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Wavelength Monitoring of Remote Node by Using Self-Locked Reflective Semiconductor Optical Amplifier for Bidirectional WDM-PON

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Abstract

A wavelength monitoring technique of remote node (RN) is proposed using RSOA self-locked by Bragg grating at the RN. The temperature variation of RN can be monitored by measuring the lasing wavelength of the RSOA.

I. Introduction

Wavelength division multiplexing - passive optical network (WDM-PON) is highly concerned with future broadband access networks. For commercial deployment, many studies have been focused on the WDM-PON with simple and low cost solutions. Bidirectional WDM-PON is one of the solutions in terms of fiber capacity and maintenance. In this WDM-PON, however, how to discern and offset the wavelength drift of an arrayed waveguide grating (AWG) at the remote node (RN) without complicated wavelength monitoring technique is important [1].

Previously, a stable optical source such as multi-frequency [2,3] or distributed feedback - laser diode [4] should be used to monitor the temperature-induced wavelength drift. Its optical power is monitored and fed back to the optical line terminal (OLT), and can be adjusted to accommodate the misalignment of the wavelength. However, these optical sources are expensive. Moreover, those techniques require an additional output port of the AWG at the RN to monitor the wavelength drift [3,4].

In this paper, we propose a simple monitoring technique on the temperature-induced wavelength drift at the RN using a reflective semiconductor optical amplifier (RSOA) and a Bragg grating (BG) (Fig.1). The RSOA is self-locked by the BG, and its lasing wavelength follows the center wavelength of the BG, reflecting the temperature-induced wavelength drift of the AWG. Thus, the temperature variation of the RN can be monitored by measuring the lasing wavelength of the self-locked RSOA. It can be used to control the wavelengths of the transmitters and the AWG. The proposed technique is simple and cost-effective, and the additional port is not needed for the wavelength monitoring technique.

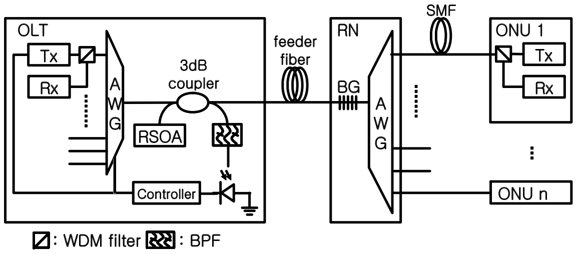

Fig. 1. WDM-PON architecture employing the proposed monitoring technique. RSOA: reflective SOA, BG: Bragg grating, BPF: band-pass filter

II. Operation Principle

Silica-based Bragg grating has the same temperature-induced wavelength drift ratio as that of silica-based AWG, 0.01*nm/°C* [2]. When the RSOA is self-locked by the reflected light from the BG, its lasing wavelength is shifted with the same amount of the wavelength drift in the AWG. This drift is detected by measuring the optical power of the self-locked RSOA passed through a narrow optical band-pass filter (BPF). The detected wavelength drift of the AWG can be used to control WDM channel wavelengths at the OLT to minimize the misalignment along the optical path [4]. In bidirectional transmission, a cyclic AWG with skip-band is mostly used and, as a result, the lasing light from the self-locked RSOA could be transmitted to the optical network unit (ONU) and the OLT. Therefore, we select a wavelength for monitoring in our experiment within the skip-band, not a pass-band of the AWG.

III. Experiment and Results

The experimental setup is shown in Fig. 2. The RSOA is added through a 3-*dB* coupler to the downstream. One output from the coupler was coupled to the feeder fiber. To investigate length-dependent wavelength change, various lengths of single mode fibers were tried. The peak wavelength of the self-locked RSOA was measured by the optical spectrum analyzer (OSA) instead of the optical BPF and the optical power meter. The bias current of the RSOA was set at 70mA. The fiber Bragg grating (FBG) with 3-*dB* bandwidth of ~0.35*nm* was used as a BG, and its center wavelength was 1550.82*nm* at 30˚*C*. The temperature of the RN was changed by the oven over a temperature range from 20˚*C* to 60˚*C*.

Fig. 3 shows the spectra of the reflection of the FBG and the self-locked RSOA at the back-to-back operation. Side-mode suppression ratio (SMSR) and the 3-*dB* bandwidth of the self-locked RSOA appeared to be ~36*dB* and ~0.15*nm*, respectively. By comparing of two spectra, the peak wavelength of the self-locked RSOA was placed at the falling edge of the FBG. The inset of Fig. 3 shows the spectra of the self-locked RSOA according to different fiber lengths at 30˚*C*. As a result, the peak wavelength of the RSOA does not change according to the fiber length. Therefore, the proposed technique can be used independently of the length of the feeder fiber.

Fig. 4 shows that the temperature-induced wavelength drifts of the self-locked RSOA, the reflection curve of the FBG, and the AWG were measured from 20˚*C* to 60˚*C*. Their drift ratios were about 0.0136*nm/˚C,* 0.0141*nm/˚C* and 0.0117*nm/˚C*, respectively. This slight difference was within a measurement error range due to the resolution of the OSA.

IV. Conclusion

We have proposed and experimentally demonstrated a simple wavelength monitoring technique of the RN based on the RSOA, which is self-locked by the FBG at the RN. By measuring the wavelength drift in the lasing wavelength of the self-locked RSOA, we can effectively reduce the misalignment of wavelength by temperature variation of the RN in WDM-PON.

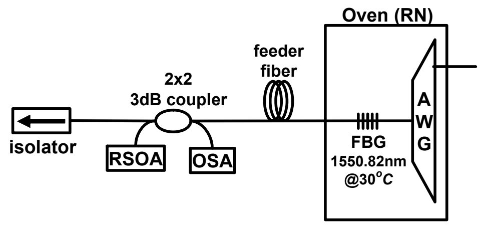

Fig. 2. Experimental setup.

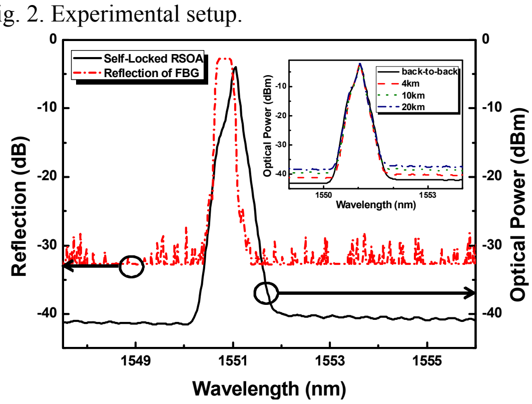

Fig. 3. Spectra of the reflection of the FBG and the self-locked RSOA under the back-to-back operation.

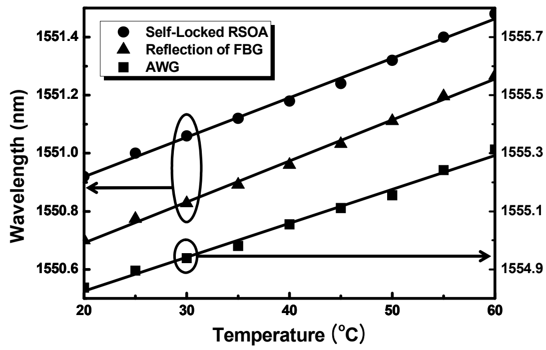

Fig. 4. Temperature-induced wavelength drift.

Acknowledgement

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