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A New Wavelength Converter with Tunable Output Wavelength Based on a Self-Seeded Fabry-Perot Laser

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Wavelength converters with tunable output make the all-optical networks reconfigurable and give lots of flexibility [1]. Although several wavelength converters with tunable output wavelength have been demonstrated using multi-section DFB or DBR lasers [2], they need complex electrical control for stable wavelength tuning.

We report a new all-optical wavelength conversion scheme, which can provide tunable output wavelength. Our scheme is based on the self-seeded Fabry-Perot laser diode (FP-LD) connected to a linearly chirped fiber Bragg grating (LCFBG) [3].

Fig. 1 shows the experimental setup used for realizing our scheme. The FP-LD used is a commercially available module, having 100 GHz mode spacing. The LCFBG has 12.14 nm of spectral BW from 1544.05 nm to 1556.20 nm with 68 % of reflectivity. The multi-mode characteristics of FP-LD and the wide spectral BW of LCFBG make external cavity length wavelength-dependent. Therefore, each FP mode has its own cavity resonance frequency. With the external RF modulation, only the FP mode whose cavity resonance frequency or its harmonic matches the applied external RF modulation frequency can be excited. Consequently, by changing the external RF modulation frequency, wavelength switching between FP modes can be achieved. Fig. 2 shows excited lasing wavelength and the side-mode suppression ratio (SMSR) as function of the applied RF modulation frequency. In order to increase the pulse repetition rate, RF frequencies in the range of 2.65 GHz are used, which correspond to the 12th harmonic of the cavity resonance frequencies. The applied RF power is 11 dBm measured at the output of RF source. The FP-LD is biased slightly above the threshold current so that the maximum SMSR can be obtained. As can be seen from the figure, change in RF modulation frequency produces different excited wavelength. The RF frequency shift required for switching from one FP mode to the next adjacent mode is about 3.715 MHz. In our experiment, 14 FP modes can be excited with larger than 25 dB SMSR. The total number of the excited FP modes is limited by the spectral BW of the LCFBG.

In order to achieve all-optical wavelength conversion, we used injection-lock technique. If the power of incoming optical signal, whose wavelength lies outside LCFBG pass band, is sufficiently large so that one of the FP modes can be injection-locked, the FP-LD lases dominantly at the mode into which external light is injected. Lasing due to self-seeding occurs only when there is no external light injection and, consequently, inverted wavelength conversion can be achieved. Although the wavelength of the input signal should lie outside the grating BW, this problem can be resolved by utilizing two facets of FP-LD for input and output.

Fig. 3(a) and (b) show the output spectra of the tunable self-seeded laser before and after the external light injection, respectively. The converted signal is detected by low speed photodiode for filtering out the high frequency component of the pulses. Fig. 4(a) and (b) show the eye patterns of input and converted signals. The input signal externally modulated 1540.57 nm optical signal by 10 Mbps PRBS generator. Due to the long external cavity length of the self-seeded laser used in our initial investigation, the data rate is limited to 10 Mbps. Asymmetry in eye patterns shown in Fig. 4(b) is due to the difference in turn-on and turn-off transients of the self-seeded FP-LD. Schell *et al.* reported that it takes about 10 times of cavity round trip time for the external cavity laser to be turned on [4]. For turn-off, however, no significant transient effect exists. It is expected that with proper control of the bias level and the amount of optical feedback, reduction in turn-on delay time is possible.

In summary, All-optical wavelength conversion into 14 wavelengths, each of which is separated by 100 GHz, is demonstrated at 10 Mbps using a self-seeded FP-LD with a LCFBG. With this technique, conversion wavelength is easily tunable to the desired wavelength by changing the RF modulation frequency.

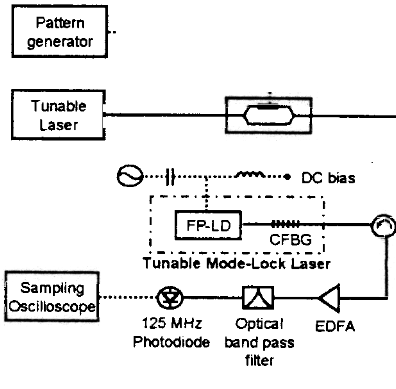

Fig. 1. Experimental setup for wavelength conversion

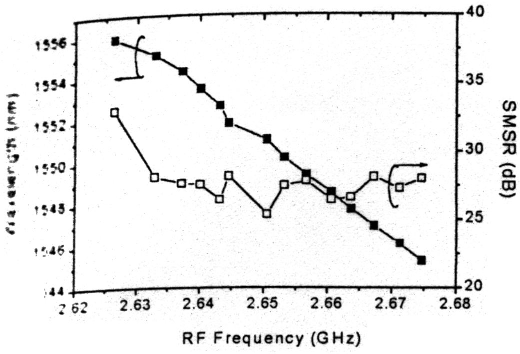

Fig. 2. Wavelength switching characteristics of the Self-seeded FP-LD with LCFBG

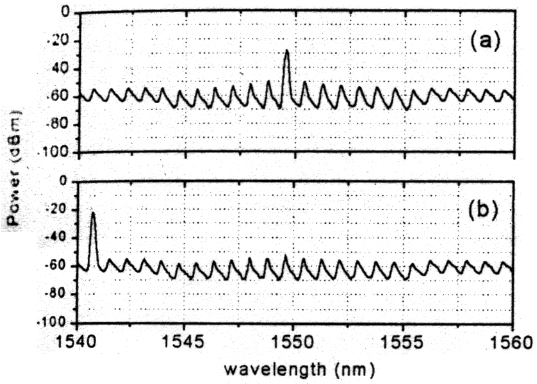

Fig. 3. On/off switching of FP-LD with LCFBG before (a) and after (b) external optical injection

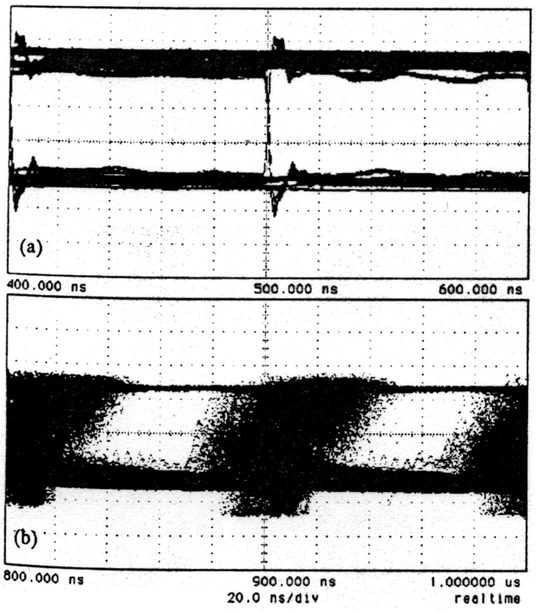

Fig. 4. Eye diagrams before (a) and after (b) conversion

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