SINGLE FREQUENCY MOPA SYSTEM WITH NEAR DIFFRACTION LIMITED BEAM QUALITY

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Compact and reliable laser systems providing both high-energy (in the tens of mJ range) and high-peak power (>10MW) pulses at kilohertz repetition rates with diffraction-limited beams find applications in new materials synthesis, remote imaging, chemical sensing and high efficient nonlinear conversion. Passively Q-switched microchip lasers are simple, miniature and robust sources that can provide single-frequency, high-repetition-rate, and sub-nanosecond pulses with diffraction-limited output in the near infrared [1]. However, the small gain volume limits the amount of energy that can be stored in the active medium, thus microchip lasers can reach only very modest output energy, typically up to hundreds of micro joules. In order to overcome this deficiency complicated amplification geometries have been developed and up to 5.7 W (0.2 mJ) and 0.4-MW at 500-ps were achieved [2]. Recently, a Nd:YVO_4 bounce geometry was used for amplification of a passively Q-switched laser with energy up to 0.545 mJ and 577-ps pulse duration [3]. However, in the vast variety of the existing kHz laser systems the output pulse energy is substantially smaller than 10 mJ while, on the other hand, the repetition rate of the 10-100 mJ systems does not exceed 100 Hz.

In this work we report on the amplification of a near diffraction limited, single frequency, passively Q-switched Nd:YAG laser (240-μJ, 830-ps at 0.5-kHz) up to 9.5-mJ in a two stage diode pumped amplifiers, whilst preserving pulse duration, beam quality and linear polarization. We use a passive Q-switched Cr^{4+}:YAG/Nd:YAG laser, with mirrors coated on the YAG element as an master oscillator emitting up to 240 μJ at 0.5 kHz with 830 ps pulse duration and diffraction limited beam. The signal from the oscillator is amplified in two stage amplifier in double pass configurations of each stage. Using an input energy of 240 μJ (into the first amplifier stage), and 200-μs pump pulses (at a total of 82.8 mJ pump energy into the amplifier head), we were able to produce up to 2.12 mJ pulse energy at 0.5 kHz, with near-diffraction-limited beam quality. With this energy level as an input of the second stage and the same pump conditions for the laser head we achieved maximum output energy of 9.5 mJ, corresponding to 4.75 W average power and above 10 MW pulse power. The amplified pulse duration is the same as the pulse duration of the microchip oscillator, i.e. 830 ps. The output from the oscillator and the amplified pulse duration were measured by a 1-GHz oscilloscope and an InGaAs photodiode with detection system pulse response (350 ps). The beam quality of this master oscillator power amplifier (MOPA) system was measured with a commercial CCD based beam-analyzer at the output of the oscillator (Mx2 x My2=1.38 x 1.31) after the first stage (M_x^2 x M_y^2=1.39 x 1.33) and at the output of the second stage of the amplifier (M_x^2 x M_y^2=1.4 x 1.35). The results show lack of considerable beam quality deterioration after the first as well as the second stage of the amplifier. **Acknowledgements:** We acknowledge support from project DO/02/134/2009 funded by the Bulgarian ministry of education, youth and science.

References:

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