

Application Note #08

Spot Welding with Long Pulse Fiber Lasers

Introduction

Low heat input spot welding has been achieved with flash lamp-pumped solid state lasers for many years; it is now possible to replicate their performance with a zero maintenance fiber laser. These new fiber lasers have identical pulse durations and pulse energies and similar peak power capabilities to YAG lasers.

Pulsed Fiber Lasers

The rapid growth in market share of fiber lasers demonstrates that their benefits are now well recognized but until recently only continuous wave (cw) or cw modulated lasers were available for welding. Although pulsed laser welding could be achieved by modulating a continuous fiber laser beam, average power was substituting for peak power and a more costly higher average power laser was required to achieve the necessary multi-joule pulses. IPG has now developed a new type of fiber laser that replicates the pulse parameters of the most widely used flash lamp-pumped lasers in pulse length, pulse energy, peak power and pulse repetition rate.

At the 150 watt average, 1500 watt peak power level, these air-cooled 110V powered lasers are 19" rack mounted 4U high devices with ten times the wall plug efficiency of a conventional YAG laser – and the complete laser occupies only a small portion of the space of a YAG laser power supply cabinet. Flash lamps, a water-cooled resonator and free space optics are all replaced by a fully sealed continuous fiber system from pump diode to beam output. Pump sources are long life zero maintenance single emitter direct diode devices.

WELDING APPLICATION

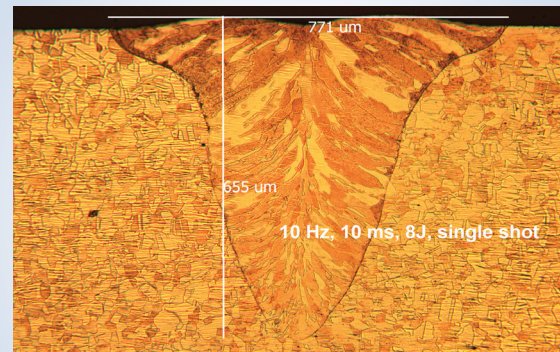


Figure 1: Single Shot Spot Weld 304 Stainless Steel, Multi-mode Feed Fiber

The benign thermal environment in which the pump source and resonator live is directly responsible for the exceptional pulse-to-pulse stability which is in turn directly reflected in the consistency and quality of the welds produced. The YLR-150/1500-QCW-AC laser can produce pulses up to 15 J from a 150 W average power laser in pulsed mode and 250 W in continuous wave (cw) mode although for most micro-welding applications < 5 J is required.

Featured Application: Pulsed Laser Welding

These fiber lasers, known as Quasi Continuous Wave (QCW) lasers, are capable of producing exactly the same types of welds produced by pulsed Nd:YAG flash lamp pumped lasers for many years.

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At higher pulse energy, this may be a ‘nailhead’ weld profile such as the transverse weld cross section shown in figure 1 (above) but to produce a continuous weld seam, these spots are simply overlapped by an amount determined by the weld speed, effective spot size and pulse repetition rate.

If weld hermeticity is required, a spot overlap of ~ 65% is required. Figure 2 (Right) shows the surface of a butt weld seam made by overlapping weld spots on a titanium device. If shallower more hemispherical welds, known as conduction limited welds are required, a reduction in pulse energy and or power density is all that is necessary.

There are however many additional benefits of this new type of fiber laser. As the beam is generated in a single mode fiber, the focusability or brightness of the laser beam is close to a perfect Gaussian beam shape. This means that when using the same optics as a conventional flash lamp-pumped laser, a much smaller spot and a much higher power density can be achieved at the workpiece. The result is in smaller welds being produced. However, for some welding applications, a more flat-top shaped beam may be required and a solution is available – quickfit fiber connectors and a range of optional fiber diameters. A range of fiber diameters from single mode to 200 um multi mode are available along with a range of collimator focal lengths and beam couplers with connectors resulting in an almost infinite range of weld spot sizes can be obtained.

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There is also evidence from extensive metallographic analysis that the unmatched pulse to pulse stability of fiber lasers is directly reflected in the lack of porosity and hence, weld quality that can be achieved.

Summary

An entirely new type of pulsed fiber laser is now available from IPG; the QCW fiber laser is a dramatic improvement over laser welding techniques currently used by conventional flash lamp-pumped Nd:YAG lasers.

IPG looks forward to helping our customers with their application needs. Contact any of IPG’s application facilities to arrange free sample evaluation & process development. Go to www.ipgphotonics.com for more information on all of IPG’s products.



Figure 2: Top Surface of Butt Welded Titanium

Parameter	YLR-150/1500-QCW-AC	YLR-150/750-QCW-AC
Max. Peak Power	1500 W	750 W
Max. Pulse Duration	10 ms	20 ms
Max. Duty Cycle	10%	20%

Table 1: Specification Summary for 150 W versions of IPG's QCW Fiber Laser