Mode-Locked Laser Arrays for WDM Applications

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Abstract

Colliding pulse mode-locked laser arrays are being developed at 20 GHz for WDM applications. Arrays with 5 wavelengths in the EDFA gain bandwidth have already been demonstrated, with the final goal being a packaged, 10 wavelength mode-locked laser array.

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Summary

High bandwidth mode-locked laser arrays are being developed for a bit-parallel wavelength (BPW) link for high performance computer networks[1]. The system design requires a 10 element WDM transmitter with an aggregate bandwidth in the 100-800 Gb/s range. Here we present results on a 5 wavelength array which falls in to the EDFA gain bandwidth as a first step towards achieving this goal.

The devices employ a colliding pulse mode-locked (CPM) design consisting of a 5 section, 3 contact symmetric cavity: a saturable absorber at the center of the cavity, 2 gain sections and 2 grating sections. The devices can operate as passively mode-locked lasers; however, in order to reduce the noise in the mode-locked laser and to synchronize the signals from all the lasers in the array, the contact to the saturable absorber section is designed for a G-S-G probe for the application of a synchronizing RF signal. 'l'he grating operates in two capacities: to determine the center wavelength and trim the excess spectral bandwidth. The devices are 3.5 micron ridge waveguide lasers, and the top InGaAs contact is etched to isolate the different sections (1-2 kΩ between contacts). The repetition rate in a CPM laser is twice the fundamental mode spacing of the cleaved cavity; for 20 GHz operation, the cavity length is -4.3 mm.

When the devices are operated as Fabry-Perot mode-locked lasers (no gratings), typical threshold currents arc I_{th} = 150 mA (best =120 mA), and external differential efficiency of - 10O/O. Significant reduction of the phase noise can be achieved in these devices with as little as -20 dBm RF power, with the best mode-locking results occurring for 10 dBm. Reverse bias to the saturable absorber is typically -1.0 to -2.0V. Mode-locking occurs up to an output power of approximately 1-2 mW /facet.

The initial WDM array devices incorporating gratings were designed for 3.3 nm spacing between channels, with all the wavelengths occurring in the EDFA gain bandwidth. Development of the grating-based devices required optimization of the grating strength (length and etch depth). An additional constraint is added by presence of gain material in the grating section in these initial devices. The best results were obtained by shorting the grating section, and by using a high κ grating with very short length (75 μm at each end). The repetition rate of the arrayed devices is 18.2 GHz. The spectrum of the five channel array is shown in Fig. 1. An interferometric scan of a single mode-locked spectrum shows a FWHM of 85 GHz (Fig. 2) and a complete suppression of the cavity fundamental frequency of 9.1 GHz is observed. The RF frequency response shows this as well (Fig. 3), with a 10 dB enhancement of the mode-locked peak over the resonance frequency peak. The measurement of the temporal width has been instrument-limited to -20 ps; autocorrelation measurements of the pulses will be performed.

[n conclusion, we have demonstrated a 5 wavelength array of CPM lasers. Additional work towards the reduction of the threshold current and removal of the gain from the grating section is being pursued through the development of BH structures and active/passive transitions within the device cavity. Packaging of the devices, including the synchronous RF feeding of the lasers, is also being addressed. Results will be also presented for this additional work.

[1] L. Bergman, L.Lome, A. Mendez, "nit Parallel Wavelength Links for t High Performance Computer Neworks," *SPIE Critical Review*, CR62, Jan. 96, 210.

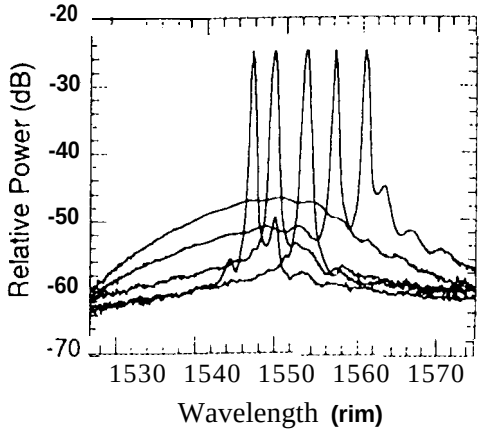

Fig. 1 Optical spectrum of the 5 element mode-locked laser array.

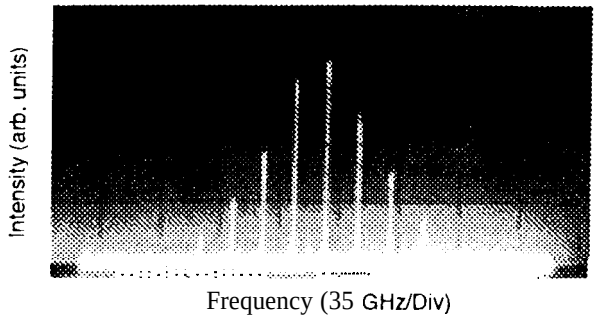

Fig. 2 Interferometric scan of the mode-locked spectrum (center wavelength -1546 rim). The mode spacing is 18.2 Ghz.

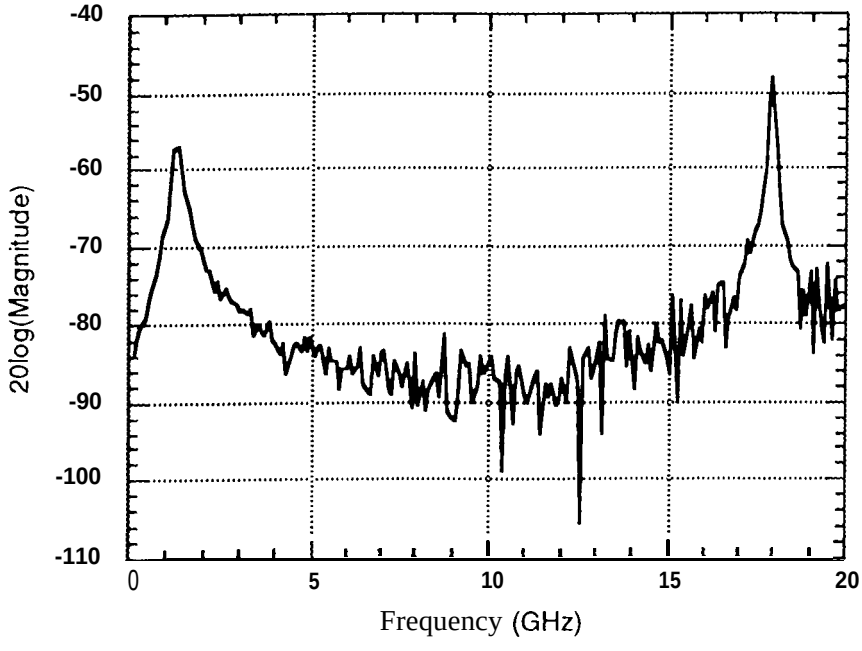

Fig. 3 The RF frequency response of a typical mode-loclwd laser.