Performance and lifetime of high-power narrow-linewidth 1180 nm GaInNAs DBR-LDs

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We report the highest power narrow spectrum 1180 nm distributed Bragg reflector (DBR) laser diodes prepared using GaInNAs quantum wells as a gain material. In particular, we demonstrate a CW output power up to 560 mW from Ridge Waveguide (RWG)-DBR laser diodes and up to 2.75W for Tapered DBR-LDs. The demonstration targets applications in second harmonic generation (SHG) for generating high brightness yellow radiation. RWG-DBR LDs are optimal light sources for waveguide SHG-crystals allowing high efficiency coupling to single mode WG embedded in the SHG-crystal. On the other hand, tapered DBR-LDs provide a power level that suitable for bulk SHG-crystals that can withstand more IR-light and alleviate the need for waveguide alignment. To reach the 1180 nm range we have developed high-quality GaInNAs quantum wells embedded in GaAs waveguide, a material system that has been in the past recognized for poor reliability in laser operation. In our case, preliminary lifetime test for GaInNAs RWG-DBR LDs showed no signs of degradation in a room-temperature operation for over 2000hours under high current driving at 1500 mA drive-current. The DBR section was defined using nanoimprint-lithography as described in [1]

Moreover, the carrier confinement of GaInNAs QWs lead to improved temperature stability of the laser characteristics, a feature that has been recognized since the proposal of GaInNAs/GaAs QWs for uncooled telecom lasers at 1.3 μm [2]. The improved temperature stability is expected to benefit especially the miniaturization of frequency-doubled lasers and in general the development of photonic integration approaches, which thermal management issues currently limit. For example, the ability of lasers to operate at elevated temperatures will reduce the constraints of mounting them close to frequency doubling crystals, which often require elevated operation temperatures [3]. In this respect, the CW maximum output power of the RWG GaInNAs DBR varied between 660 mW to 210 mW when the ambient temperature was varied between 5 and 80 °C. Moreover, the tapered RWG-LDs exhibited an output power up to 2750 mW at 10A current with narrow spectrum locked to the grating. In summary, the high output power, the large temperature range for CW operation, the spectral features, and the lifetime result reported here are expected to be instrumental for demonstration of compact and practical frequency doubled lasers with yellow emissions for applications in spectroscopy and medicine.

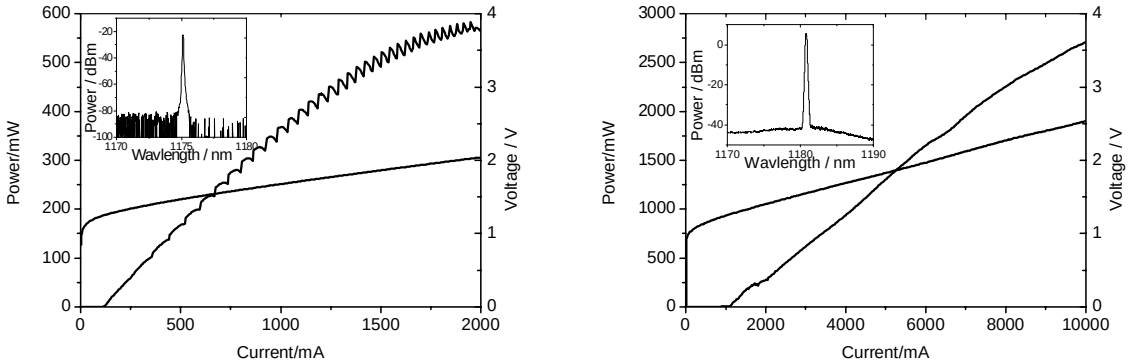

Fig. 1 Left panel: ILV for non-tapered DBR-LD in CW at room temperature. Inset shows measured spectrum at 1.5A. Right panel: LIV for tapered DBR-LD at room temperature. Current is swept in tapered section. Insert shows spectrum at 6A tapered section operation current. In both measurements with tapered DBR-LD ridge waveguide section current is fixed to 250mA.

References

[1] V. Korpijärvi, J. Viheriälä, M. Kosinen, A. Aho and M. D. Guina, "High-power temperature-stable GaInNAs distributed Bragg reflector laser emitting at 1180 nm," Optics letters 41 (4), 657-660 (2016).
[2] M. Kondow, T. Kitatani, S. Nakatsuka, M. C. Larson, K. Nakahara, Y. Yazawa, M. Okai, and K. Uomi, "GaInNAs: a novel material for long-wavelength semiconductor lasers," Selected Topics in Quantum Electronics, IEEE Journal of 3, 719-730 (1997).
[3] A. Jechow, R. Menzel, K. Paschke, and G. Erbert, "Blue-green light generation using high brilliance edge emitting diode lasers," Laser & Photonics Reviews 4, 633-655 (2010).