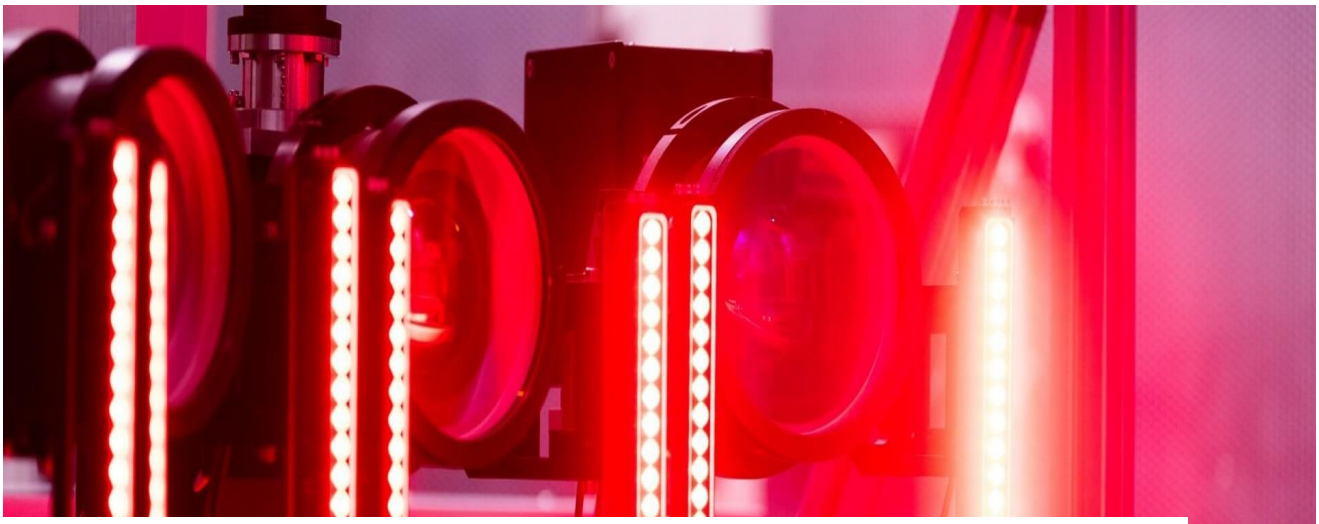


GABRIEL PANKOW

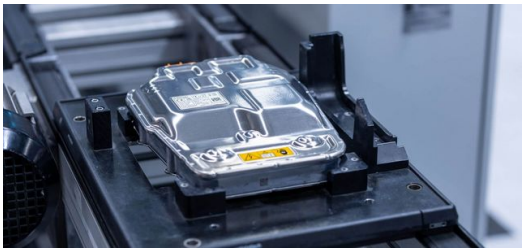
How TRUMPF lasers are heating up the electric car

The heating system in an electric car is a complex feat of engineering and crucial to the vehicle's performance. By using three high-end laser applications, the German automotive supplier Webasto has taken this vital component to a new level.

When you're buying a new electric vehicle, you never give a second thought as to whether the heating works. You take it for granted. The heater in an EV is not only there to provide a warm and cozy interior, or to clear the windows of frost and condensation in the winter. Equally important, it also enhances the efficiency of the battery, which operates best within a certain temperature range.

Unlike an internal combustion engine, an electric motor does not produce any waste heat. An EV therefore requires an auxiliary heating system equipped with sufficient power. This uses electricity from the battery to heat a medium – either conventional coolant or battery oil – and thereby deliver warmth. As with any other EV component, the same golden rule applies to the heating unit: the lighter, the better; the smaller, the better. Leading the way on both these counts is Webasto, the market leader in automotive heating technology.

With its new high-voltage heater, the German manufacturer has now turned the dial a further notch. Designed to function with various EV system voltages and offering continuously adjustable power, this new development also helps stabilize the onboard electrical system. The innovative design and outstanding features are the result of three laser applications.



Laser 1: Gas-tight aluminium welding. Webasto uses a disk laser, which can be operated under atmospheric pressure and without a shielding gas – as quickly and as powerfully as possible, the aim being to create a weld seam free of pores. – FIUMU/TRUMPF

Laser 2: Connecting Copper with a green laser. TRUMPF's green laser has a wavelength that is well absorbed by copper. Using the right pulse sequence, extremely accurate welding depths can be consistently achieved – free of spatter and without the need for a shielding gas. – FIUMU/TRUMPF

Laser 3: Ultraprecise ablation. Rather than attaching separate conductors, Webasto simply etches them directly into a thin layer of metal. The USP lasers from TRUMPF take the material directly from a solid to a gaseous state and make such a flat product design possible. – FIUMU/TRUMPF

Laser 1: Gas-tight aluminium welding

Jörn Schmalenberg is head of production engineering for the manufacture of electric heaters at Webasto's factory in Neubrandenburg. This facility produces 95 percent of the heater components that the company makes for both ICE and electric vehicles: millions of units manufactured with reliable high-performance lasers and then shipped globally. "An EV heater works like any other heater: you warm a liquid via a heat exchanger and then feed it through pipes. Liquids and high voltages don't mix. It's therefore vital to ensure that the housing is as tight as a drum."

For this purpose, Webasto uses a lightweight housing made of die-cast aluminum. One way of creating gas-tight welds with this material is to use conventional electron-beam welding in a high vacuum. This is too expensive, however, as well as far too slow. Instead, the company uses a disk laser, which can be operated under atmospheric pressure and without a shielding gas. Ideally, this must operate as quickly and as powerfully as possible, the aim being to create a weld seam free of pores. If the laser dawdles at low power, this can cause pores to form in the material as it melts, with the result that the housing will not be gas-tight. "By using the 16-kilowatt TruDisk laser, we're going for the sledgehammer effect, so that there isn't any time for gas bubbles to form in the first place."

It is crucial that the laser creates as big a keyhole as possible. "A lot of laser power gives you a stable keyhole. The more you use, the better it is," Schmalenberg explains. Webasto is very happy with the results right now but is also looking at the new Multifocus optics for this application. This splits the laser beam into four individual spots, which form a square in such a way that their effective radii overlap, thereby creating a very large keyhole. The laser power is spread evenly across the entire area of action, so that the keyhole stays open, without collapsing, and there are no pores.

> **When it comes to welding copper, we only use green lasers. Nothing else.**
>
> Jörn Schmalenberg, Webasto

Laser 2: Connecting Copper with a green laser

Once the housing has been gas-tight welded, Webasto then connects up the heating elements. As a good electrical conductor, copper plays a key role here. "The mating parts, along with the copper, are highly reflective, which makes laser welding much more difficult," Schmalenberg explains. Moreover, as with battery cells, the weld seams for the Webasto heating unit must not penetrate too deeply. Otherwise, this could damage the layers below. "We have to be able to precisely regulate the welding depth of the laser. A conventional infrared laser is of no use here."

TRUMPF's green laser has a wavelength that is well absorbed by copper. Using the right pulse sequence, extremely accurate

welding depths can be consistently achieved – free of spatter and without the need for a shielding gas. The TruDisk Pulse does this with a power of four kilowatts and pulse durations in the millisecond range. "We haven't had a single defect in several million components," Schmalenberg says. "That makes everything much more relaxed. We don't use anything else for welding copper now – just a green pulsed laser. Infrared is passé."

Jörn Schmalenberg and colleague Knut Hoffmann can afford to look happy together with TRUMPF: they make the best heating systems for electric vehicles.

Laser 3: Ultraprecise ablation

Once Webasto is satisfied with the copper welds, attention turns to the actual heating elements. This is where the company's very own thin-film technology comes into play. Rather than attaching separate conductors, Webasto simply etches them directly into a thin layer of metal. This makes the heater as flat as possible. "Extreme precision is required when etching the material, so that the laser doesn't go to deep and damage the layers below," says Schmalenberg, who uses a TruMicro ultrashort pulse laser for this purpose. "The aim is clean ablation and precise edges. It's vital to avoid any melting, as this can cause defects. The USP lasers take the material directly from a solid to a gaseous state. Without them, we'd be unable to achieve such a flat product design."

Making the heating unit super flat means it can be installed very close to the components that carry the coolant. "This proximity ensures an extremely fast response time when heating the coolant. What's more, the special design means that heating power can be almost continuously regulated – both at 400 and 800 volts. We were the first to offer this," says Schmalenberg proudly. During voltage peaks, the heater also functions like a small capacitor and therefore helps stabilize the onboard electrical system. Manufacturing in a high-wage country like Germany demands a high degree of automation and innovation.

For a company like Webasto, that means using advanced laser technologies. As Schmalenberg explains, this makes Webasto a preferred partner worldwide: "It's safe to say that not many of the EVs produced around the world roll off the assembly line without featuring first-class electrical components from European manufacturers like us."

About the company Webasto

WEBASTO manufactures and markets a range of components for the automotive industry. The company is a long-established player in this sector and operates from over 50 locations worldwide. With a 70 percent market share in Europe, Webasto is the world market leader for heating systems for ICE vehicles and for innovative roof systems. It has been supplying the e-mobility market with EV heaters, batteries and charging solutions since 2012. To ensure a steady stream of new ideas that swiftly make their way to market, Webasto collaborates on various projects with the Schweißtechnische Lehr- und Versuchsanstalt (SLV) and with Fraunhofer IGP in Rostock.

GABRIEL PANKOW
SPOKESPERSON FOR LASER TECHNOLOGY