

488 nm Solid-State Laser by PIC Using a Nichia Diode

GaN diodes are very interesting light sources to develop and manufacture visible continuous wave solid-state lasers for biotechnology instrumentation applications and other markets. GaN diodes enable compact and efficient laser designs. Typical laser diode based designs only require a couple of Watts electricity and therefore only generate a similar amount of heat load. 405 nm has already developed into a very important wavelength option

and now with the availability of 488 nm diodes such laser designs can be extended into the most dominant color option in the visible solid-state laser market.

488 nm diodes in free running operation exhibit a broad range of cavity modes that change for example with operating power as shown in figure 1 (data provided by Nichia Corp.). Laser operation shows multiple modes at higher power levels, which are changing and cause instabilities (spectrum and noise). Mode hops cause a significant change in the peak wavelength of the spectrum on the order of 0.5 to 1 nm and would render these diodes unusable for applications like flow cytometry due to large changes in the fluorescence signal. PIC's Whisper technology, to our knowledge, is the only technology that can be used to overcome these drawbacks and can turn 488 nm GaN diode light into useful laser light for biotechnology applications.

To demonstrate this a 488 nm GaN diode was integrated into a PIC Whisper laser package. The first improvement when operating with the PIC technology is the stabilization of the spectrum. Instead of a distribution of fluctuating individual modes the spectrum using Whisper is a smooth and stable distribution with a full-width-half-maximum of about 2 nm. We have conducted measurements of the stability of the spectrum and have seen no change over 6 hours (figure 2).

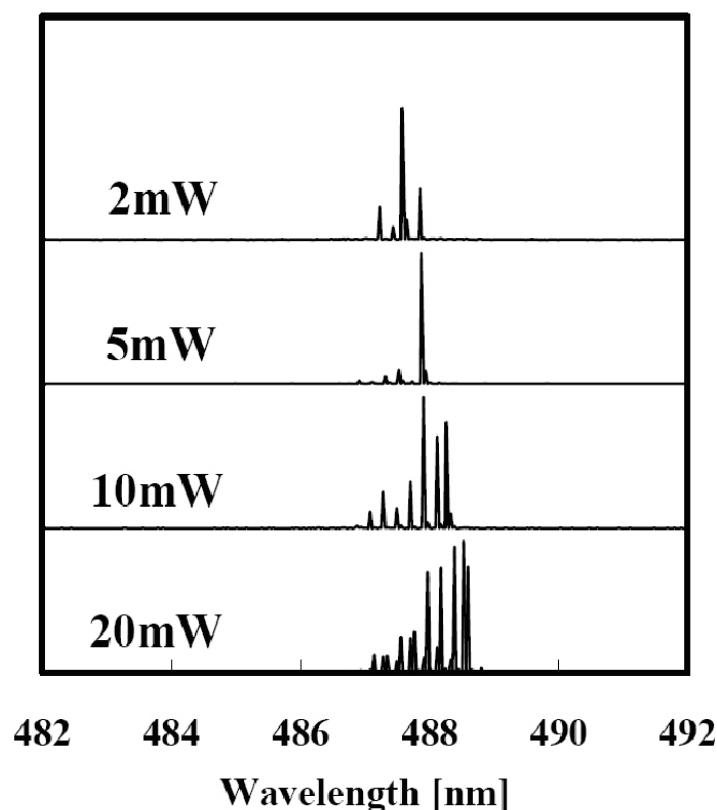


Figure 1: Spectrum of free running 488 nm GaN diode

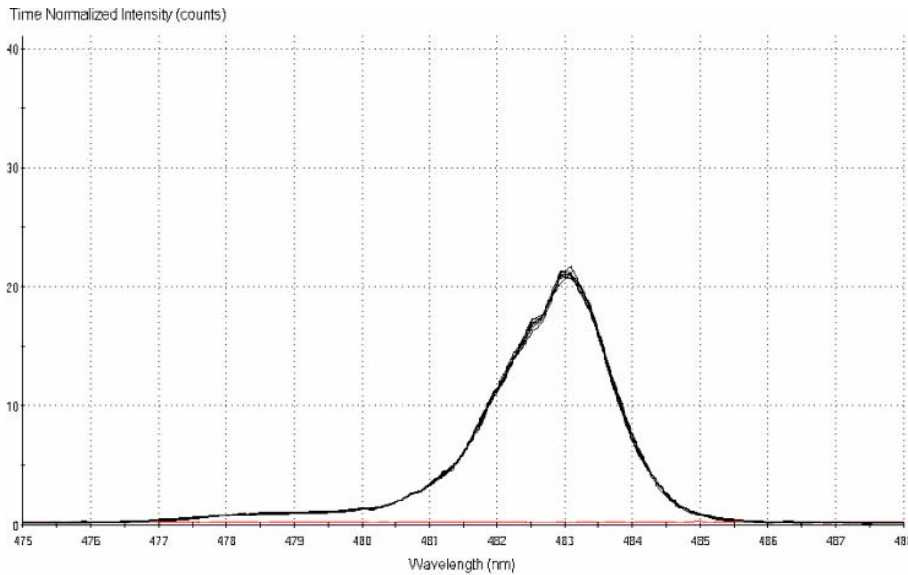


Figure 2: Stabilized spectrum measured over 6 hrs showing a smooth and stable distribution.

More importantly, our noise measurements show a dramatic improvement when using the Whisper technology. Figure 3 shows RMS noise measurements with and without Whisper stabilization over several hours of operation under standard lab environment (the measurement with Whisper electronics is a 8 hr test). The measurement shows a dramatic difference in the absolute RMS noise value, but also demonstrates the stability improvement. Besides stabilizing continuous wave operation the same improvements are observed when modulating the diode. Therefore, the combination of a Nichia GaN diode with the PIC Whisper technology enables a product solution that offers a wide range of benefits to instrument designs. Such benefits are the possibility to turn the laser on fast, vary the power and modulate the laser directly without the use of a shutter, neutral density filters or an acousto-optic modulator. The design enables a small package, especially when an elliptical beam is needed, and provides very good electrical efficiency with minimal heat load (<4W).

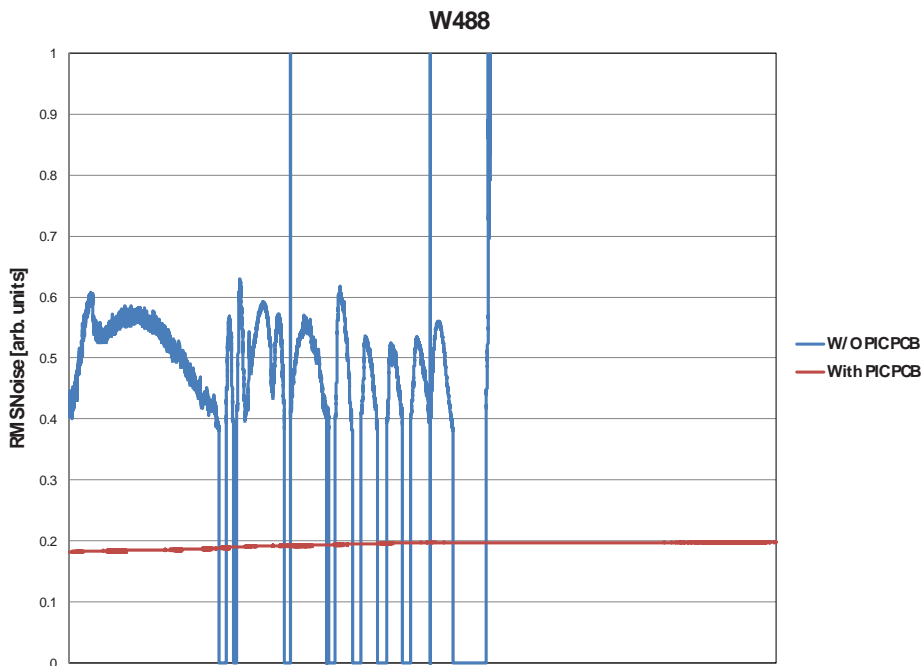


Figure 3: Long term noise measurement with (blue) and without (red) Whisper electronics