23 Wavelength with 100 GHz spacing comb generator source

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Received 8 November 2002; accepted 28 January 2003

Abstract. Simultaneous oscillation of 23 wavelengths, spaced at 100 GHz, is demonstrated from a single source using a semiconductor optical amplifier linear cavity. The wavelength comb is generated from an intra cavity, fiber implemented Lyot filter. Each oscillating wavelength has a linewidth of 12.5 GHz and the maximum power variation between the 23 wavelengths was less than 3 dB.

Key words: comb filter, linear cavity, multi-wavelength source, polarization maintaining fibre, semiconductor optical amplifier

1. Introduction

In the recent past there has been an intense effort in the development and deployment of very high capacity DWDM systems. As the number of wavelengths continues to increase beyond a few hundred, the cost of the laser transmitters and electronic drivers will start to make a significant part in the cost of the system. With this in mind, a number of alternative techniques of obtaining multi-wavelength operation from single laser sources have been investigated. One of the successful techniques is that of spectrum slicing and this has been applied to LED’s (Reeve et al. 1988), superluminescent diodes (Wagner et al. 1990), amplified spontaneous emission from EDFAs (Lee et al. 1993), supercontinuum generation in fiber (Morioka et al. 1995) and femtosecond pulses (Lewis et al. 1998; Boivin et al. 1999; Collings et al. 1999). A different approach has also been investigated, in which multi-wavelength oscillation was obtained in a semiconductor optical amplifier (SOA) laser with the use of an intra-cavity grating (Shi et al. 1998) and Fabry–Perot etalon filter (Papakyriakopoulos et al. 1999; Vlachos et al. 2000).
Recently, 24 line operation was demonstrated with a liquid nitrogen cooled EDFA laser oscillator that used a Lyot-type comb fiber filter (Park et al. 1996). In the present communication we report the demonstration of a stable laser source capable of generating 23 wavelengths, with 100 GHz line spacing, 12.5 GHz line width, 17 dB extinction between lines and less than 3 dB power variation between them. The source operates at room temperature and uses a SOA for gain and a fiber Lyot filter for wavelength comb generation. It was also possible to extend the number of lines to more than 30 at the expense power equalization between them.

2. The Comb generating filter and multi-wavelength source

Fig. 1 shows the polarization maintaining (PM) fiber Lyot filter. It consists of a length $L$ of PM fiber, placed between polarizers aligned at 45° with respect to the birefringent axes of the PM fiber. Due to the different propagation constants of the two axes of the birefringent fiber, a squared cosinusoidal filtering function is imposed on light travelling through the structure. The free spectral range is determined by the length and the birefringence of the PM fiber. The single-pass transmission function through the filter is given by

$$T = \frac{1}{4} |\exp(-j\beta_x L) + \exp(-j\beta_y L)|^2 = \cos^2 \left[ \frac{(\beta_x - \beta_y) \cdot L}{2} \right],$$

where $\beta_x$ and $\beta_y$ the propagation constants through the axes of the PM fiber. The free spectral range of the filter is given by

$$\delta\lambda_{FSR} = \frac{B \cdot \lambda}{L},$$

where $B$ is the beat length of the PM fiber.

With commercially available PM fiber of 3 mm beat length, 5.77 m of fiber are required to construct a comb filter with 100 GHz line spacing. Distinguishing features of the filter that result from its cosine-squared transmission function, are the low single pass finesse (2) but very high extinction at the

![Fig. 1. The PM fiber, comb-generating filter.](image-url)