マイクロチップレーザによる 6MW ピークパワー355nm 光パルス発生

6-MW peak, 355-nm pulse generation using microchip laser

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Passively Q-switched microchip lasers are very attractive sources for efficient wavelength conversion, due to their very simple configuration, compact size and very high peak powers, even for moderate pulse energies [1, 2]. Several applications, such as, laser processing and 3D printing, require high peak power at the third harmonic of Nd:YAG (355 nm). So far, near 1-MW peak power generation at 355 nm, using a microchip laser within a MOPA configuration, has been reported [3]. MOPA configuration increases the laser size and the advantage of compactness of a microchip laser is lost.

Here, we report for the first time, > 6 MW peak power generation at 355 nm from a microchip laser, without a MOPA configuration, by using a novel, cost-effective pumping method.

The experimental setup is shown in Fig. 1. The microchip laser is pumped through the output fiber of an in-house designed and fabricated fiber combiner, whose construction is shown at the left of Fig. 1. The 400-μm core output fibers of three 150 W laser diodes are coupled through splicing to a 1000 μm core step-index optical fiber, which is used to pump the microchip laser. This novel pumping method using a fiber combiner enables the use of relatively low-cost/low-power laser diodes to achieve high pumping power, while maintaining high beam quality required for end pumping.

The microchip laser comprises a YAG/Nd:YAG composite as the gain medium, to reduce depolarization, and a Cr^{4+}:YAG as the passive Q-switch. The input mirror is deposited on the undoped YAG and a partial transmission flat mirror is used as the output coupler. The third harmonic is obtained by sum frequency generation, using Type I and Type II LBO crystals.

The microchip laser is quasi-continuous–wave (QCW) pumped with a power of 380 W, 300 μs pump pulse width at 20 Hz. We obtain 11.3-mJ output pulse energy at 1064 nm with a pulse width of 935 ps, resulting in a peak power of 12 MW.

After sum-frequency-generation, we obtain 4.1-mJ pulse energy at 355 nm. The pulse width is 645 ps, resulting in a peak power of 6.36 MW. The 355 nm output characteristics are shown in Fig. 2. The maximum wavelength conversion efficiency from 1064 nm to 355 nm is 52%.

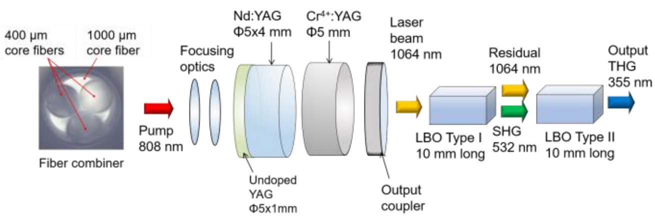

Fig. 1. Experimental set-up.

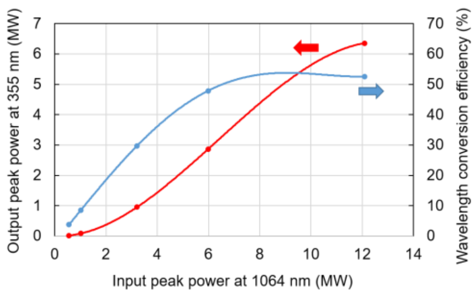

Fig. 2. 355 nm output characteristics.

To the best of our knowledge, the achieved peak powers, at 1064 nm and 355 nm, are the highest values obtained so far from a single microchip laser. The method of pumping described here is scalable, to further increase the output power. The results reported here will be very useful for high peak power 355 nm applications.

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References:

[1] J. J. Zayhowski, “Microchip lasers,” Opt. Mater. **11**(2-3), 255–267 (1999).
[2] R. Bhandari, N. Tsuji, T. Suzuki, M. Nishifuji and T. Taira, “Efficient second to ninth harmonic generation using megawatt peak power microchip laser,” Opt. Express 21, 28849–28855 (2013).
[3] F. Cassouret, A. Kausus, V. Yahya, G. Aka, P. Loiseau and T. Taira, “High peak-power near-MW laser pulses by third harmonic generation at 355 nm in Ca5(BO3)3F nonlinear single crystals,” Opt. Express 28, pp. 10524-30 (2020).