Society Conference (2019)
[7] B. Biswajit, MD S. Islam, K. Kitamura, and H. Masuda, B1-22, HISS Conference (2019)