All-Semiconductor Master Oscillator Power Amplifier at 1.5 µm for High Power Applications

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High power (> 0.5 W) single-mode frequency laser at 1.55 µm are nowadays key components for a large number of applications such as lidar systems, telemetry or free-space communications. For this level of power, the most suitable and available sources are solid-state lasers and fiber lasers. Semiconductor devices, which are more compact and more efficient, have still to demonstrate very high power operation to be a credible competitor. In order to obtain these levels of power with semiconductor devices, the more suitable device seems to be the Master Oscillator Power Amplifier (MOPA). Single-mode emission is generated by a Distributed Feedback laser (DFB) and the signal is then amplified with a Power Amplifier (PA). To avoid complex optical coupling and to simplify the packaging, it is possible to integrate on the same chip the laser and the amplifier. The main challenges are the fabrication of the multi-section device (at least 2 sections: one for the laser and one for the amplifier) and the reduction of the reflections. Indeed the facet and the internal reflections can create multiple cavities behavior and disturb the laser single-mode emission [1].

In this contribution, we report the realization of a 3-section monolithic MOPA on InP (Fig. 1(a) and (b)). The 1st section is the oscillator (DFB laser), the 2nd section is a modulation section and the 3rd section is a flared amplifier. As Hou et al. [2], we have included a bent in the MOPA in order to reduce the facet reflections at the end of the amplifier. We observe that this architecture is more stable than the straight one, where all the sections are aligned [3]. We show stable emission around 1583 nm with a side mode suppression ratio better than 45 dB. The optical power is 420 mW for I_{DFB} = 400, I_{MOD} = 300 and I_{PA} = 3000 mA bias currents respectively for the laser, the modulator and the flared amplifier. Fig. 1 (c) shows the optical power as a function of I_{PA} for I_{DFB} = 400, I_{MOD} = 300 mA. The measure was performed at 18ºC, by decreasing the temperature to 12 and 6°C, we have obtained a maximum output power of 510 and 600 mW respectively. Fig. 1 (d) shows the optical spectra dependence on I_{DFB} for I_{MOD} = 300 mA and I_{PA} = 3 A. The laser exhibits multimode operation close to the threshold (DFB laser without phase-shift) and single-mode operation without any mode hopping from 300 to 500 mA. For other lower I_{PA} values, single-mode operation is observed from the threshold to 500 mA. The wavelength increases parabolically with the current due to heating effects. The full width at half maximum far field is 2.4 x 23.5°. Initial experiments show that an extinction ratio of 35 dB can be achieved by varying the supply of the modulation section.

We also describe new designs with various epitaxial stacks and various section lengths. These devices will be evaluated for range finding and for CO_2 spectroscopy [4].

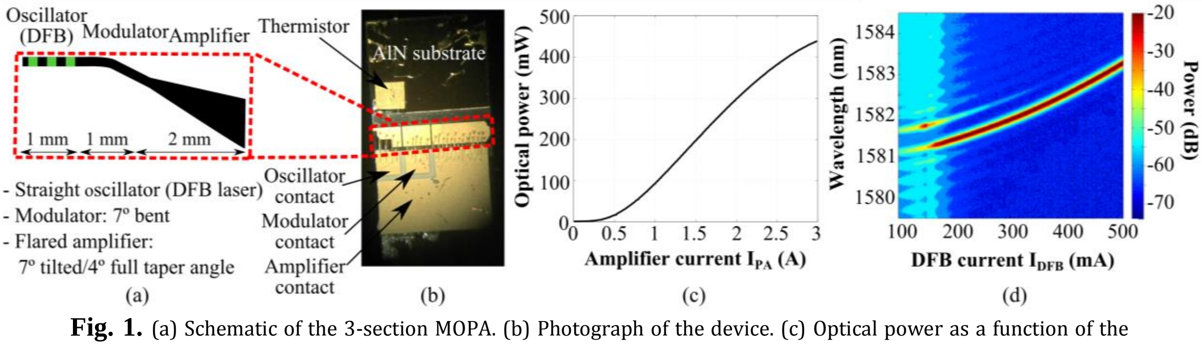

Fig. 1. (a) Schematic of the 3-section MOPA. (b) Photograph of the device. (c) Optical power as a function of the amplifier current I_{PA} for I_{DFB} = 400 and I_{MOD} = 300 mA. (d) Optical spectra varying the DFB current I_{DFB} for I_{MOD} = 300 mA and I_{PA} = 3 A.

References

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