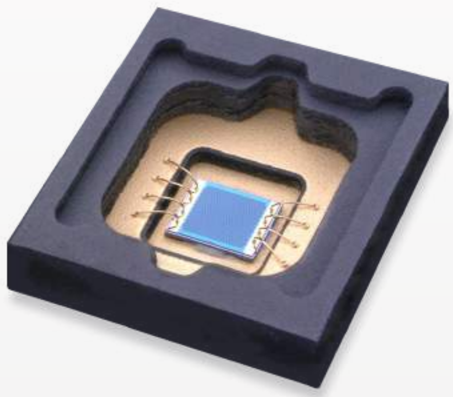
II-VI



HVS7000

High Power VCSELs for Gesture Recognition

INTRODUCTION

Gesture recognition is rapidly becoming a preferred interaction with electronic systems in the gaming, 3D cameras and entertainment environment. The initial deployment of gesture recognition technology and systems used high power edge emitting Fabry Perot lasers as the light source. These lasers have several disadvantages in the application, including high packaging cost wavelength stability over temperature, and reliability.
II-VI has developed a VCSEL based alternative that provides application benefit. The HVS7000-001 described here is packaged in a TO can and is intended to be used in a short pulse mode operation with low duty cycle. While this is one form of component that can be used in 3D machine vision and gesture recognition applications, there are several other methods that are in use today. Please contact II-VI for customization of power levels, emitter geometry, packaging and operational characteristics.

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VCSEL Characteristics

High power operation in a VCSEL can be achieved by either scaling the emitting region in diameter (typical datacom VCSELs are ~10µm) up to 100µm or larger, or using 2 dimensional arrays of individual emitters. To preserve low manufacturing cost and obtain optimal device performance, we have chosen to scale using a 2D array of individual emitters. A picture of a typical top emitting laser pattern with approximately 200 individual emitters is shown in figure one.

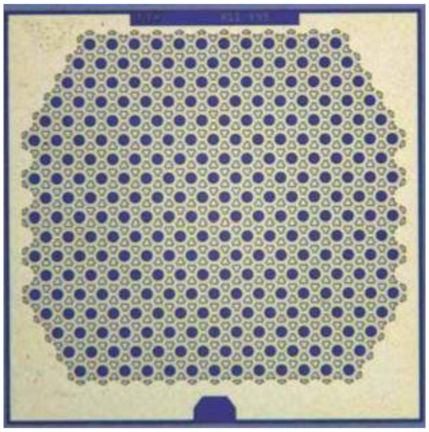

Figure 1 Picture of typical 2D high power VCSEL array

Scaling power by a 2D array has several advantages in the application. First, the lasers are all emitting independently, so the coherence of the source is reduced, but since the VCSELs are all in close proximity, the emission wavelength is still very tightly controlled. Second, an individual element in the array can fail, but the overall power and source properties are only modestly affected. Third, the heat generated by the laser is spread over a larger area and thus allows for improved heat-sinking. Figure two is an image of a typical near field of the 2D array showing good uniformity of power emission (shown in color scale) from each aperture.

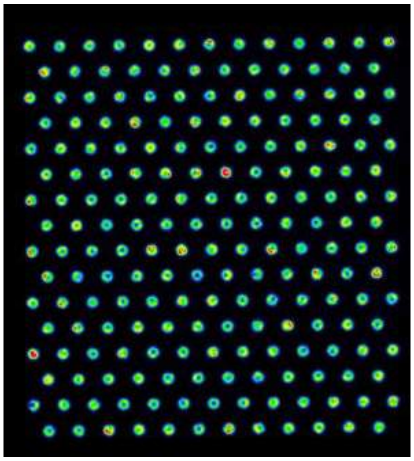

Figure 2 Near field emission pattern of a typical 2D high power VCSEL array

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The CW light output is plotted as a function of current, temperature, in figure three.
Packaged in this form, lasers typically emit up to 1W of optical power. However, the TO can package is not an ideal heat sink, and CW operation is not recommended for these lasers, and they should only be used with electrical pulses less than 100ns in duration, and at duty cycles less than 5%. Other packaging schemes need to be considered for evaluation of these arrays under CW drive conditions.

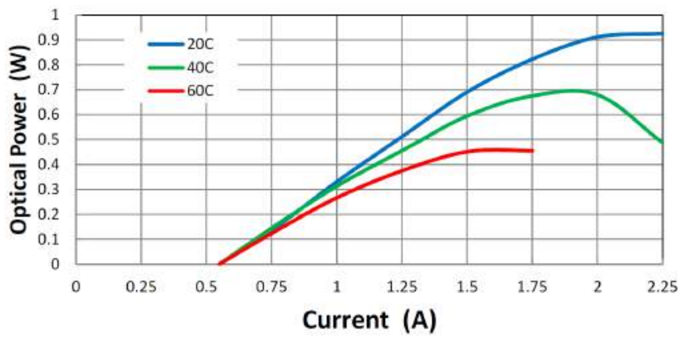

Figure 3 CW light output as a function of current for several heat sink temperatures

Higher peak power operation can be obtained when driving the laser with short electrical pulses that are significantly shorter than the thermal time constant of the VCSEL. In order to determine the thermal time constant, we drove the laser with a 100µs electrical pulse and measured the optical response as a function of time as shown in figure four.

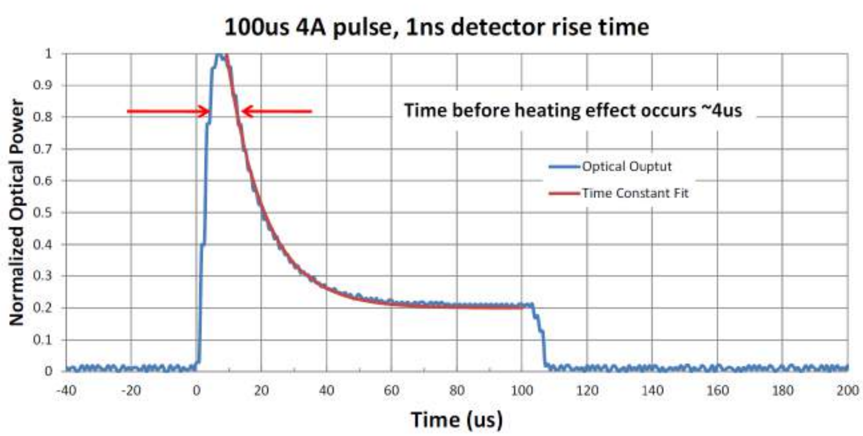

Figure 4 Temporal response of the optical power to a 100us electrical pulse (blue) and the fit thermal time constant (red)

The decrease in optical power was fit to an exponential decay function and a time constant of approximately 12μs was obtained which contains the VCSEL and associated packaging. The active region of the VCSEL itself reaches thermal equilibrium much faster, typically on the order of 1μs. When the VCSEL is driven with pulses significantly shorter than the thermal time constant, and at a low enough duty cycle to have low overall temperature rise, significantly higher optical peak power levels can be obtained.
The benefit of pulsed drive current depends on the pulse width and duty cycle which ultimately determine the overall temperature rise of the VCSEL and the package. The continuation of drive conditions is demonstrated in figure five. Note that both the optical power and the drive current are plotted on a log scale. For a more detailed explanation of the effects of pulsing a VCSEL please see the II-VI application note entitled "Pulsed Operation of VCSELs for High Peak Powers."

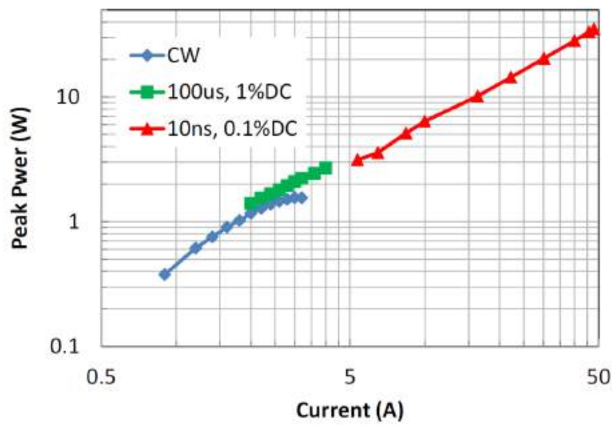

Figure 5 Log-Log plot of the peak optical power as a function of drive current for several different operating conditions.

The transient response of the VCSEL in the TO package typically has rise and fall times that can be made less than 1ns. It is important to drive the VCSEL with a current limited waveform to insure that the laser is not damaged. The electrical resistance of the 2D array is significantly less than 1Ohm, and the total capacitance will be less than a few pF when forward biased. The package inductance and capacitance typically dominate the pulse performance. Figure six shows a typical transient response of a 2D VCSEL array driven with a commercial laser driver from IXSYS.

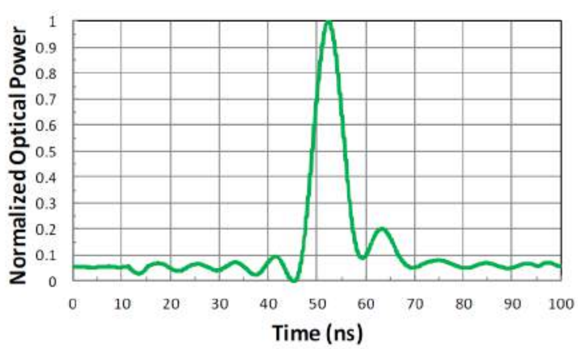

Figure 6 Temporal response of a high power VCSEL showing rise and fall times less than 1ns

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The emitted optical beam profile also has a dependence on the laser driving condition. When the VCSEL is driven CW, or with pulses longer than the thermal time constant, a thermal gradient appears in the VCSEL active region that makes the emission pattern appear to have a dip in the center. However when driven with short pulses, the emission pattern is normally distributed as indicated in figure seven.

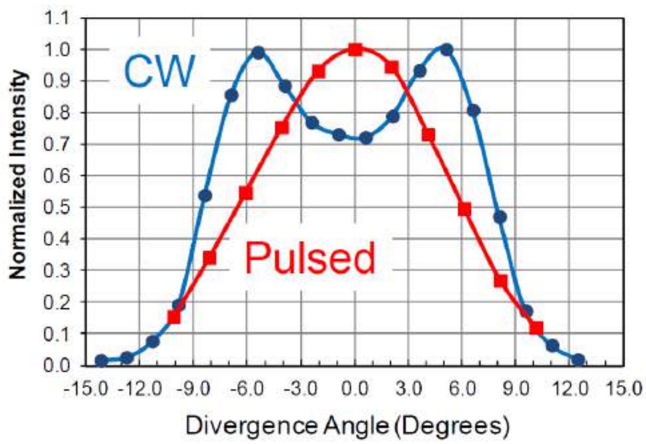

Figure 7 Far field beam profile from a 2D VCSEL array when driven CW and pulsed

Summary

II-VI has introduced a new laser suitable for the gesture recognition market. The scalable 2D VCSEL technology can be customized to fit a variety of application types and different electrical and optical requirements.

References

II-VI application note “Pulsed Operation of VCSELs for High Peak Powers”