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A wavelength converting and switching method based on Fabry–Perot laser diodes

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Abstract

We propose and experimentally demonstrate a new wavelength converting and switching technique, which is based on a Fabry–Perot laser diode (FP-LD) pair with optical external injection method. Therefore, adjusting properly bias current levels of FP-LDs can be realized the optical conversion and tuning. For the experimental demonstration, three different wavelengths [side-mode suppression ratios (SMSRs) are above 20 dB] are converted and the wavelength switching response time is less than 6.8 ns.

Keywords: Wavelength converting; Fabry–Perot laser; Optical switching

1. Introduction

Wavelength converting and switching techniques are necessary optical devices for wavelength-division-multiplexing (WDM) systems and optical switching applications. Especially, wavelength converters may be important components in future WDM networks because they improve network management and internetworking between networks [1,2]. Wavelength converters with reconfigurable functionality may enable WDM networks to have improved operation flexibility over WDM networks employing wavelength converters without such functionality. Amongst several wavelength conversion techniques, all optical wavelength conversion based on semiconductor optical amplifiers (SOAs) are promising because they can be operated at high speed with high-conversion range [1,3,4]. Moreover, various

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methods for all-optical wavelength conversion have been investigated up to now, including nonlinear optical gating based on fiber loop, cross-gain modulation, cross-phase modulation, four-wave mixing techniques using semiconductor optical amplifiers [5,6], using absorption modulation of an injection-locked Fabry–Perot laser diode [7], and difference frequency generation in quasi-phase-matched waveguides [8]. One of the major goals of the current research is to develop simpler cost-effective wavelength converters that can operate at submilliwatt input powers and, thus, avoid the need of an additional amplifier stage [7,9].

Recently, several fast wavelength tuning studies have also been reported, such as the sample grating (SG) or super structure grating (SSG) distributed Bragg reflector (DBR) lasers, grating assisted co-directional coupler with rear sampled grating reflector (GCSR) laser, and high speed electro-absorption-SSG-DBR lasers [10–13]. All of these techniques employ the fiber grating device to produce self-seeding for the wavelength tuning. In this paper, we have proposed and demonstrated a new technique for wavelength converting and fast wavelength tuning simultaneously. This proposed technique, based on optical external-injection method, is constructed by two Fabry–Perot laser diodes (FP-LDs), which act as host and optical injection sources, respectively. Then, we can obtain the wavelength converting by controlling the bias current levels of FP-LD. The behaviors of the response time for wavelength switching have also been investigated. Compared with other wavelength converting and tuning techniques [3–13], this proposed configuration has the advantages of simple architecture, potential low cost, wavelength conversion, direct modulation ability, wavelength conversion, and fast wavelength tuning. In future, this experimental architecture would be integrated on a package to reduce the cavity length and enhance the stability of optical output.

2. Operation principles and experimental setup

Fig. 1 shows the proposed and experimental setup for the wavelength converting and switching. The Fabry–Perot laser, LD-1, which can provide different spectral tilt and power by controlling bias currents, acts as injection light source. The output of LD-1 is transmitted through an optical circulator (OC), a multi-band filter that is composed by two 1×4 couplers and three tunable bandpass filters (TBFs), and is launched into LD-2. Both LD-1 and LD-2 have similar longitudinal multimode wavelengths with mode spacing of around 1.12 nm and 20 dB bandwidth of 10 nm. The LDs can be directly modulated at 1 GHz. The TBFs have 3-dB bandwidth of 0.8 nm and central wavelengths located at 1540.90, 1542.04 and 1543.20 nm, respectively. However, these filters are used to enhance the wavelength selectivity and reject unwanted light wave for tuning or converting wavelength. The optical spectrum of this

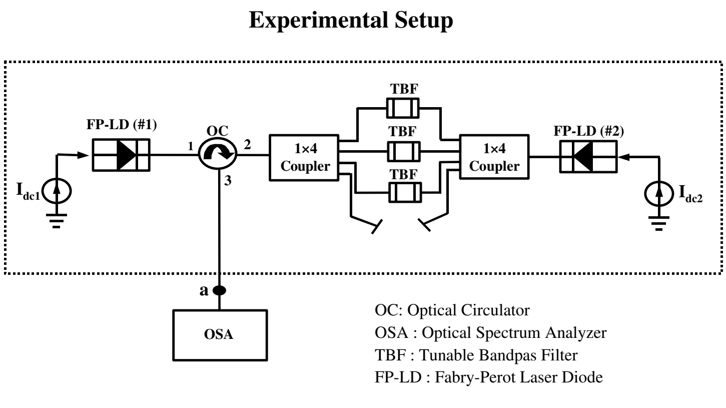

Fig. 1. The proposed and experimental setup for wavelength converting and tuning.