SAND99-2050C

RECEIVED

AUG 18 1999

High Peak Power Gain Switched Flared Waveguide Lasers

OSTI

Alan Mar, G. Allen Vawter, S.W. Koch*, W.W. Chow
Sandia National Laboratories
Photonics Research Department, MS 1153
Albuquerque, NM 87185
(505) 844-6613 email: amar@sandia.gov

R. Indik and J. Moloney
Arizona Center for Mathematical Sciences
University of Arizona, Tucson, AZ 85721

Abstract

We gain-switch flared waveguide lasers to obtain 14.5 W peak powers and 0.5 nJ pulse energies with laser structures compatible with the generation of diffraction-limited beams. The results are in excellent agreement with a microscopic laser model.

*Permanent Address: Physics Department, Philipps University, Marburg, Germany

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

High Peak Power Gain Switched Flared Waveguide Lasers

Alan Mar, G. Allen Vawter, S.W. Koch*, W.W. Chow

Sandia National Laboratories

Photonics Research Department, MS 0603

Albuquerque, NM 87185

(505) 844-6613 email: amar@sandia.gov

R. Indik and J. Moloney

Arizona Center for Mathematical Sciences

University of Arizona, Tuscon, AZ

Record (14.5 W) peak powers and pulse energies of 490 pJ from a gain-switched flared waveguide quantum-well laser are presented in this paper. Because of their compactness, reliability, efficiency, and relatively low cost, semiconductor lasers are attractive sources of picosecond optical pulses of high peak power. The flared waveguide expands the optical mode from a narrow region which gives a single lateral optical mode, to a wider multimode region for higher power. Flared laser amplifiers have previously been used for mode-locking [1,2], Q- and gain-switching [3,4] of diode lasers. Flared structures have also been utilized for post-amplification [5,6] to achieve high peak power. Gain switching offers a considerable advantage in terms of simplicity over mode-locking, in that no resonant cavity is required to be synchronous with the electrical drive, while the external amplifier approach requires additional alignments. High single-mode peak powers have also been obtained from bulk single-heterostructure lasers with ion implanted saturable absorbers [7]. In this work, we gain-switch a flared waveguide laser with a reverse-biased saturable absorber section to obtain high peak powers and pulse energies from a single laser diode without post-amplification. Numerical simulations based on a microscopic laser model verify the effectiveness of the saturable absorber in the generation of high peak power, single-pulse output. Insight obtained from the model suggests that the quantum-confined Stark effect (QCSE) is primarily responsible for saturable absorber operation.

The flared waveguide gain-switched lasers utilize a dry-etched AlGaAs double heterostructure rib waveguide with a single quantum well active region, and a lasing wavelength of 850 nm. As shown in Figure 1, a short single-mode section of the laser waveguide is biased separately to function as a saturable absorber or modulator. Oxygen ion implantation was used to create an electrical isolation region between the single-mode and flared sections. The flared devices have linear tapers from 4 μm to 150 μm over a 1500 μm distance, and lengths of single-mode waveguide/absorber section varying from 30 to 100 microns were tested.

The measurements and calculations demonstrate the effectiveness of the reverse-biased

saturable absorber in generating short (~ 33 ps), single pulses with increased peak power. To gain switch the lasers, the output (100 V, 1 ns) of a high voltage pulser was applied to the flared gain section of the laser while -9V DC bias was applied to the saturable absorber contact of the laser. The optical output was measured using a fast photodetector and 50 GHz sampling oscilloscope. As shown in Figure 2, this resulted in pulses of 14.5 W peak power, and a pulse energy of 490 pJ. Excellent qualitative and quantitative agreement between the measurements and calculations is observed. At this power level, no damage to the lasing facets was observed, and higher peak powers and pulse energies are expected with the use of higher power electrical pulses.

This work was supported by the United States Department of Energy under Contract DE-AC0494AL85000. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed-Martin Company, for the United States Department of Energy.

References

1. L. Goldberg et al., *Photon. Tech. Letts.*, V6 no.9, pp. 1070, (1994)
2. A. Mar et al., *Appl Phys. Letts.*, V66 no.26, pp. 3558, (1995)
3. K. A. Williams et al., *Photon. Tech. Letts.*, V9 no.2, pp. 167, (1997)
4. S. Yang et al., *Photon. Tech. Letts.*, V8 no.3, pp. 337, (1996)
5. A. Mar et al., *Photon. Tech. Letts.*, V6 no.9, pp. 1067, (1994)
6. M. Poelker et al., *Appl Phys. Letts.*, V67 no.19, pp. 2672, (1995)
7. E. Portnoi et al., *IEEE Journ. Of Sel. Topics In Quant. Electron.*, V. 3(#2) pp. 256 (1997)

Figure 1. Diagram of flared waveguide gain switched laser

Figure 2. Measurement and simulation of gain switched pulses with and w/o saturable absorber reverse bias