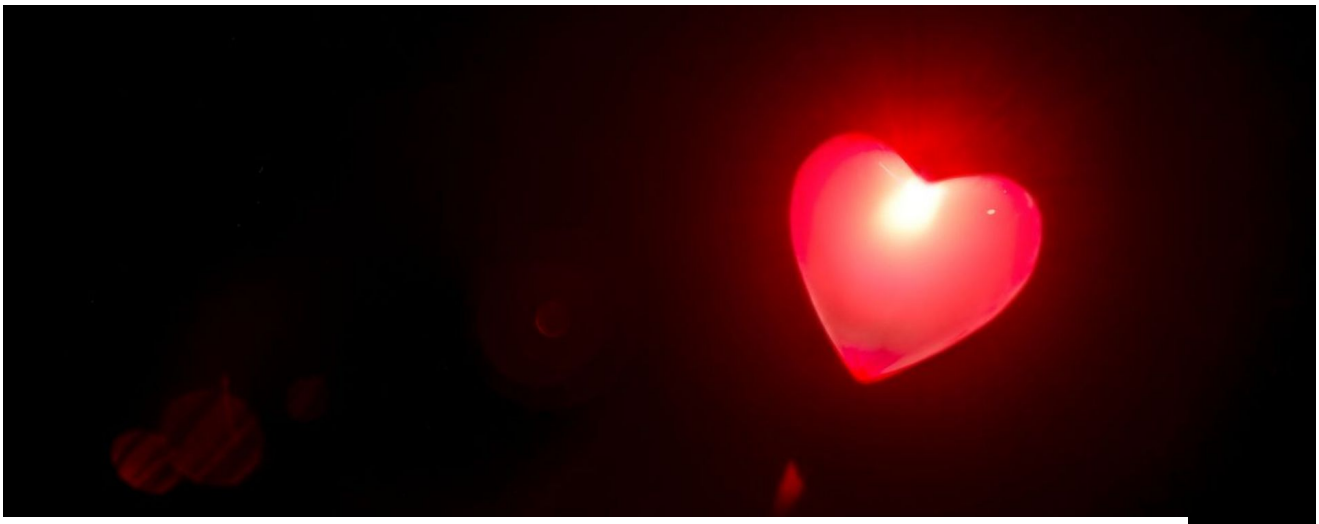

ATHANASSIOS KALIUDIS

Yes, We Are in Love!

Why lasers and induction belong together, like Romeo and Juliet.

Behind the protective doors of the laser welding station, the inductor surrounds the drive shaft without touching it. While power is flowing, nothing is visible to the naked eye. But if Zoran Bubic, responsible for process planning at GKN Driveline, were to touch the spot where tripod and tube will soon be joined by a laser beam, he would burn himself. The metal here – and only here – has reached a temperature
of about 500 degrees Celsius. Mr. Bubic turns away from the manufacturing cell and explains: "The inductor provides a large amount of heat extremely quickly, to a very small volume of steel. The laser then works a welding point that has been perfectly pre-heated, resulting in a highly reliable process."

Many successful welding processes today make use of induction, particularly in applications that call for pre-heating. The laser's minimal heat input has a downside when it comes to deep penetration welding of high-carbon steels. The cold workpiece chills the welding seam, and this can lead to hardening and quality defects such as cracks in the zone affected by the heat. Conventionally, prewarming has meant heating an entire component in a furnace. With the inductor, however, the heat is generated in a matter of seconds, on a very limited space. Moreover, "pre-heating takes place in the welding cell," says Zoran Bubic. "This lets us eliminate the preheating station and avoid handling hot components. What's more, we can save quite a bit of heating energy, not to mention a lot of time.

Precise, fast, and contact-free

Even the most enthusiastic lecture on induction is likely to put a room-full of mechanical engineering students to sleep. Induction sounds a lot like high school physics and it's everywhere — even in an IKEA cooktop. But induction's low-tech nimbus soon dissipates when real know-how is involved. Every induction application is dedicated to a specific workpiece as a balanced system that combines an inductor and a high-frequency generator. Locally, its effect can be precisely controlled, to within one Kelvin. This controllability and the speed at which heat is generated make induction a wonder weapon of sorts. And induction really is easy to handle: induction systems can easily be integrated into manufacturing processes, interlinked automation systems, and production plant concepts.

Inductive hardening of a gear part: Like the laser, induction is extremely local. Good conditions for efficient cooperation in flexible process chains. (Image: TRUMPF)

A coil envelops a fusion crucible. The material to be melted is put into the crucible and heated. Alternating current flowing through the coil, generates an electromagnetic field which transfers the electrical energy to the melting stock in a non-contact manner. (Image: TRUMPF)

Applications range from work at room temperatures to work at several thousand degrees Celsius. As of 200 degrees Celsius, things start to get interesting for metal processing and laser technology. Above this temperature, many non-metallic protective and functional coats evaporate. This means that the same inductor that pre-heats the weld spot can now also clean or decoat this spot — and this spot only. At temperatures exceeding 900 degrees Celsius, workpieces can be hardened or softened locally. When it comes to induction, the possibilities are just about endless.

Pearls on a string

"At first glance, using induction in laser processing isn't always an obvious choice,"says Dr. Torge Behrens, Head of production line Induction at TRUMPF Hüttinger. "But while user-programmable lasers remove the limitations of mechanical processes, the pyrometer-controlled induction systems replace conventional heating systems such as furnaces and put thermal processes exactly where they belong. In power trains, for instance, they are located directly at the welding joint." At the same time, the inductors can be designed to handle a large number number of component variants. As a result, it no longer matters which transmission model is being welded, as Dr. Torge Behrens explains. In the hotforming process sequence, too, induction offers more than one possibility for heating sheets prior to pressing. Locally induced heat can soften specific sections of hardened components.

The automotive industry is now discovering this can be useful, both to make welding joints possible and to actively influence how high-strength body parts deform in the event of a crash. While these parts need to be rigid, the steel must not break if a crash occurs. Energy is dissipated only if the part deforms. For this reason, manufacturers are beginning to soften up the areas that are at risk of breaking in a crash, with the aim of increasing their ductility in defined areas. Once again, this takes place directly in the laser processing cell, where the laser perforates and trims the pressed and hardened component. Once this is done, inductors soften the areas that are to bend in the event of a crash.

Room for two

No contact, no mechanical forces, and limited energy consumption. Its effect can be restricted to a limited area, it can act on a large surface if desired, and its userprogrammable heating parameters provide complete process control. Indeed, the laser has had a sibling for several years now. At first glance, it does not appear as exciting as the sci-fi tool of light. But having a closer look is worthwhile. Induction technology not only shares many of the qualities that make lasers so interesting; it also contributes a wealth of benefits.

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