High-Energy, Passively Q-Switched, Diode-Pumped Nd:YAG Laser with Reciprocal Multiloop, Self-pumped Phase-Conjugate Cavity

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Abstract—Passive Q-switching in a reciprocal multiloop, self-phase-conjugated Nd:YAG laser pumped by 2D diode stacks was studied. The use of a passive F2 :LiF Q-switch resulted in pulse train oscillation depending on the passive Q-switch position and the number of diffractive feedback loops in the cavity. The laser energy of up to 0.6 J in trains of 12 pulses with 12-ns duration was obtained.

Keywords—open-loop cavity, gain grating, passive Q-switch

I. INTRODUCTION

Recently [1-3] we studied lasing in the self-phase-conjugate diode-pumped Nd:YAG laser and tried some of passive Q-switches. In this work, we report the results of the comparative experimental study of a passive Q-switching for two schemes of the reciprocal multiloop, self-phase-conjugate Nd:YAG rod laser side-pumped by 14-kW peak power 2D diode stacks with the help of an optically dense F2 :LiF crystal.

II. SYSTEM ARCHITECTURE

Fig. 1 shows the laser cavity schemes completed by the multiloop gain grating self-phase-conjugate mirror in the Nd:YAG active element and also by the rear mirror. The cavities have three-loop (Fig. 1a) and four-loop (Fig. 1b) configurations. The passive Q-switch based on a 30-% transmitting F2 :LiF crystal is placed near the active element from the rear or from the front of one in the area of beams self-intersection. Q-switching feedback in the loop cavity is caused not only by saturable absorption in the passive Q-switch, but also by saturable gain gratings in the active element.

Fig. 1. The multiloop self-phase-conjugate laser cavity schemes.

III. EXPERIMENTAL RESULTS

In the first scheme (Fig. 1a), an energy efficiency of passive Q-switching of up to 65% (relative to free-running) was obtained if the passive Q-switch was placed in the optimum position— from the rear of the active element. At 14-kW (6.4 J) pumping, the laser generated trains of 13 pulses with the pulse duration of 17 ns and peak power of 2 MW. In the second scheme (Fig. 1b), the energy efficiency of passive Q-switching increased up to 75% at the same optimal position of the passive Q-switch. At 14-kW pumping, the number of pulses in the train was 12 with the shortening pulse duration of 12 ns, but the pulse train energy and the peak power increased up to 0.6 J and 4 MW respectively. The increase in the output laser characteristics is caused by increased diffraction efficiency of gain gratings because of additional loop of diffractive feedback in the second laser scheme. The beam quality was high ($M^2 = 1.4-1.5$) for both laser schemes due to self-pumped phase conjugation via gain gratings in the active element, and possibly via absorption gratings in the passive Q-switch.

REFERENCES

