LASERS PUMPED BY INJECTION INGAN LASERS

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Development of the growth technology of nitride compounds allows now to create efficient lasers emitting in the violet and blue regions of the spectrum. There are currently on the market "violet" InGaN laser diodes emitting in the spectral range of 400-415 nm in a continuous wave mode with power value of 0.5 W (Opnext HL400023MG) and even 1.2 W (Nichia NDV7375E). The output power of commercially available "blue" InGaN laser diodes emitting in the spectral range of 435-455 nm reaches 2 W. Laser diodes NDB7875 of Nichia firm in 9 mm housing have an operational emission power of 1.6 W and LDs PL TB450 of the OSRAM company have 1.4 W. Although output power of these lasers is inferior to infrared laser diodes, it is sufficient for pumping many promising laser media having absorption in the violet-blue regions of the spectrum.

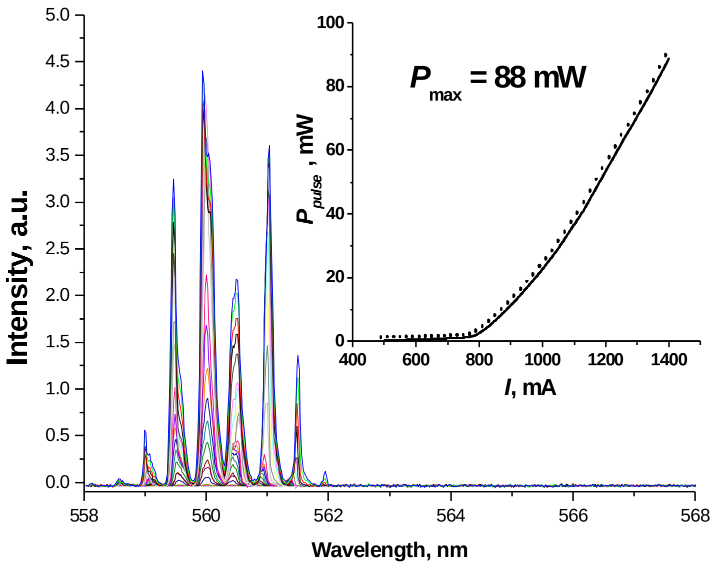
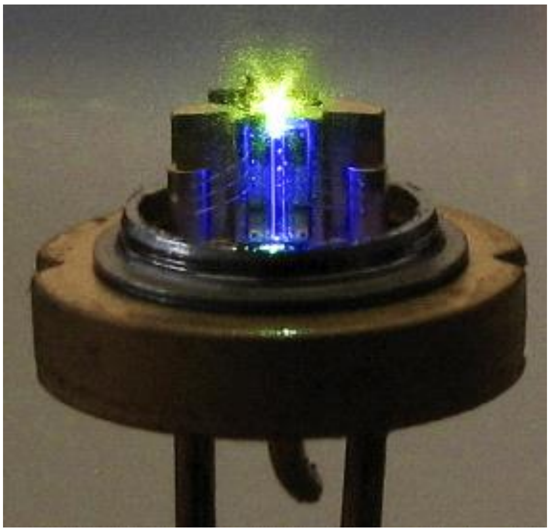


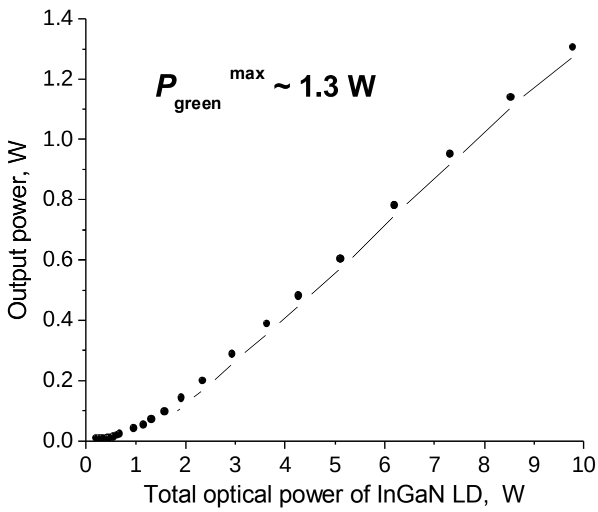
Fig. 1. Spectra and pulsed emission power of microchip laser (inset) as functions of injection current

On the base of InGaN pumping laser diodes, emitting in the blue region of the spectrum and optically pumped heterostructure lasers with an active region consisting of ZnCdSe quantum dot insertions in ZnSe quantum wells, enclosed into a graded index superlattice waveguide, we have created miniature lasers emitting in the green [1] and blue-green (fig. 1) [2] spectral range. It should be noted that InGaN laser diodes are limited currently to wavelengths < 540 nm.

Prospects of studies in this direction and possibility of using such lasers for multimedia picoprojectors is confirmed by the report [3].

Use of only one cylindrical microlens for focusing the pumping emission of excitation laser diode in the direction perpendicular to the heterostructure allowed to miniaturize these lasers as much as possible and create a microchip laser with a size of standard housing TO-18 (5.6 mm) of the laser diode (fig. 2a). Application of current pulses shorter than 10 ns for excitation of InGaN pumping laser diodes allowed to reduce overheating of the active region of the laser diode and to enhance respectively their output pulse power up to 10 W without visible signs of degradation. This in turn allowed to reach the pumping power density significantly above the laser threshold for the heterostructures and to pump effectively the active region. Pulse power exceeding 1 W in the green region of the spectrum was achieved using such microchip lasers (fig. 2b) which allows to use them in spectroscopy and in a number of biological and genetic applications.


a)



b)

Fig. 2. Photo of microchip laser (a); pulsed emission power in the green spectral region of the microchip laser as a function of excitation power of InGaN laser with pulse duration of 4 ns (b)

The laser threshold of the heterostructures with an active region consisting of a single ZnCdSe quantum dot insertion is currently less than 1 kW/cm^2 that in principle allows pulsed optical pumping of ZnCdSe heterostructures even by LED emission. Naturally, pumping of the laser ZnCdSe heterostructures by InGaN LED emission will allow lowering dramatically the cost of microchip lasers emitting in the green spectral region to a few dollars. The results on pulsed injection of InGaN LEDs as well as conditions and opportunities necessary to create this type of lasers are discussed.

Pumping of the active laser media by InGaN laser radiation is relevant from the standpoint of reducing cost and size of the lasers and increasing stability and efficiency of their operation. Foreign authors have carried out a number of pioneering works on pumping of Al_2O_3:Ti and Pr:KYF_4 by InGaN laser diodes. Application of InGaN laser diodes is also promising for pumping of organic laser media, media with samarium ions and other materials.

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