>50MW ピークパワー不安定共振器マイクロチップレーザー

>50 MW peak power microchip laser with unstable resonator

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A compact and high peak power laser is very useful for various applications based on laser induced plasma breakdown requiring a high degree of movability, such as laser ignitor [1], laser peening of metallic bridges [2], long-distance laser induced breakdown spectroscopy (LIBS) [3], laser material processing with robot arms, and so on. Passively Q-switched compact microchip lasers (MCL) with > MW peak power based on a short sub-ns pulse width (τ) and a single axial mode are therefore very attractive for such applications. Further peak power scale of MCL as well as keeping compactness is necessary for applications requiring more intense laser induced plasma. From a practical view point, a higher peak power allows a wider plasma area which results in a faster process speed such as for laser peening. However, peak power and brightness [$B = E/\{\tau(\lambda \cdot M^2)^2\}$] scale of flat-flat cavity MCL was limited by pulse width broadening and M^2 increase because of the degradation of beam pattern due to transverse higher-order modes. As a solution, we reported unstable resonator MCL having a record peak power of 27.7 MW and a brightness of 68 TW/(sr·cm^2) at 10 Hz [4]. Here, we demonstrate further improvement of the peak power and brightness of unstable cavity MCL by using a homogenized pump [Fig. 1(a)] such as a new record peak power of 59.2 MW (E=24.1 mJ, τ=407 ps), to the best of our knowledge, and a high brightness of 88.9 TW/(sr·cm^2) at 20 Hz [Fig. 1(b)]. The successful brightness scale in contrast to flat-flat cavity [Fig. 1(b)] is promising further brightness scale of MCL without amplifier. However, the high intense center part of Bessel-like beam in far-field increased its brightness effectively more than 8 times, up to 736 TW/(sr·cm^2), which will be discussed in detail at presentation. This work was partially supported by JST-Mirai Program Grant Number JPMJMI17A1, Japan and by Innovative Science and Technology Initiative for Security Grant Number JPJ004596, ATLA, Japan.

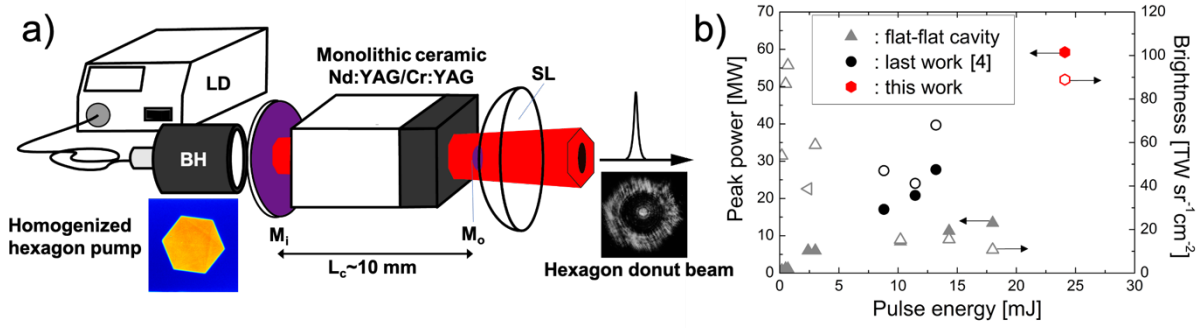

Fig. 1. (a) Schematic experimental setup of unstable-cavity microchip laser. (b) Measured peak power and brightness as a function of pulse energy. The new results (red hexagon) were compared with reported results using unstable cavity (black circle) [4] and flat-flat cavity (gray triangle).

References

[1] T. Taira, et al., The 1st Laser Ignition Conference (LIC'13), Japan, April 23-25, LIC3-1 (2013).

[2] Y. Sano, et al., Metals **11**, 176 (2021).

[3] K. Tamura, et al., J. Nucl. Sci. Technol. 1-10 (2020), DOI: 10.1080/00223131.2020.1776648.

[4] H. H. Lim and T. Taira, Opt. Express **27**, 31307 (2019).