High–power 980–nm DFB diode lasers with a small vertical farfield divergence

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Abstract: We report on FP and DFB lasers with a vertical farfield angle of only 18° due to a super large optical cavity. Details of the structure and the characteristics up to 1Watt optical power will be presented.

High-power diode lasers emitting in the spectral region around 980 nm are of particular interest for the pumping of erbium and ytterbium doped fibres and waveguides as well as for non-linear frequency conversion. These applications require a high spatial-mode purity in the lateral farfield or/and a high spectral purity of the lasing emission. Additionally, in order to reduce the facet load and to facilitate low-cost coupling to fibres and waveguides the vertical farfield divergence should be lowered as much as possible.

We developed a vertical layer structure consisting of an AlGaAs-based super large optical cavity (SLOC) in order to reduce the farfield angle below 20° with almost no increase of threshold current or decrease of efficiency. Fig. 1 shows the light-current-characteristics of a 3-mm long Fabry-Perot (FP) laser having a 2-µm ridge-waveguide and a single-quantum-well active region. The threshold current is 34 mA and the slope efficiency slightly above threshold is about 0.8 W/A. The characteristic is kink-free up to 890 mW output power and the maximum power is 925 mW, limited by thermal rollover. The vertical farfield profile depicted in the inset of Fig. 1 exhibits a full width at half maximum of 18°.

Fig. 2 shows the light-current characteristics of a 1.5 mm long distributed feedback (DFB) laser having the same vertical and lateral structures like the FP laser from Fig. 1, except of additional thin Al-free grating layers. Because of the reduced cavity quality factor, the slope efficiency is increased to about 1 W/A slightly above threshold. The dips in the power-current characteristics are caused by absorption lines of water vapour present in the lab's air [1]. The optical spectrum depicted in the inset of Fig. 2 reveals single-longitudinal mode operation with a side-mode suppression ratio of 60 dB at an output power of 500 mW. The spectral linewidth is limited by the optical spectrum analyser used (10 pm).

The DFB lasers developed can be used for the integration of pump sources having densely-spaced stabilized emission wavelengths and erbium or ytterbium doped waveguides on a single chip as well as a replacement for certain argon ion lasers (λ = 488 nm) by frequency doubling utilizing periodically poled $LiNbO_3$ or KTP crystals.

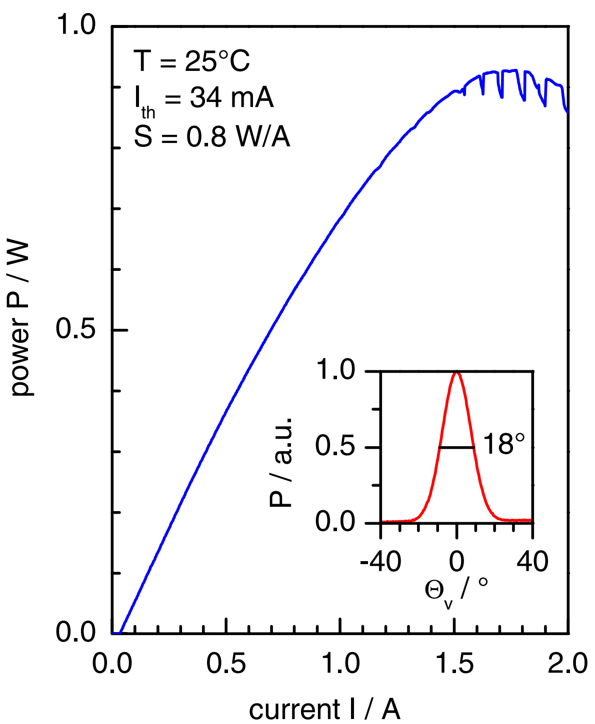

Fig. 1: CW light-current characteristics of a FP RW laser (L = 3 mm, R = 1% / 95%) mounted p-up on C-mount. Inset: vertical farfield profile

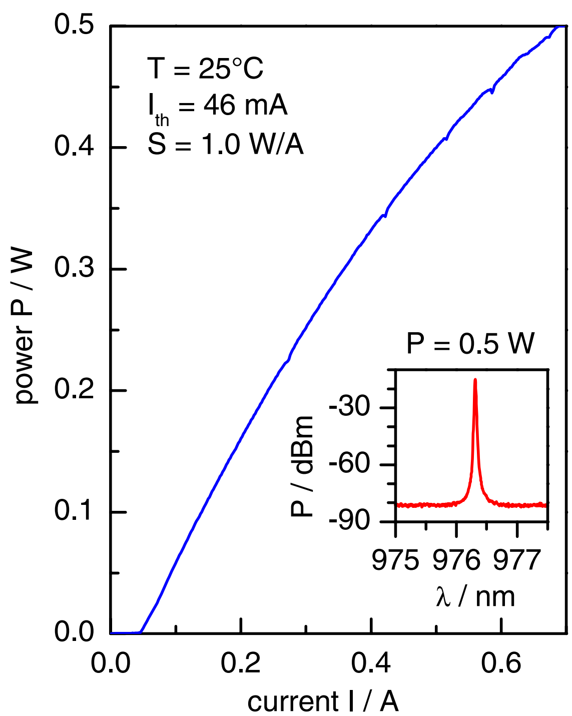

Fig. 2: CW light-current characteristics of a DFB RW laser (L = 1.5 mm, R = 0.01% / 95%) mounted p-down on C-mount. Inset: optical spectrum measured at a power of 0.5 W.

[1] H. Wenzel et al., "Design and realization of high-power DFB lasers," Proc. SPIE, vol. 5594, to be published.