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50. Internationales Wissenschaftliches Kolloquium
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R. Güther

Planar filtering in semiconductor laser diodes with high beam quality and power

ABSTRACT

Planar laser diodes with high power and high beam quality base on different filtering principles which will be treated. A figure of merit for enhancement of laser properties by filtering is proposed.

INTRODUCTION

The vertical design of planar semiconductor lasers is directed to the monomodal property along the vertical direction. The structure in the plane containing the active zone can be designed by the thickness of the waveguide, current distribution, implantation or other means in such a way that the mode emitted at the emission facet is a fundamental mode. The 2-dimensional filtering schemes used for this goal in a 2...4 mm x 200 µm area, for example, are mostly stimulated by the optical filtering technique, the volume holography [1] and by the optical resonator theory.

FILTERING SCHEME: PLANE - „FREE SPACE“ - PLANE

The filtering scheme using a modal pinhole in a Fourier plane is applied in the taper laser [2]. Here, a narrow ridge wave guide (RW) with a width of 2-3 µm is coupled to a pumped trapezoidal shaped range which widens until 200 µm for example. The RW part acts as an modal screen for the radiation feedback. These lasers achieve cw-power values 3 until 5 W, in maximum 7 W [3] with quasi diffraction limited emission. The maximum resonator lengths are 4 mm, now. The optical focussing of the emitted radiation requires an higher effort because of the considerable astigmatism. A new filtering method in semiconductor lasers is made up of two mutual tuned phase filtering structures near to the facets [4,5] in such a way that the propagation of the fundamental mode between both facets is preferred by loss in comparison with the propagation of higher modes.

FILTERING SCHEME: SPATIAL DISTRIBUTED FILTERING

The angular and wavelength selectivity of reflection at a two-dimensional Bragg grating is used in the α-DFB laser [6]. Repeated reflections at a Bragg grating are combined with facet reflections in such a way that the lateral single mode property is combined with a spectral narrowing until 5 pm with a power of 3 W. Another new proposal with help of the Bragg grating filtering is the transfer of the principle of the self pumped phase conjugation to planar semiconductor lasers as well in hybrid as in monolithic version [7]. Then, the optical nonlinearity is used, which occurs as an refractive index change by change of the carrier density by stimulated emission (photorefractive effect).

FIGURE OF MERIT OF OPTICAL FILTERING IN SEMICONDUCTOR LASERS

Approaching the emitted partial coherent radiation of a semiconductor laser by a Gauss-Schell model [8] one concludes for a beam quality $M^2 > 1$ that the radiation can be screened of until $M^2 \approx 1$. This means: The beam quality can be increased at the expense of power. An estimation on a figure of merit of filtering can start with a laser 1 without filtering (for example a broad area laser) and a second laser 2 generated from the first laser by additional filtering. Since filtering includes additional losses it can happen that the laser 1 screened until $M^2 \approx 1$ shows the same power like the laser 2 with filtering. Then, there is no enhancement. Therefore, a filtering-enhancement factor $E = \frac{Max\{P_2 / M_2^2\}}{Max\{P_1 / M_1^2\}}$ is proposed with M_1^2 and M_2^2 the beam qualities of lasers 1 and 2 respectively and P_1 and P_2 the corresponding powers. For example, the Bragg grating filtering inside of an α-DFB laser results in E = 4. The factor E can be related to the temperatures T_1 and T_2 of the radiation both of the lasers, respectively [9].

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References:

[1] R. Güther, Lecture „Wave optics and holography“, Ilmenau 1981-1990, part of the lectures H. Haferkorn „Optics“

[2] M.T. Kelemen, J. Weber, S. Kallenbach,C. Pfahler, M. Mikulla, G. Weimann, „Astigmatism and beam quality of high-brightness tapered diode lasers“, Proc. SPIE, vol. 5452, p. 233-243, 2004

[3] K. Paschke, B. Sumpf, F. Dittmar, G. Erbert, J. Fricke, A. Knauer, S. Schwertfeger, H. Wenzel, G. Tränkle, “Nearly-diffraction limited 980 nm tapered diode lasers with an output of 6.7 W”, Dig. 19th ISLC, Matsue/Japan, IEEE 2004, pp. 43-44, September 2004

[4] U. Zeitner, R. Güther, „Laser resonators comprising mode-selective phase structures”, Pat. WO 01/97349 A1

[5] A. Büttner, U.D. Zeitner, „Intracavity beamshaping in waveguide lasers“, Proc. SPIE, vol. 5182, p.168 (2004)

[6] K. Paschke, A. Bogatov, F. Bugge, A.E. Drakin, J. Fricke, R. Güther, A.A. Stratonnikov, H. Wenzel, G. Erbert, G. Tränkle, „Properties of Ion-Implanted High-Power Angled-Grating Distributed-Feedback Lasers“ in IEEE J. Sel. Topics Quantum Electronics **9**(5): 1172-78 (2003)

[7] P.M. Petersen, “High power diode laser system”, Pat. WO 03/075419 A2

[8] R Güther, „Gausian beams in der applied optics, part 2“, Jahrbuch für Optik und Feinmechanik,vol. 46, Ed.. W.-D. Prenzel, Schiele & Schön, Berlin, 1999, p.40

[9] M. Planck, „Theorie der Wärmestrahlung“, Barth, Leipzig, 1923

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