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Fast wavelength switching in a widely tunable GCSR laser using a pulse pre-distortion technique

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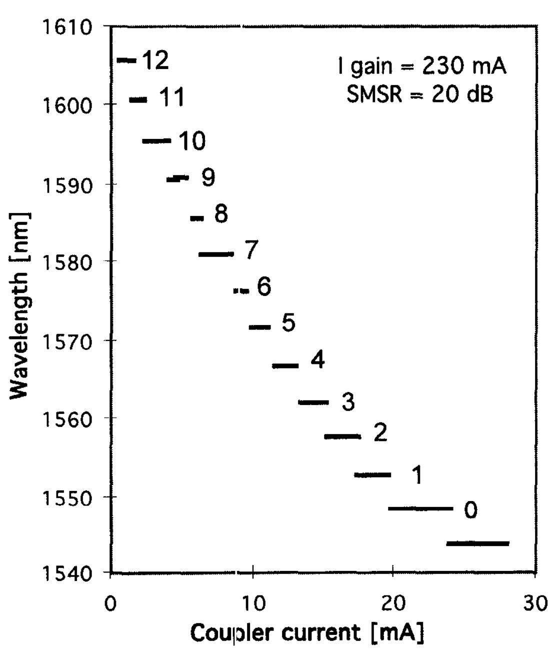
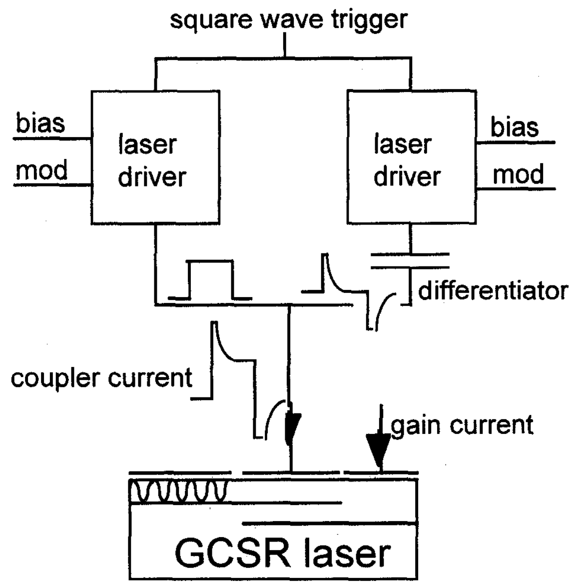
Wavelength switching using widely tunable lasers is important for broadband wavelength conversion and signal routing in wavelength-division multiplexing (WDM) networks.[1,2] Here, the switching time is defined as the time it takes the laser to switch from the original wavelength to reach steady-state at the new wavelength.

In this paper, we report the measurement of wavelength-switching times in a GCSR laser over 57 nm. Through use of a pulse pre-distortion technique to compensate for carrier spontaneous lifetime, an improvement by a factor of 2 in time was obtained. However, the switching time was shown to depend strongly on the static tuning characteristic.

The vertical Grating assisted codirectional Coupler laser with a Sampled Bragg Reflector (GCSR) laser is describe in Ref. 3. By changing the coupler section current, i.e., the carrier density, the wavelength is tuned over 60 nm in steps of about 5 nm as shown in Fig. 1. The side-mode suppression was at least 20 dB. We compared the switching time with and without pulse pre-distortion. Pre-distortion is achieved by over-driving the current pulse at the rising and falling edges of the pulse by combining ac- and dc-coupled drivers as shown in Fig. 2. Wavelength-switching time was measured using an optical filter with a 0.2-nm bandwidth tuned at the start and then stop wavelength. After filtering, the signal is detected and recorded on a sampling oscilloscope. The coupler section is driven by a square wave and the switching time is measured both at the up step and down step. The measurements were made from a base wavelength (#0 @ 1548 nm) to wavelength #i (i ∈ [1,12]) back and forth.

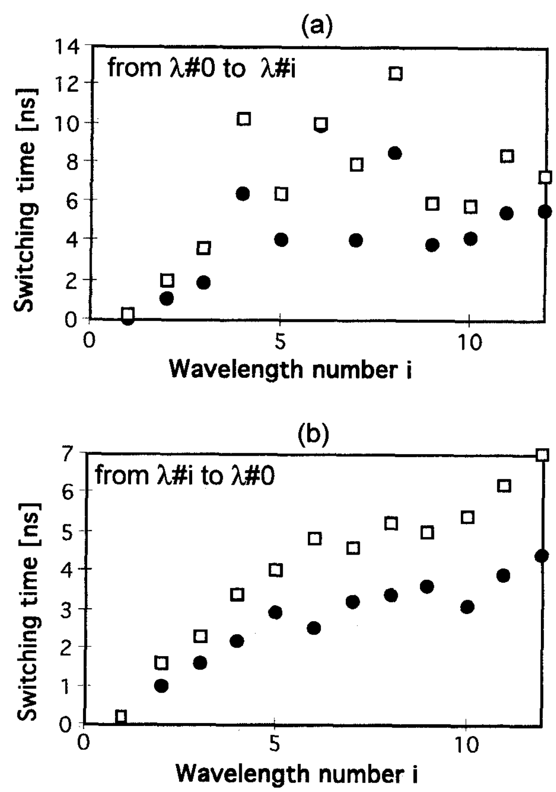


WL63 **Fig. 1.** Static wavelength tuning vs. coupler current of the GCSR laser.



WL63 **Fig. 2.** Driving circuit showing the principle of pre-distortion.

Figure 3 (open squares) shows the switching times without pre-distortion. The switching event was stable from 1 kHz–50 MHz showing the thermal stability. The large variation in the switching time from #0 to



WL63 **Fig. 3.** Switching time for wavelength jump (a) from 1#0 to 1#i and (b) from 1#i to 1#0 with pre-distortion (filled circles) and without (open squares).

#i is correlated to the tuning current interval for wavelength #i. For an input current step, the carrier density varies as $(1 - \exp(-t/\tau))$, where τ is the carrier spontaneous lifetime. Hence, a narrower interval leads to a longer switching time because the switching occurs at a larger percentage of the switching current step. Switching from #i to #0 gives the expected logarithmic dependence because the tuning current interval for target wavelength is constant.

Figure 3 (filled circles) shows the switching time with pre-distortion. The ac-coupled current pulse had an maximum amplitude of 60 mA and a duration of about 2 ns. The pre-distortion decreases the switching time by a factor as large as 2.

In conclusion, we measured switching time in a widely tunable GCSR laser and showed that it depends on the carrier lifetime and the static-tuning characteristic. By using pre-distortion technique, a decrease of switching time by a factor 2 could be measured.

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1. D.J. Blumenthal *et al.* in *Optical Fiber Communication Conference,* Vol. 2, 1996 OSA Technical Digest Series (Optical Society of America, Washington, D.C., 1996), p. 108.
2. H. Yasaka *et al.* IEEE J. Lightwave Technol. **14**, (June 1996).
3. P.-J. Rigole *et al.*, IEEE Photon. Technol. Lett. **7**, (November 1997).