Precision Power Laser™

LONG-FORM WHITE PAPER

Battery packs, typically housed in aluminum boxes, power modern electric vehicles. These boxes vary in size depending on the vehicle; however, all battery trays require some kind of joining during production. There are several joining processes, but it is critical to protect the battery pack from environmental elements. Welding is the preferred method; however, with conventional welding methods, such as MIG, the amount of welding needed to join the battery tray can require lengthy production times and cause distortion. Distortion can result in parts that are out of tolerance and will not fit either the vehicle or the batteries inside. Because the boxes are made out of aluminum, neither autogenous laser nor friction stir are a fit as there will be concerns of stress concentrations without the addition of a filler material. The ideal solution for welding battery trays is one that can travel fast, have excellent quality, and minimize distortion. That process is known as Precision Power Laser™ from Lincoln Electric Automation™.

Precision Power Laser is a process that can produce TIG welding quality at 3 times MIG welding speed. It produces a weld deposit at high travel speeds with independent control of power inputs of the weld. As a completely non-synergic process, no longer are the limitations of an arc defining factors in weld speed, size, and quality. Travel speeds of over 3m/min are possible, depending on material thickness and laser power being used.

The Precision Power Laser process combines a heated welding wire with a laser beam. Electrical resistance heats the wire, much similar to a hair dryer or space heater. This brings the wire to a plastic state, nominally two-thirds of the melting point, before it enters the molten weld pool. Recent advances in laser technology and power supply electronics, such as Lincoln Electric®'s Power Wave® R450, have improved the capability and performance of traditional Hot Wire Laser systems. With Precision Power Laser, special controls in the power supply monitor the condition of the wire and maintain as much heat into the wire without it going into an arc. Much like a fuse of any sort, if too much current is applied to the wire, it will cause a loss of electrical conductivity, resulting in an arc. If arcing does occur, the event is suppressed and the resistance heating is re-established. Since different materials have different electrical resistance, more or less current will be applied in order to heat the wire. For instance, an aluminum wire has much lower resistance than a steel wire. It will take significantly more energy to heat the aluminum due to it being such a good conductor of electricity. This is why the Lincoln Electric Power Wave R450 with the Precision Power Laser waveform is capable of 500A of current without breaking into an arc.

Precision Power Laser is an extremely flexible process because of the waveform control and gap-bridging capabilities of the large-diameter laser spot size. Most often, Precision Power Laser operates without a keyhole which is an area of specific concern in Hybrid Laser processes. The Precision Power Laser beam size is nominally tailored to the weld size requirement. Beam diameters over 6mm and 8kW of power are often used in a heat conduction mode rather than the traditional keyhole method of laser welding.

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Thanks to diode lasers creating the advantage of a top hat profile, a homogeneous power distribution leads to a smoother welding behavior. Changing the power level on a conduction mode weld allows for increased/decreased penetration levels and travel speed.

Hot Wire Laser processing in its simplest form uses a laser beam of low power density to combine a preheated wire with a work piece into a puddle. The most cost-efficient way to add energy into the process is through resistance heating, which requires that current to be sent through the wire over some distance. Some choose to have the heating done between anode and cathode points above the substrate; Lincoln Electric Automation chooses to use the work piece as one of those points. By doing so, the energy gradient is close to the deposition zone. Inherently, if too much energy is added, the wire will no longer sustain its integrity, resulting in an electrical arc. Arcing is a difficult event to recover from when using a traditional, constant-voltage power source. Outside of Lincoln Electric Automation, the process needs to be run at a level much below the arcing threshold in order to maintain stable heating without breaking into an electrical arc. Lincoln Electric's Power Wave R450 power source with the Precision Power Laser waveform eliminates this arcing concern and provides an extremely stable weld process.

The Precision Power Laser process is applicable to a variety of materials and applications throughout many industries. Adding heat through the filler metal has proven to be a very efficient way of increasing deposition rates and travel speeds while reducing overall heat input. This makes Precision Power Laser a preferred choice over traditional MIG and TIG welding in processes such as cladding, brazing, welding, and additive manufacturing, especially in situations where distortion must be mitigated. Precision Power Laser operates at higher speeds with only as much weld as the part calls for, which results in smaller welds with less heat input and less metallurgical change to the base material. All of these factors significantly reduce distortion. In situations where speed and quality count, such as the modern electric vehicle battery tray, Lincoln Electric Automation's Precision Power Laser is the process to lean on.

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