980–nm DBR lasers using higher order gratings fabricated in a single-step process

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Abstract: Single-longitudinal mode emission from two-section RW DBR diode lasers having 6th and 7th order gratings will be reported. Grating and RW have been simultaneously defined and fabricated using wafer stepper lithography and reactive ion etching, respectively.

Wavelength stabilized semiconductor lasers find wide-spread applications in optical communication, spectroscopy, non-linear frequency conversion and pumping of electronic transitions in atoms. For wavelength stabilization, usually 1st to 3rd order Bragg gratings are integrated into the semiconductor chip, leading to grating periods from 100 to 500 nm for a wavelength range from 800 to 1000 nm. The fabrication of these Bragg gratings, however, requires complicated additional technological steps like, for example, a second epitaxial growth.

We present two-section distributed Bragg reflector (DBR) lasers for which the ridge wave guide (RW) and the Bragg grating were simultaneously defined in the same lithography and etching steps, avoiding a two-step epitaxy as well as the slow and expensive electron-beam lithography. Additionally, the usage of a wafer-stepper provides a high fabrication flexibility. We obtained sufficiently large reflection coefficients for 100 to 500 µm long DBRs by choosing an appropriate shape for the 6th and 7th order Bragg gratings (periods of 914.5 and 1067nm) which have been etched down to the p-waveguide layer. The vertical laser structure is based on an standard structure [1], already used for high-power Fabry-Perot RW lasers. An i-line wafer stepper was used for lithography and the etching was performed with a BCl_3/Ar plasma. In Fig 1. the Bragg grating and a part of the ridge waveguide is shown.

Only the gain sections of the DBR lasers were contacted and biased, the reflector sections acted purely passive. The investigated 1.5 mm long uncoated devices have light-current characteristics with an output power of about 60 mW at a current of 200 mA (Fig. 2), exhibiting the kinks typically for DBR lasers. The reflectivity of the reflector sections is sufficiently large to ensure single-longitudinal mode operation of uncoated lasers with a side-mode suppression ratio greater than 30 dB (Fig 3), limited by the optical spectrum analyser used.

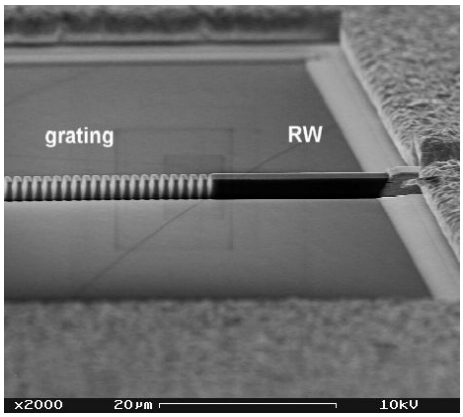

Fig. 1: SEM picture showing a part of the reflector section and the ridge wave guide that merges into the gain section.

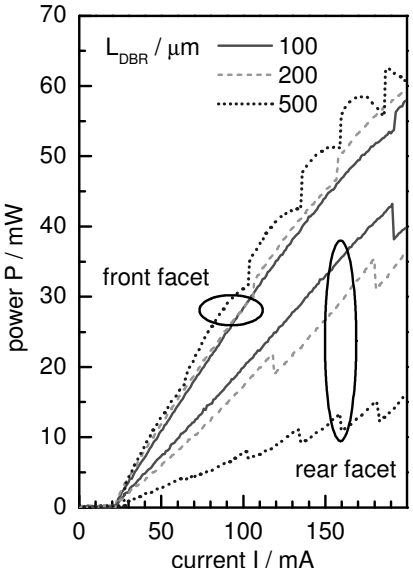

Fig. 2: Light-current characteristics of three uncoated DBR lasers having 6th order Bragg gratings. Parameter is the length of the reflector section.

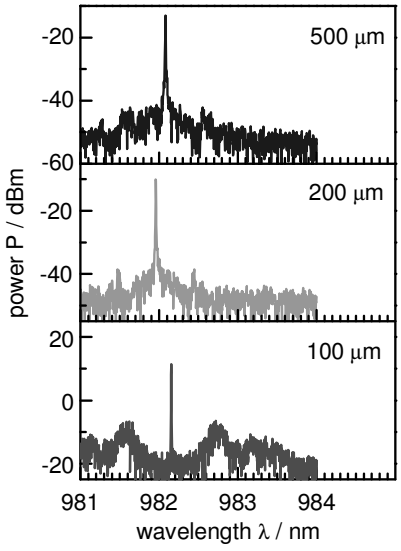

Fig. 3: Optical spectra of three uncoated DBR lasers having 6th order Bragg gratings. Parameter is the length of the reflector section.

[1] G. Beister, F. Bugge, G. Erbert, J. Maege, P. Ressel, J. Sebastian, A. Thies, and H. Wenzel: "Monomode emission at 350 mW and high reliability with InGaAs/AlGaAs (l = 1020 nm) ridge waveguide laser diodes", *Electronics Lett.*, vol. 34, pp. 778-779, 1998