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Performance and Technology of High Power Density Laser Diode Bar Stacks

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High peak power laser diode (LD) bar stacks are crucial components as pumping sources for high energy solid state lasers, such as inertial fusion energy research, among others [1]. To effectively pump laser media, it is critical to enhance output power, efficiency, and power density of LD bar stacks. These improvements contribute to reducing the number of required LD bars and footprints, thus yielding cost benefits. Therefore, the development of LD bar stacks is an essential effort to realize inertial fusion.

In 2015, we developed a high output power LD bar stack wtih an output power of 1kW per LD bar. This increase in output power was achieved using a simple water cooling structure that did not require a microchannel water cooling, which was considered difficult at the time. It can operate under conditions of 10 Hz frequencey and 1 ms long pulse width for Yb:YAG [2].

We have recently achieved the development of a high power density stack structure [3], which enables the stacking of more than 50 laser diode bars. To our knowledge, we have demonstrated the highest peak output power of 57 kW and the highest power density of 29 kW/cm² from a stack of 56 LD bars under operational conditions of 10 Hz frequency, 0.3 ms pulse width, and 1000 A current. Additionally, the full width at half maximum of wavelength of the stack was suppressed to 5.1 nm at the same conditions, and a maximum conversion efficiency of 63% has been attained, 60% even at 1000 A current.

The developed stack components are scalable and have reduced dead space compared to our conventional ones, resulting in more efficient pumping sources than ever before. This conference will provide a detailed presentation on the performance and technology behind the LD bar stack.

References

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