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Quasi-cw 808-nm 300-W laser diode arrays

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Abstract. **Samples of 808-nm quasi-cw laser diode arrays (LDAs) with an output power exceeding 300 W, a pulse duration of 200 μs, and a pulse repetition rate of 100 Hz are developed and fabricated. The main output parameters of a set of five LDAs, including light–current characteristics, current–voltage characteristics, and emission spectra are measured. Preliminary life tests show that the LDA power remains stable for 10^8 pulses.**

Keywords: *laser diode arrays, quasi-cw regime, emission power, service life, C–S mount, efficiency.*

1. Introduction

The power and brightness of 808-nm quasi-cw laser diode arrays (LDAs) used mainly for pumping of high-power pulsed solid-state lasers to a large extent determine their total efficiency, because of which the problem of increasing these parameters is rather important.

To achieve a high output power (exceeding 150 W) at a pulse repetition rate of 100 Hz and higher, it is necessary to elaborate the active element design, the housing construction, and the LDA mounting technology because such high pump powers and pulse repetition rates cause an increase in peak and average dissipated powers. To decrease heat release at high pump powers and achieve the mentioned nominal parameters in a reliable operation regime (300 W, 100 Hz), we had to use the maximum total efficiency of LDA chips up to record-high values (about 75%) and to ensure high uniformity and efficiency of removal of extremely high-density heat flows by using advanced technologies of laser crystal mounting. In particular, works [1–4] were devoted to the solution of these problems.

By summing and focusing radiation of individual LDA clusters with the use of special microoptics (for example, from LIMO) or optical integrators of radiation of several LDAs, it is possible to approach a power density and a total power sufficient for direct application of laser diodes for materials processing. At present, monolithic cw and quasi-cw LDAs are key elements in solving this problem. An example of its practical solution can be found in Rofin-Sinar laser welding systems (Germany).

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2. Parameters of fabricated LDAs

The standard parameters of the LDA chip were as follows: length 10 mm, laser cavity length 1.5 mm, and filling factor 75%. The light–current characteristic of LDA1, which was the most efficient sample of the fabricated arrays, is presented in Fig. 1. One can see that this characteristic is close to linear up to the maximum emission power of 302 W, while the external slope quantum efficiency is high (about 88%).

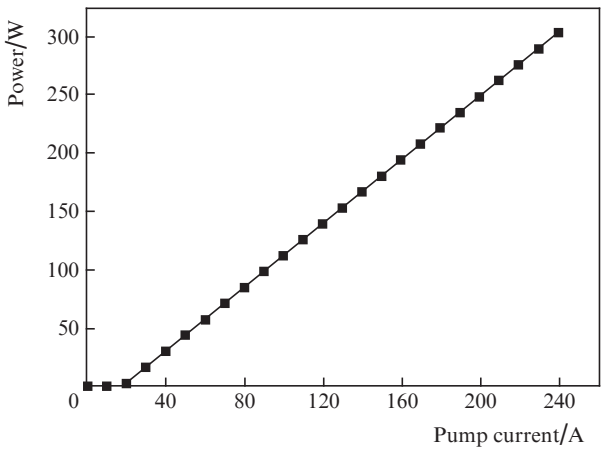

Figure 1. Light–current characteristic of LDA1 in the quasi-cw regime at a pulse duration of 200 μs and a pulse repetition rate of 100 Hz.

The LDA4 emission spectrum at a pump current of 130 A is shown in Fig. 2. The spectral FWHMs of all the arrays in these operation regimes did not exceed 3.1 nm, which testifies to a high homogeneity of characteristics of all emitting array clusters. The parameters of the developed quasi-cw LDAs are listed in Table 1.

The temperature of the LDA heat sink base and housing was kept at 25 °C using a water cooling system. As follows from Table 1, the parameters of the developed LDAs measured at a pump current of 130 A, which corresponds to a peak output power of 147 W and an average slope of 1.33 W A^{-1},

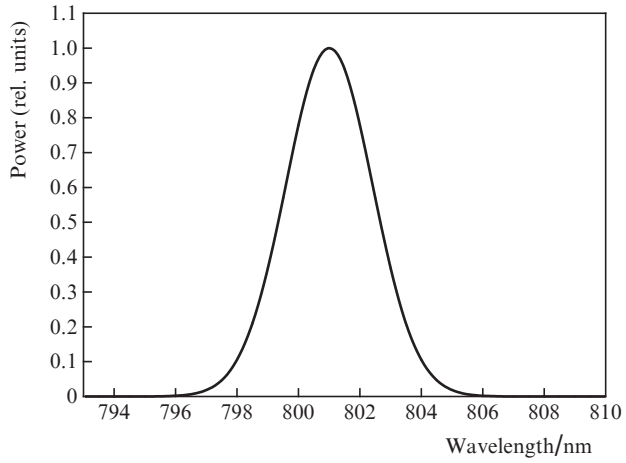

Figure 2. Emission spectrum of LDA4 in the quasi-cw regime at a pump current of 130 A, a pulse duration of 200 μs and a pulse repetition rate of 100 Hz.

Table 1. Parameters of quasi-cw 808-nm LDAs measured at the heat sink temperature of 25 °C.

Array	I_{th}/A	η/W A^{-1} at I = 50–200 A	P_{out}/W at I = 130 A	λ/nm at I = 130 A	$\Delta\lambda$/nm at I = 130 A	U/V at I = 130 A
LDA1	18	1.36	152	800.6	2.7	1.78
LDA2	21	1.30	142	800.2	3.1	1.77
LDA3	18	1.35	151	800.2	2.7	1.79
LDA4	19	1.34	149	800.7	2.9	1.77
LDA5	18	1.35	151	800.7	3.0	1.78

are rather similar. In particular, the dispersion in the slope of the light–current characteristic $\Delta\eta$ was 0.06 W A^{-1}, the radiation power at a pump current of 130 A was within the range of 142–152 W, the radiation wavelength varied by no more than 0.5 nm, the spectral FWHM was from 2.7 to 3.1 nm, and the voltage varied from 1.77 to 1.79 V.

The measured light–current characteristics were linear in the entire studied range of pump currents, from the threshold current to the maximum current provided by the driver (240 A), at which the output LDA power was 285–302 W.

3. Conclusions

The developed samples of Russian quasi-cw laser diode arrays for the spectral region of 808 nm with a service life of 10^8 pulses can be used for pumping solid-state lasers for navigation, medicine and other applications.

A photograph of an LDA mounted on the international standard C–S mount adapted to Russian materials, technology, and industrial conditions is shown in Fig. 3. The maximum measured output power of 302 W at an injection current of 240 A was limited by the pump driver. As a whole, the developed LDA is highly competitive with the best samples of leading manufacturers, such as Jenoptic, DILAS, etc.

The obtained output parameters of the LDAs, their sufficiently high similarity demonstrated on a series of five LDAs, and the service life of 10^8 pulses confirmed by life tests point to high quality and stability of developed LDAs, as well as to the highly sophisticated technology of their production.

Figure 3. Photograph of quasi-cw LDA5 on a C–S mount emitting at 808-nm with a power of 300 W.

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