5.3 W CW high brightness 980-nm tapered diode lasers

K. Paschke, B. Sumpf, F. Dittmar, G. Erbert, J. Fricke, A. Ginolas, Ch. Dzionk, A. Knauer, H. Wenzel, and G. Tränkle

Ferdinand-Braun-Institut für Höchstfrequenztechnik Berlin, Gustav-Kirchhoff-Str. 4, 12489 Berlin, Germany

Abstract: 980-nm tapered diode lasers having electrically separated straight RW and tapered sections were mounted epi-side down on conductively cooled packages. With an optimal RW current, a nearly diffraction-limited output power of 5.3 W was obtained.

Diode lasers with high output power and high beam quality are required for a variety of commercial and scientific applications. One of the most promising devices is the tapered diode laser which consists of a straight ridge waveguide (RW) section and a tapered gain-guided section. In the tapered devices under study the current through the RW and the tapered sections can be adjusted separately which allows an independent control of output power and beam quality and moreover a simplified modulation of the output power. Experimental data recently obtained in pulsed operation from devices mounted epi-side up allow a better understanding of the impact of the current injected into the RW section on output power and beam quality [1]. Here, we present experimental results of devices with separate contacts mounted epi-side down and operated in continuous-wave (CW) mode.

The tapered lasers have a super large optical cavity (SLOC) structure which consists of a very broad, 3.6 µm thick $Al_{0.45}Ga_{0.55}As$ waveguide embedded in $Al_{0.70}Ga_{0.30}As$ cladding layers. The SLOC not only reduces the facet load but also results in an excellent small vertical far field angle of 18.4° (full width half maximum). About 96% of the output power is included within a vertical far field angle of only 33.6°.

The laser diodes were mounted epi-side side down on a purpose-designed Si-submount for separate contacting. Finally, for an optimal heat removal under CW operation, the devices were mounted on special conductively cooled packages with dimensions of 25x25x7.6 mm^3.

Fig. 1 shows the light-current characteristics measured in CW operation with common and separate contacting. In the latter case, the current I_{RW} through the RW section was fixed to certain values (0, 100, 300, 500 and 800 mA) and the current I_{taper} through the tapered section was increased from 0 A to 10 A. For an optimal RW current of 500 mA the light-current characteristics is almost linear and a maximum output power of 5.5 W is achieved, limited by thermal roll over. The beam quality parameter M^2 determined from the $1/e^2$ widths of the intensity profiles at the beam waist and the far field remains below 1.5 up to 5.3 W output power (Fig.2) for I_{RW} =480 mA revealing a nearly diffraction limited emission. The advantage of a separate current control is obvious.

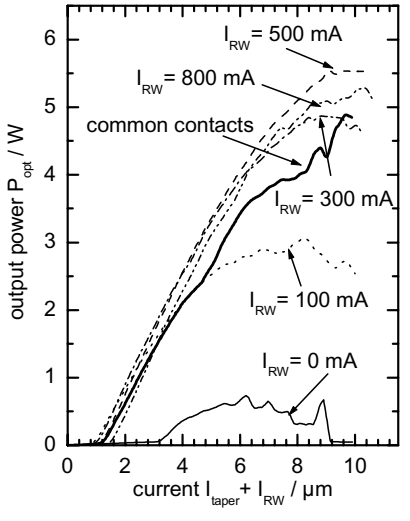

Fig. 1: CW light-current characteristics of the tapered diode laser emitting at 980 nm with common (solid line) and separated contacts with the following parameters: L = 4 mm, L_{RW} = 1350 µm, taper angle ϕ = 6°, R_f = 1%. Heat sink temperature T = 25°C.

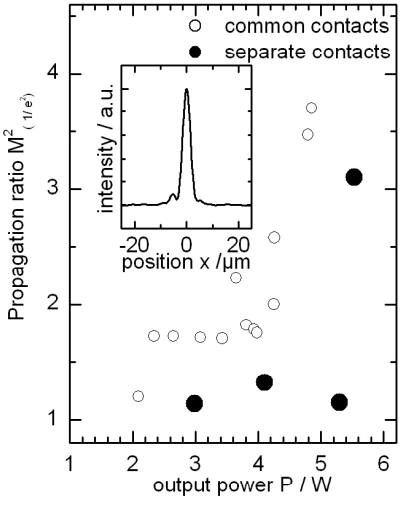

Fig. 2: Dependence of the beam propagation ratio M^2 on the output power for common and separate contacting for the same device as in Fig. 1. Inset: Intensity profile in the beam waist at output power of 5.3 W. The current through the RW section was I_{RW} = 480 mA.

[1] K. Paschke et al., "Nearly-diffraction limited 980 nm tapered diode lasers with an output power of 6.7 W", Conf. Dig. 19th ISLC, Matsue/Japan, IEEE 2004, pp. 43-44, September 2004.