New features from non-soldered clamp-mounted diode laser bars

Gregorio Viera, Miguel Galan, Albert Isern, Oksana Zsolochevsca, Antonio Leyva, Thomas Etzkorn. MONOCROM S.L., C/Vilanoveta 6, 08800, Vilanova i la Geltrú, Spain

High power diode lasers (HPDL) are conventionally mounted using a soldering process, in which the laser chip (laser diode bar) is soldered between two copper blocks acting as p-electrode and n-electrode. Such devices usually show a poor reliability mainly due to the thermal expansion mismatch between the laser bar material (GaAs) and copper, which causes different problems: a) during the bar mounting process, the cooling down after soldering leads to induced strain in the laser bar; b) during pulsed laser operation (on/off cycles or quasi-continuous wave -QCW), the thermal cycles produce a fatigue effect on solder and bar material. These problems reduce the lifetime of the HPDL devices. Moreover, the induced thermal-mechanical stress causes the curvature of the laser bar and provokes the so-called "smile" phenomenon. The smile can reduces the beam quality when using optics by a factor of 10. The soldering process can also be defective by itself, since it can give place to different defects of degradation and damage on the laser bar that strongly affect to the reliability of the device.

MONOCROM S.L. has developed a new laser bar mounting technology [1] that overcomes all of these troubles, thanks to the total elimination of the soldering process. Such technology has been called **laser bar clamping technology**, because the bars are clamped between two electrodes and fixed using mechanical pressure. Figure1 shows a schematic draw where a laser bar is clamped between one anode and one cathode. Moreover, the laser bar mounting process is performed at room temperature. This is indeed very advantageous, because avoids the strain induced by the thermal expansion mismatching. In addition, both electrodes can serve as heat sinks, thus simplifying the thermal management. The main advantages of the clamp-mounting technology are the following: A) ***Long lifetime,*** due to the absence of the thermal-mechanical stress that would be caused by a soldering process at high temperature; B) **Very low *"smile"*,** and therefore good beam shaping results; C) ***Small thermal resistance,*** because high thermal conductivity copper can be used for the two electrodes acting both as heat sinks, and moreover because no thermal barrier in present between laser bar and electrodes owing to the elimination of the solder layer; and D) **Large operating and storage temperature intervals**, very convenient for extreme conditions of use.

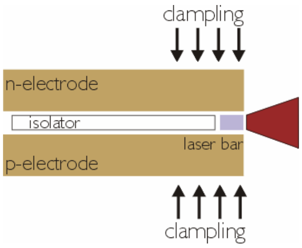

Figure1. Schematic picture of a clamped laser bar

The clamped laser bars show competitive results as compared to the soldered ones, in terms of optical power, polarization and other optical and spectroscopic features. In continuous wave (CW) operation, 60 W are available with less than 35ºC of heating using conductive cooling, and with acceptable spectral width, less than 3 nm at FWHM. In QCW operation, more that 120 W of peak power is obtained under a huge range of frequencies (Hz to tens of KHz) and pulse duration (µs to tens of ms). The clamped laser bars have been found to be very suitable for pulse operation, since the bars do no suffer the same fatigue effect than the soldered ones due to the thermal cycles. This advantage leads to mount high peak power laser bar stacks with good reliability using the clamping technology. Figure 2 shows a ten bars-clamped laser bar stack. Although such stack has conductive cooling, same features can be achieved with water cooled mounts if high duty cycle (more than 10%) is required. This conductive laser bar stack can provide more than 1 kW of peak power. In terms of pulse energy, the same stack can deliver up to 20 J per pulse, which is very suitable for medical and aesthetic applications.

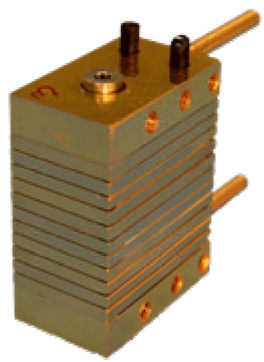

Figure2. Conductive clamped laser bar stack with 10 bars

"Smile" is not a problem in the clamped laser bars. The classical optical procedures used to measure the smile in the soldered bars, which is normally higher that 1 µm, have not enough resolution to measure precisely the "smile" in the clamped bars. From different measurement methods, the "smile" in the clamped bars has been evaluated to be in the order of 100 nm.

Extreme ambient conditions are supported by the clamped laser bars. They have been preliminary tested from -60ºC to 85ºC without any changes in the optical characteristics. The fact that no solder material is the packaging avoids the temperature limitations of this, like the thermal degradation of solder or the laser contamination by solder outgassing. This advantage is of very important relevance for aerospace applications.

For water cooled mounts, the clamping technology has an additional advantage. To achieve thermal resistance below 0.4 K/W, actually the electrodes require micro channels. Micro-channels can easily be obstructed due to particles in the cooling water system. The micro-channels erosion is also an important drawback. Since with the clamping technology the laser bars are cooled from both sides (anode and cathode), thermal resistances as low as 0.4 K/W can be achieved without the use of micro-channels. With the millimetre channels used by Monocrom, obstruction is dramatically reduced.

[1] LASER MODULE, patent number EP1341275, Miguel Galan, MONOCROM S.L.