Fabrication of Digital Planar Holograms for brighter power laser diodes

C. Peroz, S. Babin
aBeam Technologies, 5286 Dunnigan Ct., Castro Valley, CA-94546, USA
cp@abeamtech.com

A. Goltsov, I. Ivonin, V. Yankov
Nano-Optic Devices, 280 S. Chestnut St., Washington Township, NJ-07676 USA

S. Dhuey, B. Harteneck, S. Cabrini
The Molecular Foundry, LBNL, Berkeley, CA-94702, USA

Semiconductor diode lasers have achieved high output power allowing them to transition from special scientific items to true industrial tools. There is a huge interest worldwide in major industrial applications: general lighting, materials processing, and pump sources for industrial solid-state lasers. Regardless of the application, in order to improve the performance of laser diodes, both in terms of cost and efficiency, increased power and brightness are keys.

We propose a novel solution by coupling digital planar hologram with semiconductor lasers to increase the brightness and power of laser diodes (LD). Digital Planar Holography (DPH) is a disruptive technique, which provides compact planar waveguide solutions with unprecedented control of wavelength, polarization, amplitude, and phase [1]. For the first time we report how the novel combination DPH/LD suppresses lateral modes, narrows and stabilizes the spectrum of 100 µm wide laser diodes.

DPH chips have been fabricated by Electron Beam Lithography and Reactive Ion Etching (Figure 1). Holograms were made using a silicon wafer with deposited thick SiO_2 cladding and $SiO2Ge^x$ core waveguide. 100 kV Gaussian beam electron beam lithography system was used for patterning. Specific dose correction is used to reduce proximity effect. Inductively coupled plasma etching was used for pattern transfer into Ge-doped silicon dioxide film [2]. DPH chips are coupled with quantum dot LDs from Innolume Inc. emitting around 980 or 1060 nm with aperture of 100 µm and output power around 3 W (Figure 2). Far field pictures demonstrated that the combination of the wide laser diode and the hologram operates in a single lateral mode regime (Fig. 3) with two weaker side lobes. These results open a new route to develop bright high power direct laser diode systems without pumping from a solid state or fiber laser to increase brightness.

[1] S. Babin et al., Appl. Phys. Let., 95, 041105 (2009)

[2] C. Peroz et al., J. Vac. Sci. Technol B 27 3187 (2009)

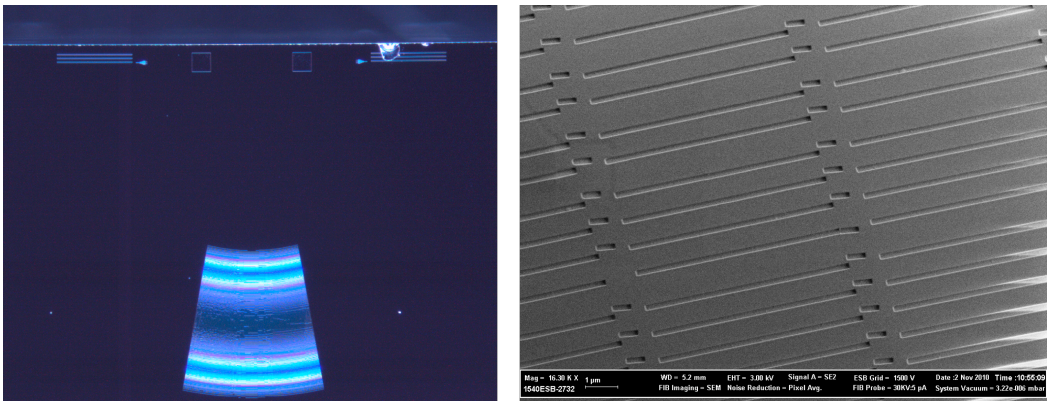

Figure 1.: Pictures of planar holograms for Hlaser application: a) optical picture of the full DPH chip b) Scanning Electron Microscope picture of the hologram.

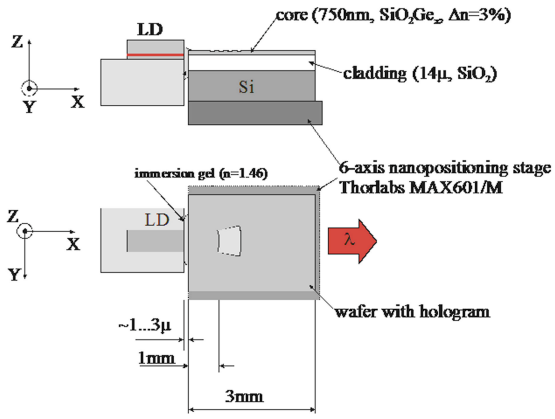

Figure 2.: Schematics of experiments on modal control of broad area LD using Digital Planar Holograms.

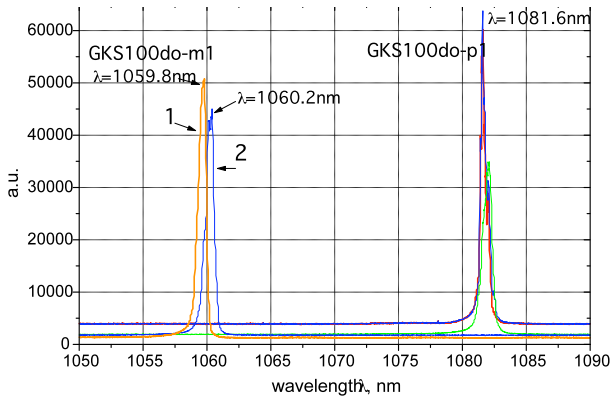

Figure 3.: Emission spectrum at the output of LD butt coupled with different DPHs scaled by 2% with respect to each other.