Nano-iTLA based on Multi-Channel Interference Widely Tunable Laser

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Abstract: A nano-iTLA based on multi-channel interference widely tunable lasers was demonstrated for the first time. The module exhibits a tuning range > 48 nm, SMSR > 45 dB and Lorentzian linewidth < 100 kHz. ©2021 The Author(s)

1. Introduction

With the development of datacenters, in order to further increase the transmission capacity, there has been requirement to introduce digital coherent communication to the datacenter interconnects. Since the digital coherent technology uses the phase information of the light, the light source is required to have low phase noise, that is, narrow spectral linewidth. And because it is a short-distance parallel high-speed optical interconnection, the light source module is also required to have a small size and low power consumption [1, 2].

Therefore, we have developed a compact integrable tunable laser assembly (ITLA) using a multi-channel interference widely tunable laser (MCI-WTL) chip, a wavelength locker and a peripheral drive and control circuit. We report the miniaturization of the control circuit and the achievement of a compact and low power consumption nano-iTLA. The final module size is 2.5 cm×1.56 cm. Figure. 1 show the final result of the hardware part.

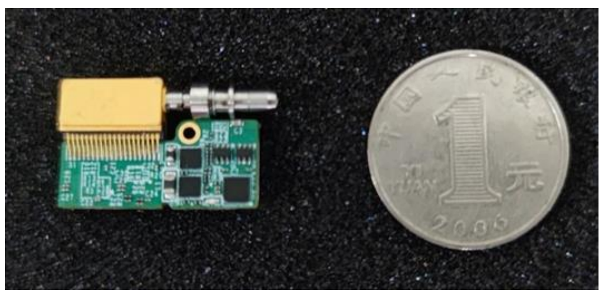

Fig. 1. Nano-iTLA hardware part.

MCI-WTL is a narrow linewidth semiconductor laser with a tuning range covering the entire C-band. The recently reported multi-channel interference (MCI) widely tunable laser has shown strong potential applications for coherent optical communications [3-5].

Figure 2 shows a microscope image of the fabricated MCI-WTL which is a monolithic integrated semiconductor tunable laser based on InP. MCI-WTL mainly includes an active section for optical gain, an SOA section for providing optical amplification and a multi-channel interference section which consists of a 1x8 multimode interferometer (MMI) for beam splitting, a common phase section for tuning the longitudinal mode, eight arms, and the multimode interferometer reflectors (MIRs) for reflection.

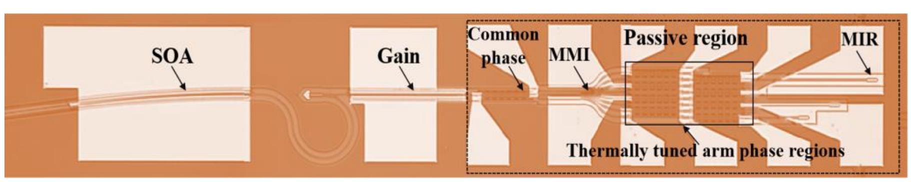

Fig. 2. Microscope image of the fabricated MCI-WTL.

Single-mode lasing of the MCI laser is realized by the mutual interference of eight arms of different lengths. The lasing wavelength is jointly determined by the eight arm phase sections and the common phase section. This structural feature of the MCI laser determines its control method that is to control injection currents into seven arm phase sections and the common phase section to achieve coarse and fine tuning.

2. System Principle

The single board of the hardware part of the system integrates 10-channel controllable current output module, temperature control module, wavelength locking module, communication interface with host computer and connection port with TOSA packaged laser.

The hardware part includes a microcontroller STM32L431, 2 pieces of LTC2662 outputting 2 channels of 0~300 mA controllable current to work in the active area and SOA area to achieve laser generation and optical power amplification, and outputting 8 channels of 0~12.5 mA controllable current to work in the common-phase area and 7 arm-phase area to achieve wavelength tuning, 2 pieces of ADN8834 combined with digital proportional-integration-differentiation (P-I-D) algorithm to control the temperature of the laser chip and wavelength locker. System block diagram is shown in Fig. 3.

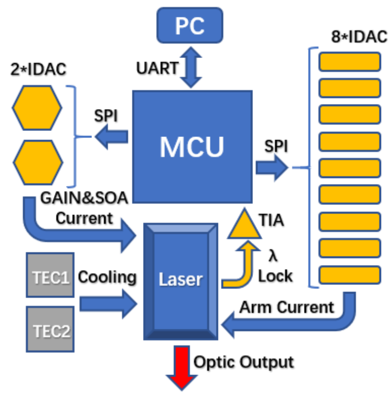

Fig. 3. System block diagram of the nano-iTLA based on MCI-WTL.

3. Test Result

The circuit part is connected to a PC through a UART to USB cable, and the DC power supply provides +3.3 V power supply. The output light is first split through a 10:90 coupler, 90% of the light enters into the optical power meter, and 10% of the light passes through 50:50 couplers which are connected to the optical spectrum analyzer and wavelength meter, respectively. All measuring instruments are connected to the PC through the GPIB bus. The block diagram of the test system is shown in Fig. 4.

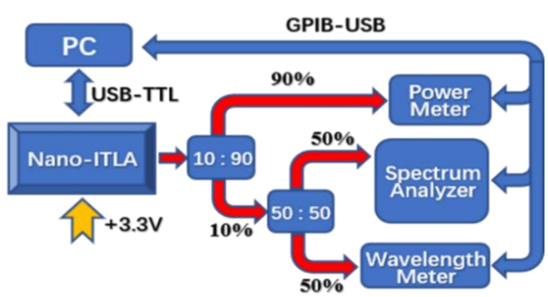

Fig. 4. Test system of the nano-iTLA.

100 mA current was injected into the active area and 300 mA into the SOA area. When the external temperature changes from -5 °C to 75 °C, the power consumption of the entire module is shown in Table. 1. When the external temperature is normal, the power consumption of the module is less than 2 W; when the external temperature is high, such as 75 °C, the power consumption of the module is less than 4 W.

Table. 1 Module power consumption versus external temperature

External temperature / °C	-5	5	15	25	35	45	50	55	60	65	70	75
Module power consumption / W	1.81	1.71	1.78	1.78	1.75	1.98	2.18	2.41	3.00	3.23	3.46	3.76

By calibrating the MCI-WTL laser, a tuning range greater than 48 nm (1524-1572 nm covering the C++ band) is obtained. Over the entire tuning range, the side-mode suppression ratio (SMSR) is greater than 45 dB; the standard wavelength deviation is less than 10 pm from the ITU grid; the output power is higher than 42 mW (16.2 dBm) while the maximum output power reaches 51 mW (17.1 dBm); the Lorentzian linewidth is less than 100 kHz. The results are shown in Fig. 5 which demonstrates good performance of the MCI-WTL and its potential in the field of coherent optical communications.

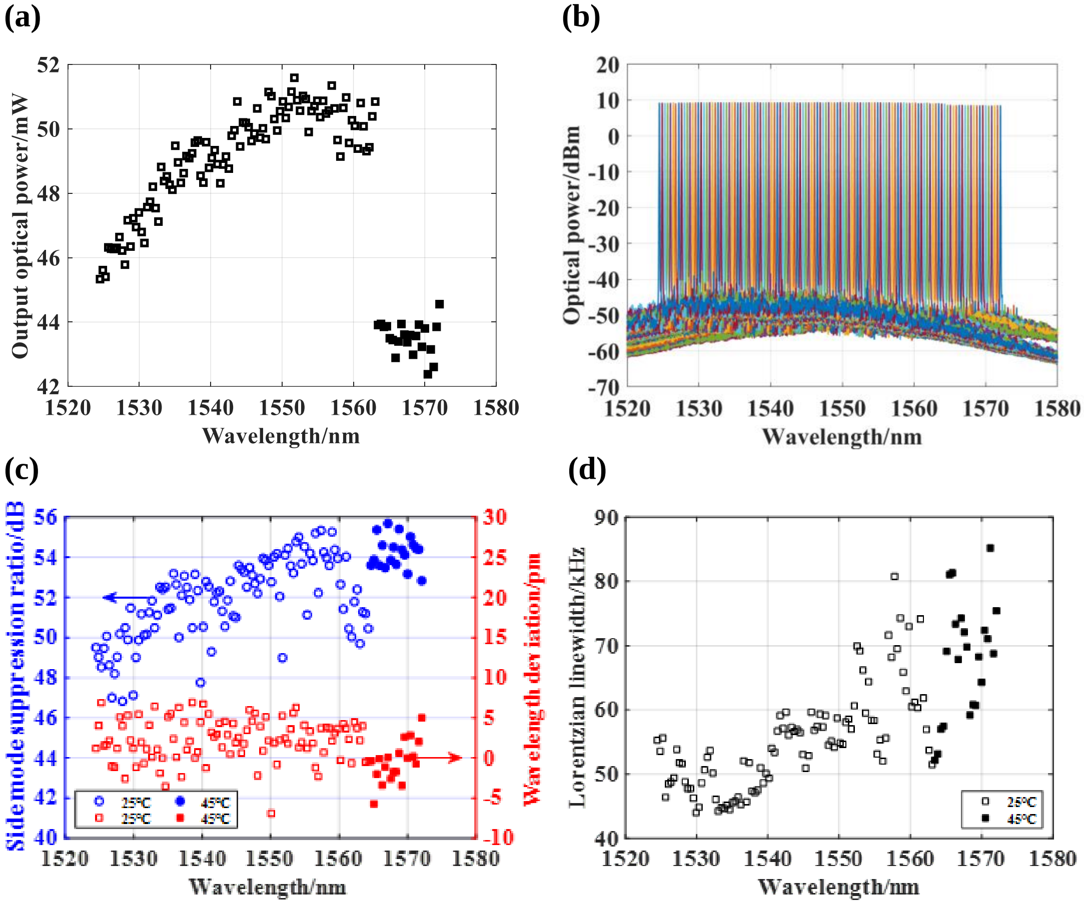

Fig. 5. Output power (a), output spectrum (b), wavelength deviation from the ITU grid and SMSR (c), and Lorentzian linewidth (d) of the demonstrated nano-iTLA.

4. Conclusion

A nano-iTLA module based on MCI-WTL has been demonstrated, which integrates all the control requirements of the laser, TEC cooler and wavelength locker into one PCB board, and realizes the miniaturization and low power consumption of the module. It conforms to industry standards in terms of size, power consumption, and control protocol, and promotes the commercialization of MCI-WTL.

5. Funding

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6. References

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