Industrial diode laser systems help drive plastic welding

MANY LOW POWER APPLICATIONS CAN BENEFIT FROM INCREASED FLEXIBILITY, REDUCED PART COSTS AND INCREASED PRODUCTION SPEED

JDSU Commercial Lasers Group has introduced a new compact series of fiber coupled industrial diode laser systems targeted for worldwide automotive and electronic manufacturers. The products are specifically engineered for plastic welding and selective soldering applications.

JAMES CHRISTIAN

In general, worldwide automotive manufacturers are conservative in their adoption of new approaches to high volume processes for their manufacturing lines. Although there has been significant utilization of laser based cutting and welding processes that have been introduced over the past decade, the industry has been slow to use laser based processing for simpler processes.

Clearly, there are a multitude of low power applications that can be transitioned to laser-based processing. This would provide benefits that include increased flexibility, reduced part costs and increased production speed, all without compromising reliability. It remains the task of laser component and system suppliers to provide highly reliable and cost effective solutions to these manufacturers. A great deal of emphasis needs to be placed on reliability, predictability and long-term cost of ownership.

Automotive plastic welding with lasers

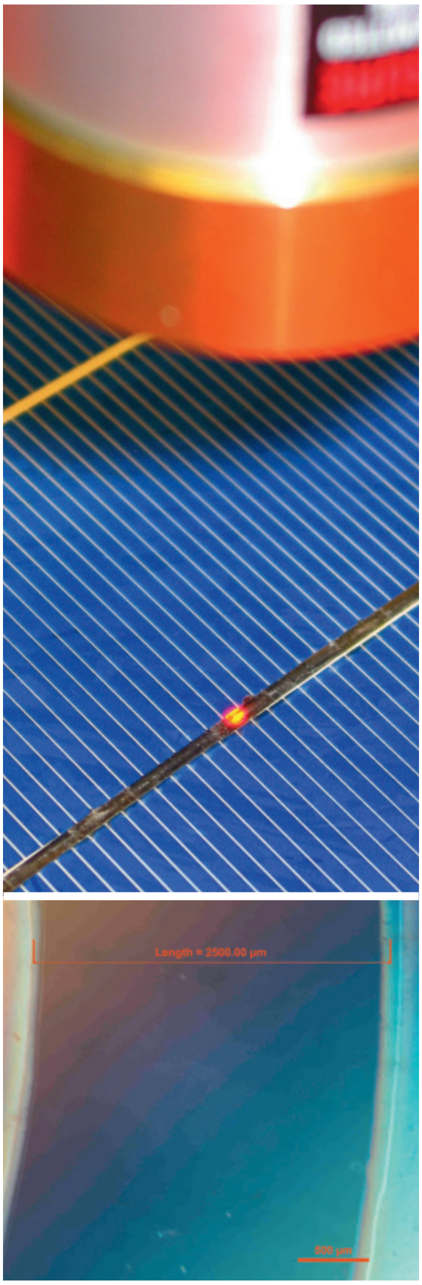
Laser based plastic welding is the process of melting the surfaces of two pieces of similar plastic materials together. Typically, one of the two materials is transparent and the other material contains a pigment to produce an opaque material suitable for the absorption of incident IR light. Contour welding is the most flexible and commonly used type of laser plastic welding process (**Figure 1**). For this process, the IR laser beam is moved along a programmed path, typically with the use of mirrors mounted on precision galvanometers. The light passes through the clear material to the interface layer, at which time the opaque material absorbs the incident light and melts into the transparent material. Solidification is nearly instant and therefore a waiting period is not required prior to the part moving off of the processing station. An alternate approach, and one that is common for circular contour welds, is to hold the incident beam stationary and move the part beneath the incident beam. Optimum beam diameters vary by process but are limited to a minimum of the core diameter of the fiber, which is commonly re-imaged at some working distance from the face of the fiber. Working distances typically range from a 50 to 100 mm.

Plastic joining in today's automotive industry is used for many applications, ranging from the assembly of driving lights, body panels, various valves, window and washer motors, relays and other small electronic components. Any point in a manufacturing process that requires the joining of plastic parts is a candidate for bonding using laser techniques. Utilization of plastic welding offers a surprising number of simplifications to the overall joining process that can result in reduced part costs and improve overall throughput through decreased processing time. Parts that need to be joined can be much simpler in design; captive flanges can be left off, channels for sealing materials such as o-rings are no longer necessary, sealing or joining compounds are no longer needed, and there are no toxic fumes. The materials that need to be joined are simply maneuvered into position, lightly held in position, and the laser beam is directed about the part.

Direct diode lasers – reliability is key

Optical engines for plastic welding are typically either bar-based (multiple laser emitters mounted in a row and operated as a single device) or multiple single-emitter package designs (several discrete devices combined in a single package). Both choices keep system costs down and allow coupling into small core fibers.

While high power laser bar sources are arguably improving in reliability, there are still known failure mechanisms that can be catastrophic. Of primary concern is thermal crosstalk between adjacent emitters – in the case of a single diode failure, a cascade failure event may be initiated as the energy that once left the device in the form of light is now forced to be dissipated as heat. The localized heating then causes damage to nearby diodes that ▶

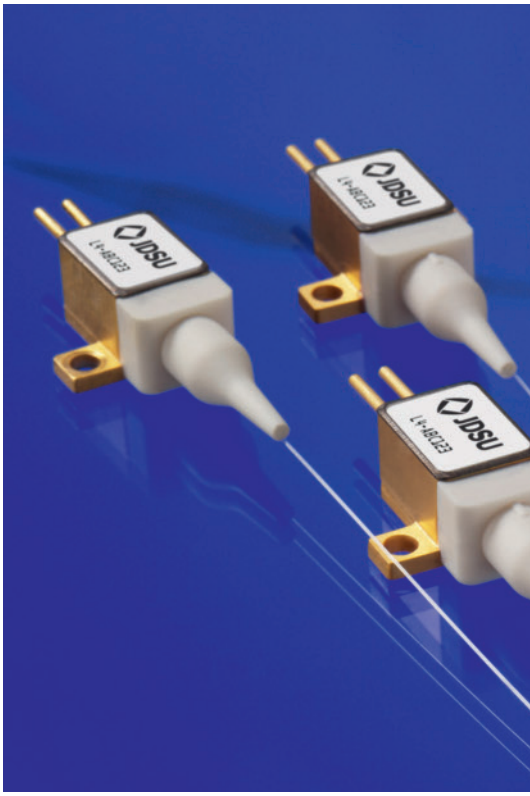


1 Typical applications suitable for direct diode lasers include selective soldering on solar cells (left) and contour welding of plastics parts

eventually leads to complete failure. Cascade failures of optical engines based on laser diode bars are not repairable. Other failure mechanisms are associated with pulsed operation of devices produced with specific materials.

Other novel approaches to improve reliability and reduce thermal crosstalk include packaging multiple single-emitter products into single, novel package designs that allow for coupling into small core diameter fibers on the order of 100 to 400 µm. This is ideal for many optical pumping applications, but not necessary for most plastic welding applications. Although much less prone to catastrophic events, failures of these packages are generally not repairable leading to high service costs.

Another common concern with a majority of optical engines is the requirement for the customer to design and implement the diode driver and interface electronics to operate the products in their specific application. Although initially deemed trivial, designing appropriate drive electronics can be a formidable challenge. There are regular reports of customers arguing warranty claims with diode manufacturers or optical engine suppliers when a given failure appears to be related to drive electronics that were designed and implemented by the customer.

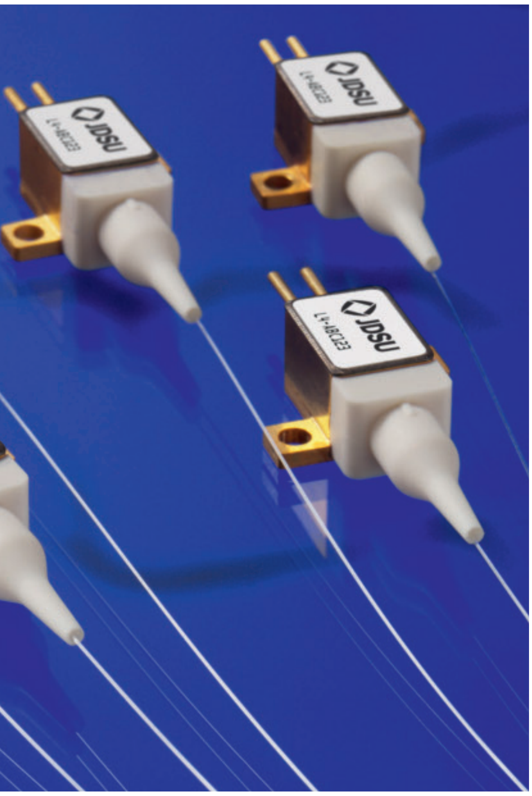


2 JDSU's L4 10 W diode laser module

New industrial diode lasers

To address the challenges mentioned above, JDSU's Lasers Business Unit has worked with customers and developed a series of unique products built upon a new air-cooled industrial diode laser system and a new compact DC operated water-cooled OEM industrial diode laser module. Both products are completely self-contained, including diode driver, interface electronics, proven JDSU L4 10 W single-emitter diodes (Figure 2), and novel health monitoring and reporting features. Products will be available with 200 W output in 400 µm/0.22 NA or 600 µm/0.22 NA

3 JDSU's diode laser system for industrial applications



CONTACT

JDSU
Milpitas, CA 95035, USA
Tel. +1 408 546 5000
Fax +1 408 546 4300
www.jdsu.com

delivery fiber and a variety of IR wavelength options (**Figure 3**). The new products are designed to easily integrate into customer systems and are designed with a focus on reliability. Product pricing can be very competitive given JDSU's vertical integration approach and established strengths with manufacturing processes.

The aforementioned industrial diode laser systems and modules incorporate JDSU's patented fiber pigtail 10 W single-emitter L4 laser diodes. Thermal crosstalk is of no concern and typical pulsed operation does not affect lifetime. Diode current is adjustable by the end user via convenient analog or RS-232 inputs. In the event of individual diode failure, the product remains fully operational until product service can be arranged; and individual diodes are easily and quickly replaceable in the system.

A novel product health monitoring system has been implemented in each industrial diode laser product to provide active notification of installation or product operational problems. Nearly a dozen internal elements, including the optical output of each individual diode laser, power supply status and various system temperatures are actively monitored. The failure of any laser diode (or other identified elements) will set a soft flag that is reported to the operator both electronically via RS-232 or analog ports, and visually through a system status indicator conveniently located on the face of the products. When such a soft error occurs, an operator may continue to use the products while correcting the condition or while making arrangements to have the product serviced.

To further assist in the process of troubleshooting soft failures, JDSU's industrial diode laser systems incorporate a unique method of communicating detailed health status to an operator and eventually to the JDSU Lasers service organization. A USB port has been provided to allow connection to a PC. The product is then recognized as a USB flash drive, and a continuously updated system health file is available on the drive for quick copy and paste into an e-mail message that can be sent for evaluation. This method overcomes the shortcomings of cellular based adapters that often do not have sufficient coverage in remote areas and large steel/concrete buildings, and Ethernet adapters that may have difficulty reaching the outside world through sophisticated firewalls, et cetera.

Summary: Designed for demanding applications

With the new JDSU IDL II based products, novel drive and monitoring features provide an ideal solution for demanding industrial applications. Vertical integration allows JDSU to offer the products at competitive prices while providing overall low cost of ownership as part of the value proposition to the customers.

AUTHOR

JAMES CHRISTIAN is Product Marketing Manager for the Communications and Commercial Optical Products business segment at JDSU in Milpitas, CA, USA.

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