High-power 1550 nm tapered DBR laser diodes for LIDAR applications

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High Peak Power Laser Diodes for Eye Safe LIDAR with Integrated Wavelength Locking Element

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We report on the development of high peak-power broad-area laser diodes emitting in the 1.5 µm wavelength band for eye-safe LIDAR applications. The laser contain a monolithically integrated surface grating section for wavelength stabilization. The performance merits of the wavelength stabilized laser is benchmark against traditional Fabry-Pérot diodes fabricated within the same processing batch and having identical quantum-well design. The study demonstrates the efficacy of the surface-grating applied to broad-area lasers and the benefits rendered possible for decreasing the spectral linewidth and reducing the temperature drift of the wavelength. This type of high-power light source can improve the signal-to-noise ratio of eye-safe time-of-flight LIDARs in bright illumination conditions by making possible the use of narrow band-pass filters for reducing the ambient sunlight. Moreover, the same advantage to reject ambient signal is expected in other applications such as gated imaging [1], or when using a pulsed laser as the illuminator in high speed imaging applications. In addition, the variation in the emission wavelengths from wafer-to-wafer and from chip-to-chip is reduced compared to non-stabilized lasers.

The reported lasers are based on InGaAsP quantum wells surrounded by InGaAsP waveguide and InP cladding-layers. The laser diodes comprised two sections as illustrated in Fig. 1a. A 180 µm wide and 4 mm long gain section is used to provide the lasing action. This is followed by a 2 mm long grating section containing a third order distributed Bragg reflector (DBR) etched down to the p-cladding layer that provides the wavelength locking. The reference chips without the wavelength stabilization contain only the gain section. The front (out-coupling) facet of both types of chips is antireflection coated with 1.5% reflectance. In the wavelength-stabilized lasers, the back facet is antireflection coated while for the reference devices the back facet is high reflection coated with a nominal reflectance above 99%. Further details regarding the fabrication can be found in [2]. The comparison between the two types of lasers is done in pulsed operation using 160 ns pulse length and 10 kHz repetition rate. Fig. 1b illustrates the wavelength-stabilizing properties of the DBR grating in two ways. First, the emission lines of the DBR laser are one order of magnitude narrower, having a FWHM spectral width of ~0.3 nm. Secondly, the wavelength of the DBR laser drifts five times less than non-stabilized Fabry-Pérot FP lasers when the temperature changes. Remarkably, the grating induces only a small additional loss to the laser cavity, and the performance of the lasers is only marginally reduced, as demonstrated by Fig. 1c.

In conclusion, the results show that the monolithically integrated surface grating enables spectral stabilization of 1.5 µm broad-area laser diodes without adverse effects in the performance. Compared to the dominant method to stabilize multimode lasers with volume Bragg gratings (VBG), the fabrication of our gratings is more cost effective and enables parallel fabrication on a wafer level. Moreover, monolithic gratings do not impose additional costly assembly steps. We expect that the proposed technology will contribute to the development of eye-safe LIDAR systems by improving their performance especially under bright daylight illumination conditions.

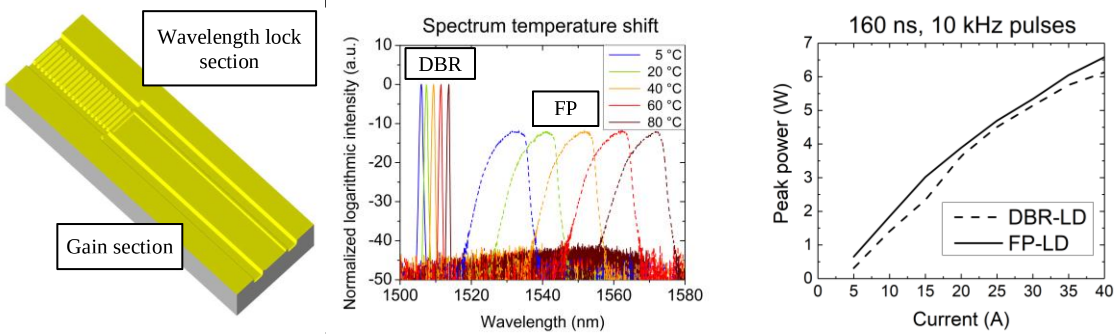

Fig. 1 Left panel (a): schematic illustration of the DBR laser. Center panel (b): spectral characteristics of a wavelength stabilized DBR laser and non-stabilized (FP) laser overlaid on same graph. Right panel (c): comparison of LI-characteristics.

References

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