Nanosecond diode laser at kilowatt power

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High Power Diode Lasers (HPDL) have become more and more important in the last few years. They are now used for a wide range of applications that include pumping of solid state or fibre lasers, material processing or medical applications. The reasons that explain their success are a good price per watt, a very high efficiency, easy control of the laser power and a compact size. However, the poor functioning of HPDL in pulse mode has been an important barrier which has limited the use of HPDL mainly to applications in continuous wave (CW) mode. Lasers are normally modulated rather than operated CW, because the pulse format can be tailored to a specific application.

The use of HPDL lasers is normally limited to CW due to their usual mounting process. HPDL are usually mounted using a soldering process in which the laser diode bar is soldered between two copper blocks which serve both as electrodes and heat sinks[1]. The thermal expansion mismatch between the laser bar material (GaAs) and the copper heat sinks causes a fatigue effect on solder and bar material when the laser is operated in pulse operation (on/off cycles or quasi-continuous wave QCW).

Monocrom SL has developed a mounting technology for HPDL which eliminates the use of solder between the laser diode and the heat sink[2]. With this technology the laser diode bars are clamped between the two electrodes and fixed using mechanical pressure. HPDL manufactured with this technology have demonstrated to have[3] long lifetime, high beam quality (very low smile[4] due to the absence of strain during the mounting process), small thermal resistance, withstand a wide range of temperatures and, more important, exhibit an excellent behaviour in both pulsed and CW mode. These diode lasers have been able to operate in very different regimes, from the usual CW mode to pulsed mode in the millisecond and microsecond range.

Further advances have extended the pulse range of these diode lasers to even shorter pulse durations. In this paper we report what is, to the knowledge of the authors, the High Power Diode Laser which can operate with the shortest pulse duration up to date. We have designed and manufactured a monolithic laser bar stack that provides 3kW peak power with pulse durations in the nanosecond range. An image of the laser stack is shown in Fig.1. Each stack can operate with high repetition rate (>100Hz) and is thermally stabilised with a TEC, to allow fine tuning of the laser wavelength. Laser stacks with several wavelengths have been fabricated with this technology (8xxnm, 9xxnm). Each stack has 10 diode bars, each collimated in both the fast and slow axis, in order to preserve the high beam quality provided by the laser.

The 3kW laser was developed together with a novel electronic control system, able to produce very short pulses at 300A. This control is attached to the laser head, and can modulate pulses below 100ns with less than 10ns rise/decay time. Higher laser power can be achieved by scaling up the laser stack.

The excellent characteristics of the laser make it suitable for a wide range of applications. These include rangefinder, material processing, or new others where very short pulses in conjunction with high power and high beam quality are required.

Future developments of the laser will include the use of diode bars with multilayer configurations. These diode bars would allow HPDL powers up to 1kW per bar in pulse mode. These would serve to scale up the laser power significantly, with a monolithic stack of only 10 bars providing up to 10kW of laser power.

Fig. 1 Image of the High Power Diode Laser monolithic stack with 3kW laser power and pulses in the nanoseconds region. On the left side of the stack the electronics to control the short pulses can be seen.

References

[1] R. Diehl (ed.), *High-Power Diode Lasers, Fundamentals, Technology, Applications.* Topics Appl. Phys. 78, Springer-Verlag Berlin Heidelberg, 303-368 (2000).

[2] Laser Module. U.S. Patent Nº. 7,215,690, Application Nº. 10/910,849, Issue Date 05/08/2007.

[3] G. Viera, M. Galan, A. Isern, O. Zsolochevsca, A. Leyva, T. Etzkorn, *New features from non-soldered clamp-mounted diode laser bars*, Conference on Lasers and Electro-Optics Europe, 2005. CLEO/Europe. 2005, 12-17 June 2005, pp 107.

[4] L. Martí-López, J. A. Ramos-de-Campos and R. A. Martínez-Celorio, *Interferometric method for characterizing the smile of laser diode bars*. Optics Communications 275 (2007) 359–371