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High-brightness single laser diodes based on the widespread taper design have demonstrated output powers of a few Watts with a single transverse mode operation [1]. The use of arrays of such lasers result in a further increase of the laser power, but with the drawback of a loss in the spatial brightness. To overcome this limitation numerous external-cavity configurations have been proposed which induce a coherence between the individual emitters of the array and result in a brightness improvement [2]. In this work we describe two external cavities intended to improve the spatial brightness of a bar of N = 6 index-guided tapered laser diodes emitting around 975 nm. The lateral structure of the emitters consists of a short ridge single-mode section, a 2.3 mm-long narrow-angle tapered ridge and a common amplified free-space 0.2 mm-long section. The array pitch is p = 30 µm, and the near-field $1/e^2$ full-width ($1/e^2$-FW) of each emitter is 30 µm too, so the filling factor of this array is 100% on the front facet and the emission section is w = 180 µm wide. No adjacent coupling between emitters is evidenced in the free running laser emission of the array alone, and its $1/e^2$-FW divergence is ~80 mrad in the slow axis. Our external cavity designs aim at controlling the slow-axis beam divergence of the whole array by inducing an angular-filtered feedback into the lasers [3,4]. The configuration forces the array to operate in the out-of-phase mode, which has two main lobes in its far-field profile at $\pm \lambda/2p = \pm 16$ mrad. We take benefit of the angular selectivity of volume Bragg gratings to favour an asymmetrical feedback on one of these peaks. The far-field of the extended-cavity array is thus expected to exhibit one diffraction-limited peak in the symmetric direction (Figure 1). Two different setups have been investigated experimentally:

In the design T (figure 1), a transmission Bragg grating with a diffraction efficiency of 90% and a full-width at half-maximum (FWHM) angular selectivity of 9 mrad is inserted in the external cavity. A high reflection dielectric mirror reflects the diffracted beam back into the emitters. We observed a narrow 6 mrad-FWHM peak in the slow-axis far-field profile, which contains 30% of the output power. The peak width is close to the diffraction limit $\lambda/w = 5$ mrad, and its M^2 parameter is < 2. The maximum output power reaches 1.3 W at 3A.

In the design R (figure 1) a reflection Bragg grating with a reflectivity $R \geq 99\%$ at $\lambda_B = 979$ nm and a spectral bandwidth $\delta\lambda \cong 0.3$ nm reflects the output beam at the angle of $+\lambda/2p$. The angular selectivity of the grating is about $\Delta\theta_R = 35$ mrad. A narrow peak appears in the far-field at $-\lambda/2p$ which contains up to 50% of the total output power (figure 2), with a M^2 parameter < 2. Furthermore the laser spectrum is locked to the Bragg wavelength λ_B resulting in a <0.1 nm-wide stabilized line. The total output power reaches 700 mW at 3 A.

These two configurations both result in quasi-diffraction limited far-field profiles and similar output powers in the main lobe; nevertheless the setup R allows concurrent spectrum stabilization.

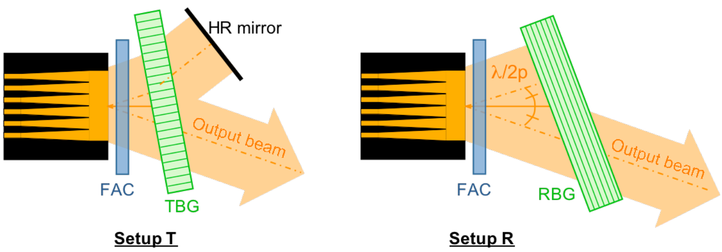

Fig. 1 Experimental external cavity setups; FAC = fast-axis collimation lens, TBG = transmission Bragg grating, RBG = reflection Bragg grating.

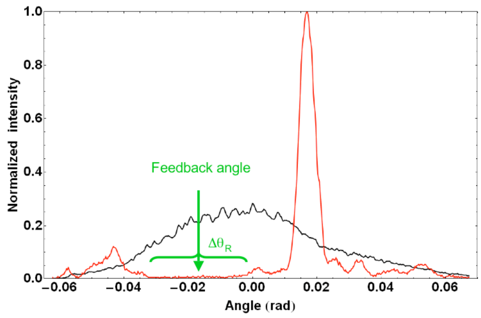

Fig. 2 Far-field profile of the free-running array (black) and of the external-cavity array in the R setup (red) at I = 2.4 A.

Acknowledgments

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