Ensuring global productivity

# Laser beam welding with concentric focal points increases productivity

*AWL is always looking for promising innovations so we can realize new options in the field of joining technologies for our customers. One new development in laser beam welding uses concentric focal points. What are the possibilities offered by this new technology, and what can be achieved with it?*

**By Wouter M. Zweers - Technology Manager at AWL-Techniek**

Laser beam welding — especially with disk and fiber lasers — is increasingly being used in series production. The metal process industry and the automotive sector, also motivated by the growing interest in electric vehicles, are implementing ever more laser applications.

Laser beam welding is a familiar technology that offers many advantages, but it naturally also has its limitations. Originally, $CO_2$ lasers were predominantly used in automated welding processes. In recent years, though, these $CO_2$ lasers have been largely replaced by disk and fiber lasers. Not only are these new types of lasers more efficient, they have the additional advantage that the laser bundle can be brought to the workpiece using a fiber-optic cable. This makes the application of industrial welding robots easier than when using a $CO_2$ laser.

## High speed, more spatter

A significant advantage of laser beam welding, compared to conventional welding technologies such as MIG/MAG welding, is the high welding speed and the extremely small heat-affected zone. This means little negative influence of the properties of the base material near the weld occurs. In many applications, the welding speed can increase to 6 meters per minute. That is very fast, compared to conventional welding techniques, where 1 meter per minute is already considered to be a high speed. However, when the welding speed is increased even further — which is possible, thanks to the availability of affordable and extremely powerful lasers — an undesired phenomenon occurs. The welding process becomes unstable and spatter formation increases (see Figure 1).

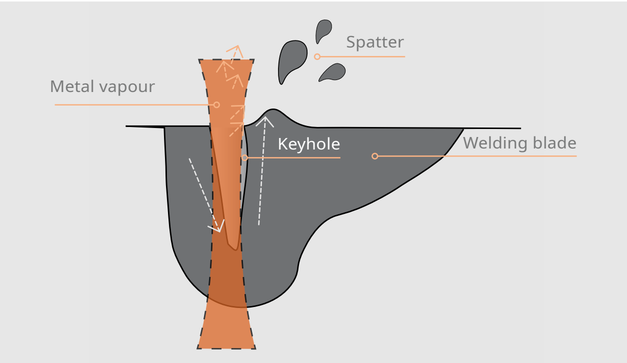


**Figure 1**

Laser welding produces welding spatter at high speeds

Source: Trumpf

This phenomenon leads to two problems. First, the quality of the weld deteriorates due to the loss of material from the weld pool and by the formation of porosities. Second, the machine becomes contaminated very quickly, especially the protective glass on the laser head. This is a simple glass window that is positioned in front of the welding head's expensive focus lens, in order to protect it. The glass forms a mechanical barrier against spatter and must be replaced regularly. The frequency with which it is replaced depends on the spatter behavior of the welding process. The spatter behavior, therefore, has a direct effect on the operational costs of the machine.

***"To understand the spatter behavior, it's useful to study the welding process in detail. When laser beam welding, in the deep welding process, the laser light creates an open tube in the melted material, called the 'keyhole'."***

To understand the spatter behavior, it's useful to study the welding process in detail. When laser beam welding, in the deep welding process, the laser light creates an open tube in the melted material called the 'keyhole' (see Figure 1). High-speed recordings of the welding process show that this keyhole moves in an unstable manner while welding and, at a higher welding speed, the keyhole becomes even more unstable. At a certain speed, this keyhole becomes so unstable that it is temporarily sealed off by the liquid metal. When that occurs, the vapor pressure — which is trying to force its way out of the keyhole — causes spatter formation. This undesired phenomenon limits the maximum welding speed that can be used.

## Move the spatter limit

A recent innovation has ensured that this 'spatter limit' can be shifted. By welding with not one but two concentric focal points, the keyhole remains open and demonstrably less spatter develops, even at higher speeds. To achieve this, a fiber-optic cable with a core is used, around which a second core is formed as a tubular sheath. The laser light in the laser is divided between the interior core and exterior core, which enables the welding head to form two concentric focal points (see Figure 2). The most interior focus provides for deep penetration while welding; the most exterior focus ensures that the keyhole remains undisturbed. Together, these two focal points ensure a calm welding process, using a high welding speed and producing little spatter (see Figure 3).

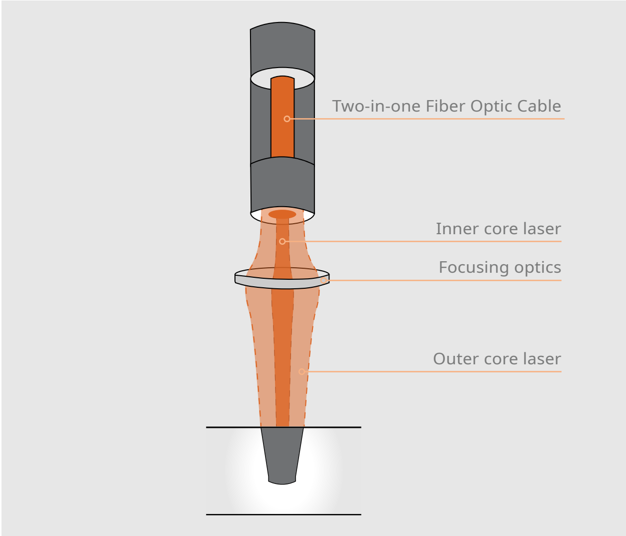


**Figure 2**

Laser welding produces welding spatter at high speeds

Source: Trumpf

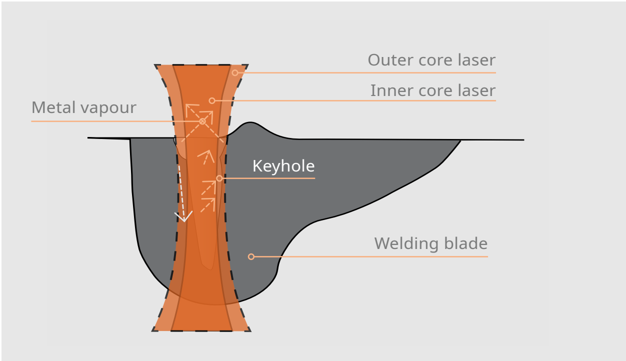


**Figure 3**

Laser welding with concentric focus keeps the keyhole open during welding and prevents weld spatter

Bron: Trumpf

## Also for zinc-coated panels and copper

Besides a higher welding speed, there are also promising results when welding a thin, zinc-coated panel with a lap joint. This technique is often used in the automobile industry. The challenge here is that the zinc layer evaporates while welding steel because the boiling point of zinc is lower than the melting point of steel. Spatter occurs when the zinc vapor that is enclosed between the sheets escapes via the weld pool. This effect is counteracted by the use of laser beam welding with concentric focus because the zinc vapor can then escape in a controlled manner, thanks to the open keyhole.

## Extensive testing

Equipment for concentric laser beam welding has been marketed by various suppliers. In close collaboration with Trumpf Netherlands, AWL has implemented this technology, called BrightLine, in the AWL Experience Center. Here, AWL has the ability to test and research new technologies and to conduct test series for customers. Customers and employees are also trained in the Experience Center, and students work there on their internship or graduation project. In the Center you'll find robots as well as welding equipment, including an 8 kW disk laser, combined with an industrial robot. AWL will extensively test the BrightLine system in the coming months to be able to contribute to the further development of welding techniques.

## Contact

More information about laser welding:
[www.awl.nl/topic/laser-welding/](www.awl.nl/topic/laser-welding/)

Questions about this article? Ask Wouter.

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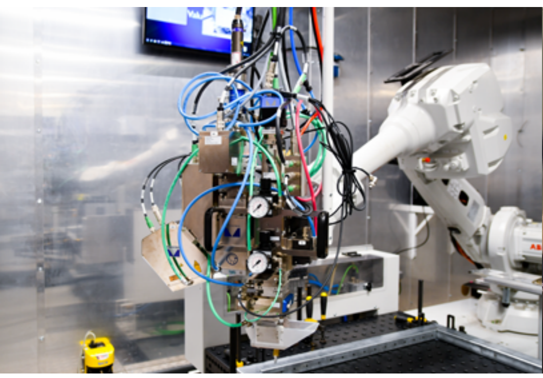

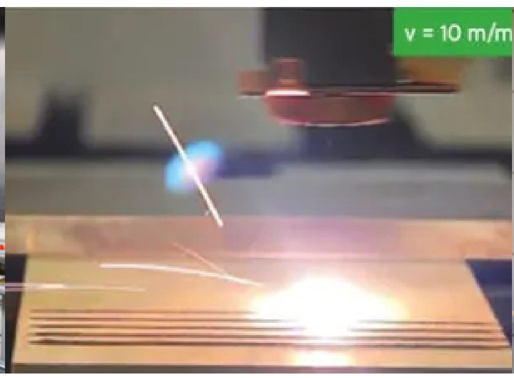

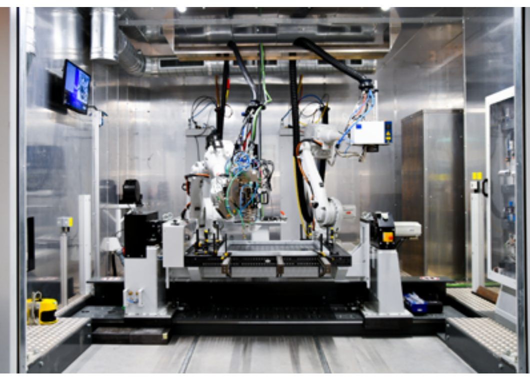

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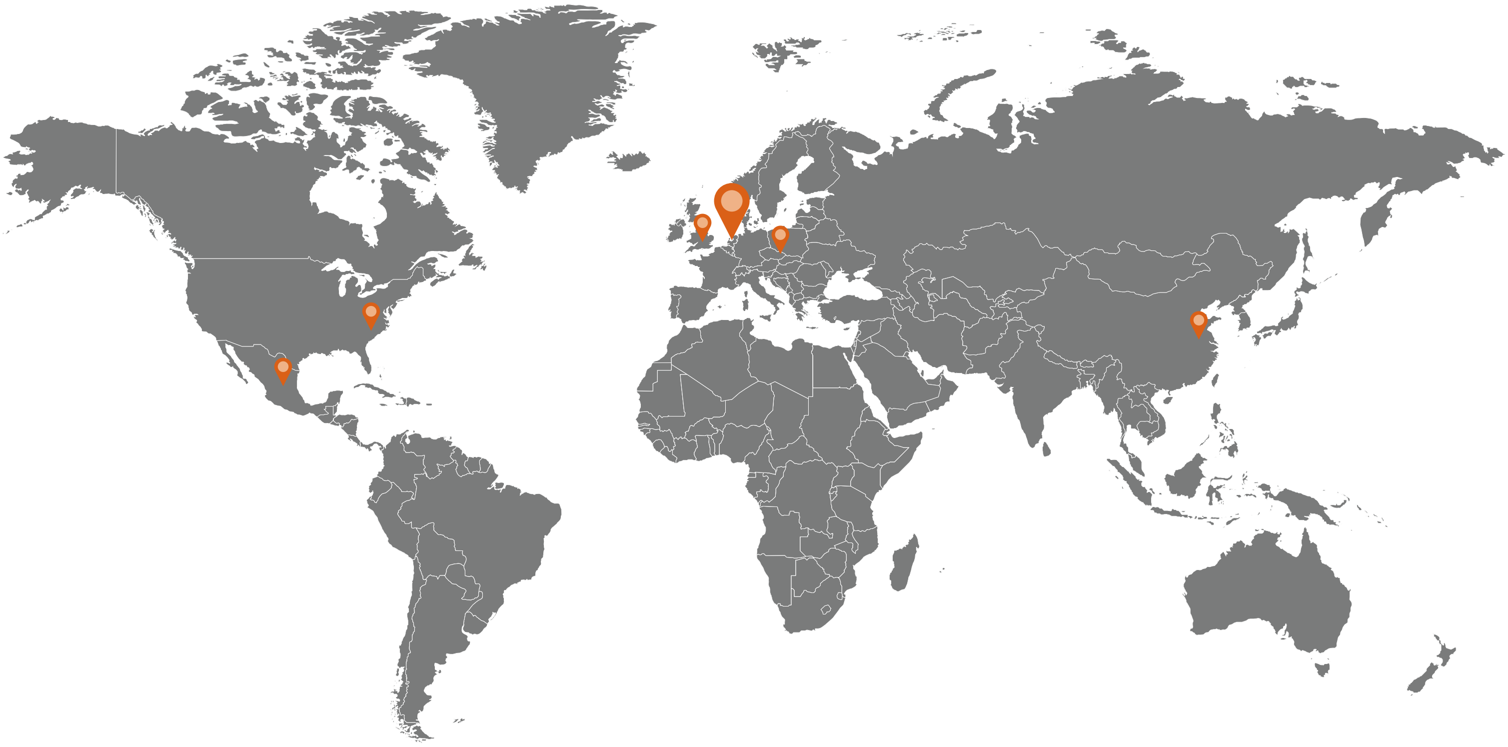


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