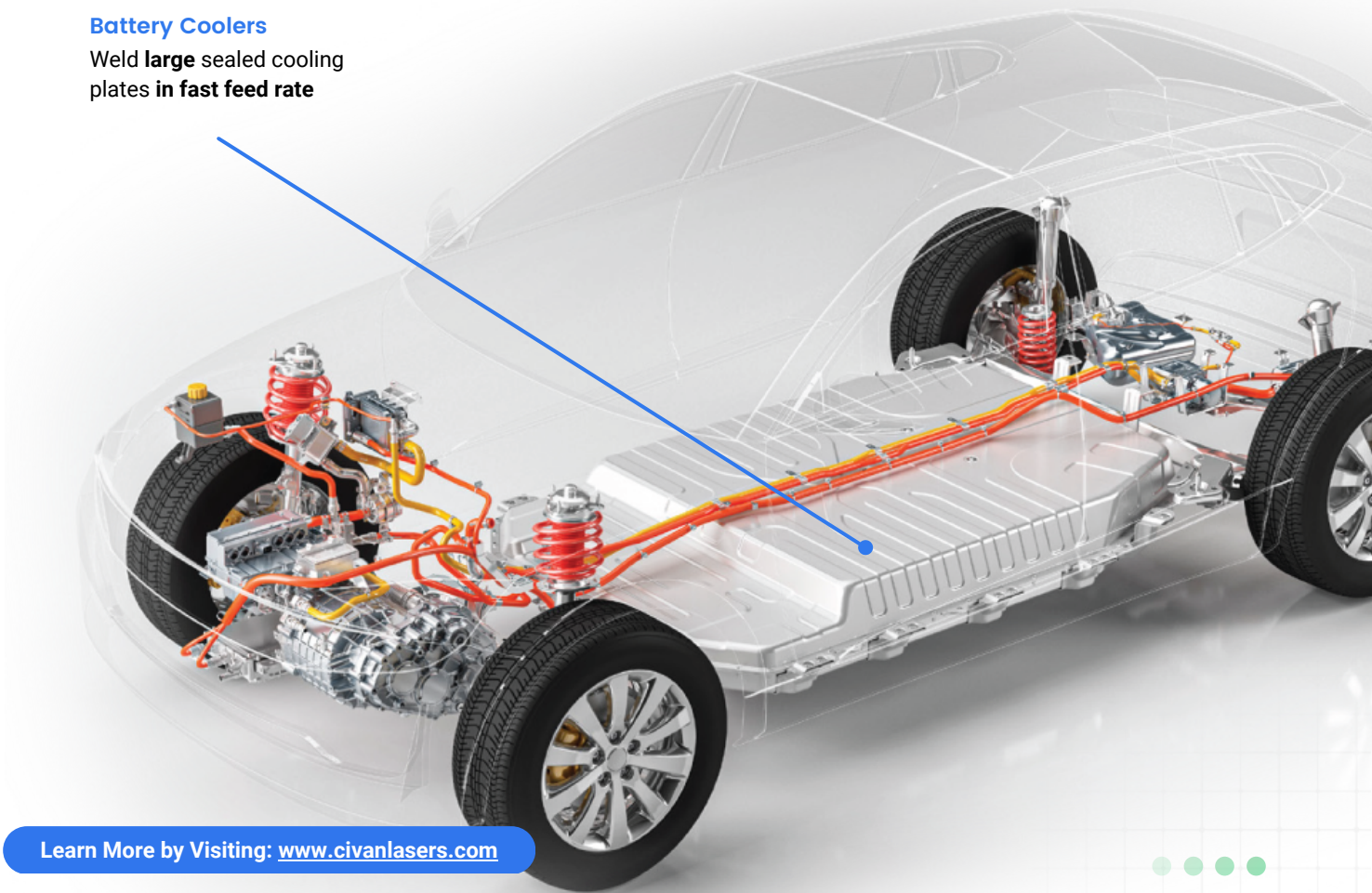
Case Study

Civan Lasers

Welding of Battery Cooling Plates.

Civan's Dynamic Beam Laser Welds **Cooling Plates for EV Battery Thermal Management**.

Battery Coolers
Weld **large** sealed cooling plates **in fast feed rate**



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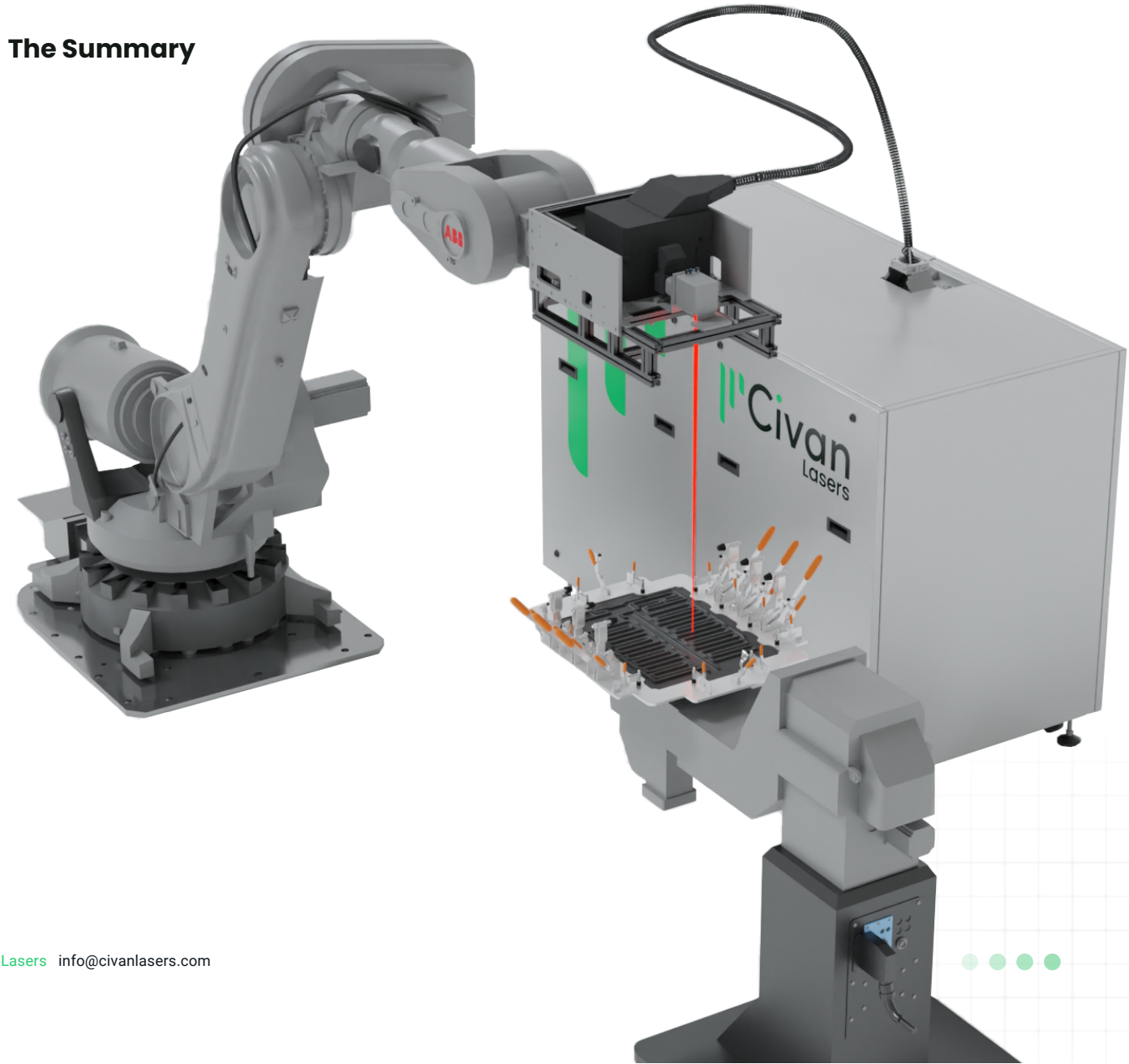


Dynamic Beam Laser Welds Cooling Plates for EV Battery Thermal Management

Switching from vacuum brazing to laser welding helps cooling plate manufacturers achieve strong, leak-free welds at 30 m/min.

Civan Lasers' dynamic beam laser technology offers tier 1 automotive companies an **improved solution for joining cooling plates using 5xxx and 6xxx aluminum (Al) alloys**. Compared to existing methods, DBL technology is more power efficient, allowing manufacturers to not only reduce costs and CO2 emissions but also increase weld speed and feed rates while achieving more rapid materials processing.

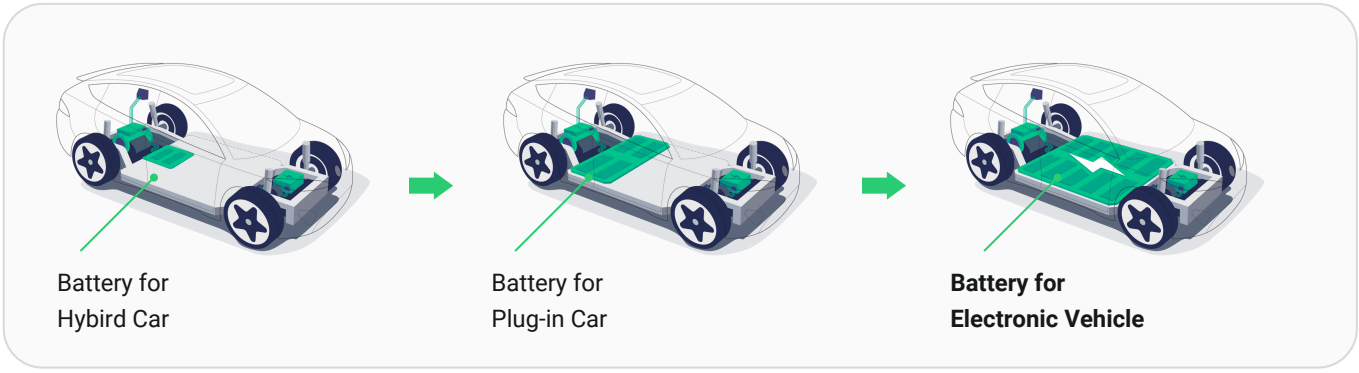


*Figure 1: **The size of the cooling plates increases with each EV evolution - from HEV to plug-in HEV to full EV.***

The Challenge: Cost-effectively Join Aluminum Alloy Plates at Feed Rates of 30 m/min Without Defects.

As the automotive industry shifts to e-mobility, automotive original equipment manufacturers (OEMs) replacing combustion engines with electric motors and large battery packs confront a host of new materials joining challenges. One such challenge is in the production of battery coolers, a critical component in battery thermal management systems.

Electric vehicle battery cooling plates regulate the temperature of the battery pack and some of the electronics by circulating coolant, which removes heat, through channels in a welded base plate. **Welding of battery cooling plates requires very high-quality, hermetically sealed joints to prevent leakage of the circulating coolant.** The joints cannot have any cracks because they lead to mechanical failure.

With the adoption of new metal-alloy-based cooling system designs, manufacturers are searching for faster, more efficient joining methods that will help them keep up with demand. Because the size of the battery cooling plates increases as electric vehicle (EV) technology evolves from hybrid EV (HEV) to plug-in HEV to full EV, these new methods must be able to reliably and cost-effectively join aluminum alloy plates at high feed rates.

The Business Case.

Today's EV battery systems require cooling plates measuring about 2.1 x 1.3 meters. The larger cooling plates, combined with new materials such as 5xxx and 6xxx Al alloys that offer improved mechanical properties and recyclability, push the limits of today's joining technologies.

Currently, manufacturers use vacuum brazing technology. Brazing, an old joining method, is not energy efficient and requires a large footprint. As a result, it is too expensive, energy intensive, and slow. The brazing process also requires the use of Al 3003, a special aluminum alloy that can be brazed. Manufacturers want to switch to a more economical alloys as Al 5xxx and Al 6xxx, which cannot be brazed.

Conventional fiber lasers cannot achieve the high feed rates required because such welding speeds result in cracks, porosity, and humping, which ruin joint integrity. The maximum feed rate of traditional lasers for welding Al 3xxx is 8–12 m/min. It is less than 15 m/min for Al 5xxx.

Due to feed rate limitations, such laser welding methods are not viable solutions to meet increasing demand, because manufactures must purchase and operate multiple laser welding stations to overcome the throughput bottleneck, which significantly increases capital equipment costs and energy consumption.

Solution

Civan's Dynamic Beam Laser overcomes federate limitations when welding cooling plates for EV battery thermal management systems. Thanks to dynamic beam shaping, shape frequency of up to 50 MHz, shape sequences, and focus steering, the DBL achieves feed rates of 30 m/min, which is more than two times faster than brazing.

Civan's Dynamic Beam Laser includes software that makes it easy to design the relevant beam shape, frequency, sequence, focus, upload it to the laser, and see the effect on the weld using cross-section analysis. The simplicity and speed of this process made it possible to evaluate multiple shapes to optimize the best shape for welding the cooling plates.

Comparison

Civan's Dynamic Beam Laser technology, which allows manufacturers to control beam shape, frequency, sequence, and focus steering, can improve weld quality and processing speed in this application. Moving the beam and focus at speeds of hundreds of megahertz traces various beam shape patterns to distribute energy over the work surface as needed to tailor the beam for a variety of applications, including welding dissimilar materials with different reflectivity, heat capacity, and melting points and joining crack-sensitive materials.

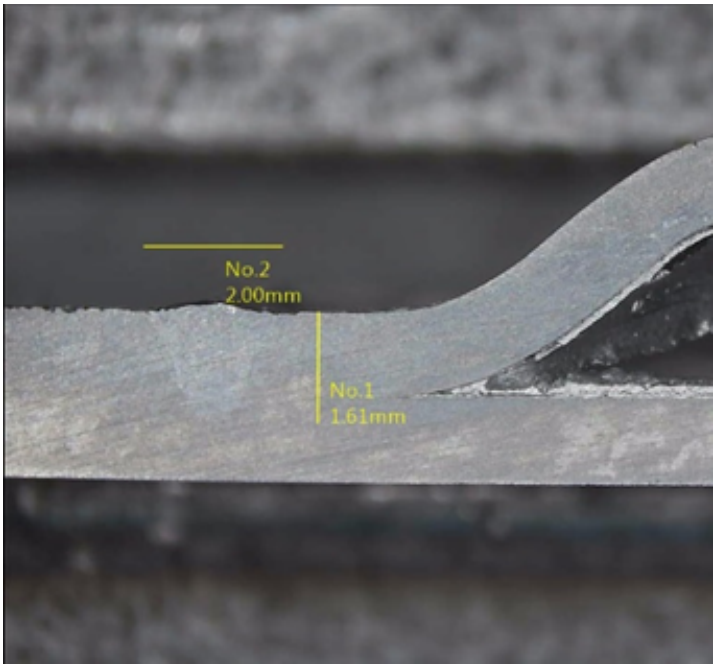
Because Civan's Dynamic Beam Laser technology allows precise control of beam shape, sequence, frequency, and focal depth, the laser can be easily optimized to meet specific welding requirements and can cost-effectively join aluminum alloy plates at feed rates of 30 m/min without defects.

	Brazing	Dynamic Beam Laser
System cost (M€)	3 - 5	1 - 2
Power consumption	4 MW	0.5 kW
Footprint	800 SQM	25 SQM
Possible materials	Al 3xxx	Al 3xxx, Al 5xxx, Al 6xxx
Consumables (FLUX)	✔	
Units per hour	60	**60**

Figure 2: From system cost and power consumption to footprint and material options, DBL technology offers many advantages over brazing.

The Welding Results

The advantages noted above can be leveraged in many ways across a wide range of materials processing applications. By quickly testing different beam shapes and frequencies to define the optimal process for a high-quality leakproof weld, the DBL platform makes it easy to conduct a multitude of tests in a brief period of time and to quickly see results.



In these materials, DBL technology can achieve stable welding of cooling plate seams at feed rates of 30 m/min. The DBL achieved 30-meter-long weld seams with consistent geometry on each plate.

By changing one condition at a time, the ideal shape, frequency, and feed rate for the strongest weld, with minimal spatter and porosity, can be quickly and easily identified. DBL technology offers various solutions for disparate cooling plate designs made from Al 3003, Al 3103, and Al 5754 alloys.

Figure 3: The DBL achieved a wide weld seam with a penetration depth reaching halfway through the bottom plate.

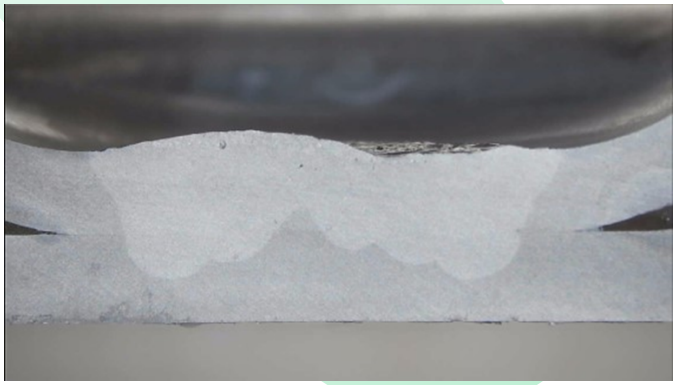


Figure 4: Some designs included large area welds, which caused hot cracks. By using complex beam shapes, DBL technology was able to prevent these defects.

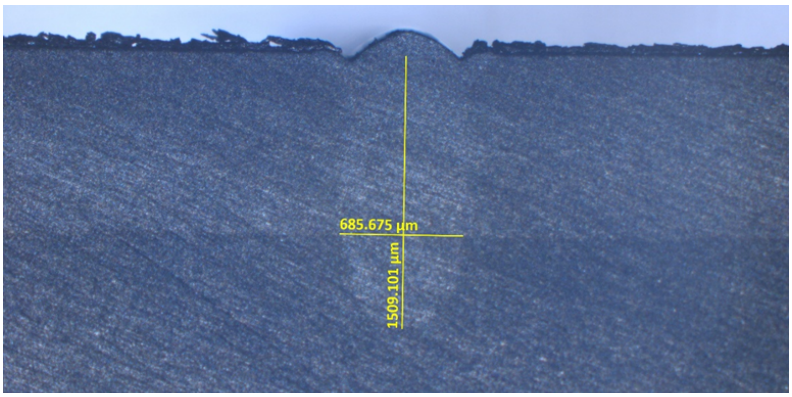


Figure 5: Another design included asymmetrical material, with the top plate measuring 1 millimeter in thickness and the bottom plate measuring 3 millimeters.

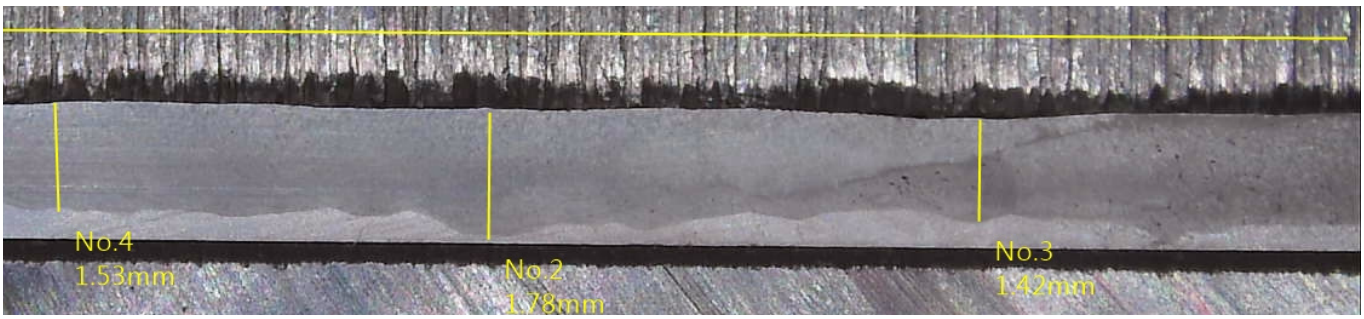
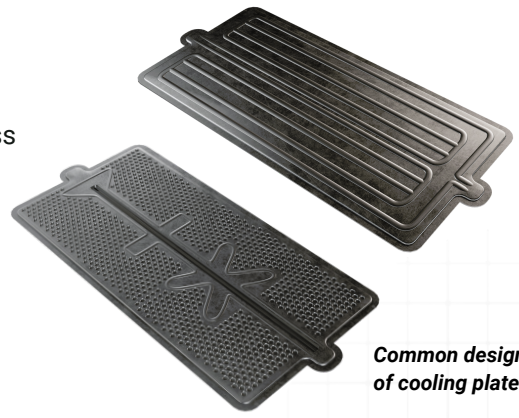


Figure 6: A process was also developed for a cooling plate made of Al 5754 alloy.

Summary.

While the advantages noted above can be leveraged in many ways across a wide range of material processing applications, **testing revealed that cooling plates welded with Dynamic Beam Lasers technology met customer requirements in metallographic, mechanical, and leak tests.** Dynamic Beam Laser technology not only opens new possibilities for laser welding but also allows tier 1 automotive companies to replace inefficient joining methods and to achieve a competitive edge when manufacturing cooling plates with strong, leak-free welds.



Common designs of cooling plates.

About Civan Lasers.

Civan Lasers is a manufacturer of fiber lasers based on coherent beam combining (CBC) technology and has over 75 patents. Civan employs 200 people in Jerusalem, Israel. **Civan's Dynamic Beam-shaping Lasers enable fast, real-time optimization of laser beam shape, focal distance, and power modulation, resulting in high-quality, defect-free welds.** Civan's Dynamic Beam Laser enables significant advances in various laser materials processing applications and the welding of new materials.

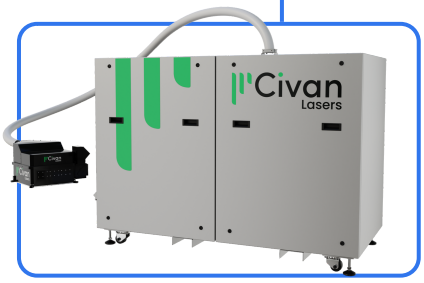
Civan Lasers partnered with leading research centers such as IFSW and Fraunhofer to open beta sites and work with OEMs, machine builders, and systems integrators such as ThyssenKrupp, Siemens, and Bosch to develop solutions for welding, cutting, drilling, additive manufacturing (AM).

Milestones.

2008
Establishment

2012
1kW

2016
5kW



2018
14Kw

2021
100kW

+75 Over 75 patents.

200 Employees worldwide.

50K Sqt. Facility of Labs and Production.

JLM Located at Jerulsaem, Israel.

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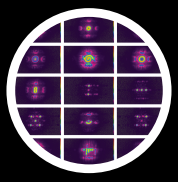
Dynamic Beam Lasers

A Game-Changer in Laser Welding.

The need for new products creates opportunities for new production methods.
Dynamic Beam Lasers aim to address the inflexibilities of existing lasers. By adding new levels of flexibility and control, Dynamic Beam Lasers (DBL) offer the following benefits:

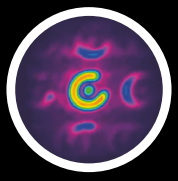


Unlimited Beam Shapes

Instead of just the traditional circle of heat, DBL can be designed in any shape using simple software. Regardless of the size or shape of the area that needs to be heated, the laser can be customized to match. For example, when welding dissimilar metals, DBL would allow for the use of 2 laser spots moving at the same time (like the movement of a kitchen mixer) to provide the homogenous weld needed.

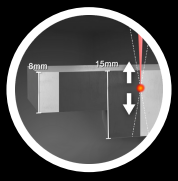
Shape Frequency

Beam shape frequency can be adjusted mid-process from 400 hz to 500 Mhz to offer much better control over the keyhole and melt pool. The speed at which the laser creates the shape determines the characteristics of the weld and a non-optimal frequency can result in spatter. By changing the speed on the fly, the operator can reduce or even eliminate the risk of spatter.



Shape Sequence

The dynamic nature of DBL means that it's possible to design and create a sequence of shapes for the laser beam to follow relative to the feed direction, providing a whole new level of flexibility. For example, instead of using the minimum properties required to suit all of the materials to be welded, it is possible to program the laser to change from one beam shape to another as it moves through layers and the material changes. The process is then optimized at each layer.



Focus Steering

Where standard lasers have a short depth of focus resulting in most of the heat being concentrated on one point, DBL allows for the focal position to be moved at any time during the process, ensuring a more consistent weld.

Introducing this new Dynamic Beam Laser technology into the production of battery cooling plates will be a game-changer, making the process much more efficient and resulting in higher quality products.

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