Simultaneous generation of eight channels with 20 nm spectral spacing from one single semiconductor laser

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Abstract: With proper control of the loss for each channel, simultaneous generation of eight wavelengths spanning from 1367.1 nm to 1526.9 nm with about 20 nm channel spacing is achieved from a single semiconductor laser.

OCIS codes: (140.3600) Lasers, tunable; (230.6080) Sources

1. Introduction

Multi-wavelength laser systems have many potential applications such as wavelength-division multiplexing communication, two-wavelength interferometry, laser spectroscopy, differential lidar, optical data processing, and so on. Many approaches have been used to achieve simultaneous dual-wavelength oscillation [1-3] and four-wavelength oscillation. [4]. Multi-wavelength oscillation from a single device has the advantage of lower cost and simpler packaging. However, the number of simultaneous oscillation modes is usually limited by the bandwidth of the laser gain medium. In this work, we demonstrate simultaneous eight-wavelength oscillation with large spectral spacing using a single semiconductor laser. It has the potential application in coarse wavelength-division multiplexing (CWDM) and optical system parallel testing.

2. Experiment

To achieve simultaneous eight-wavelength oscillation, both the gain medium and the cavity configuration need to

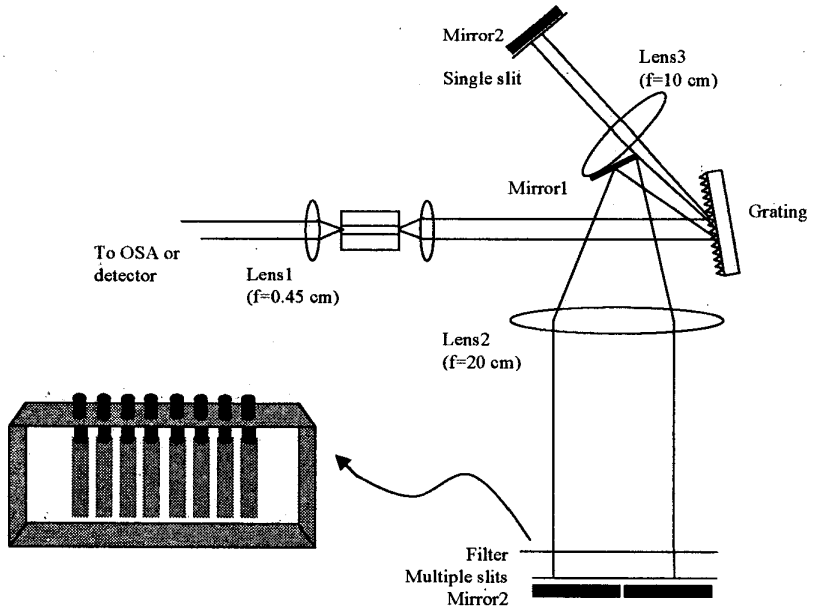


Fig. 1. Experimental setup

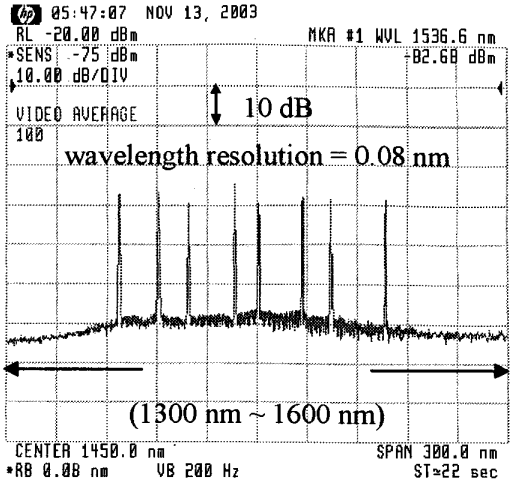
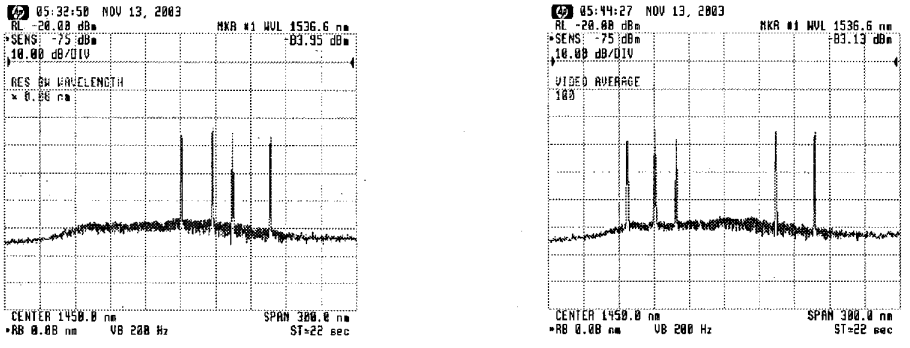


Fig. 2. Spectrum of eight-wavelength oscillation

be engineered. To reduce the operation current, we use a Fabry-Perot laser diode (LD) as the gain medium. The operation current is kept below the threshold (140 mA) of the Fabry-Perot LD. In addition, the cavity configuration is specially designed for eight-wavelength oscillation. A particular path is constructed for the loss-sensitive mode at 1526.9 nm. Other modes are directed to a handmade filter in front of the multiple slits. The filter consists of multiple 2.5 mm wide glass bars that can be separately rotated for loss adjustment. The cavity configuration is shown in Fig. 1.

3. Results and discussions

The spectrum of the simultaneously generated eight wavelengths with channel spacing around 20 nm is shown in Fig. 2. The side mode suppression ratio is typically larger than 28 dB. The ratio of the peak power of the lasing mode to the background is about 30 dB. This measurement is limited by the coupling efficiency of the output light to the optical fiber connected to the OSA. The absolute power of each mode is about 0.27 mW, and the FWHM of each mode is smaller than 0.3 nm. From Fig. 2, the variation of the spectral peak of those modes is about 3 dB. This variation can be reduced by better adjustment of the loss for each mode.



(a) (b)

Fig. 3. Spectrum for selecting certain wavelengths: (a) selecting the longest four wavelengths, (b) selecting the shortest three and the longest two wavelengths.

Fig. 3 shows the spectrum for selecting certain modes. Due to mode competition, the vanishing of some modes will increase the power of other modes, as shown in Fig. 3. However, the power increase is not significant. This implies that the competition is not strong, so those channels can be randomly selected by properly adjusting the loss of each mode. This also indicates that the gain medium can possibly amplify several channels simultaneously without much mutual influence in CWDM.

More channels with a narrower spacing can also be generated with reduced slit spacing and proper loss control. The detail will be discussed in the presentation.

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