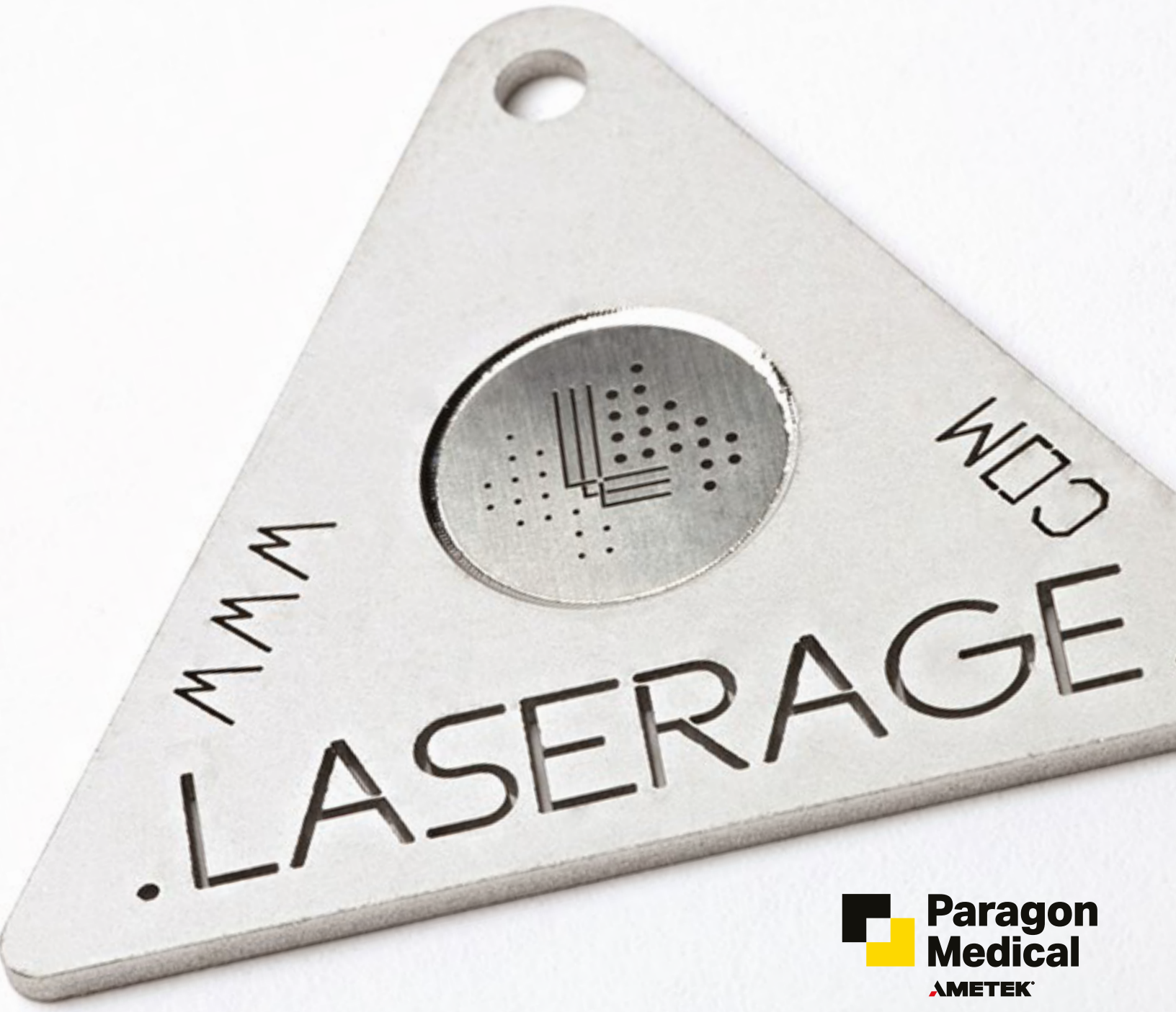
LASERAGE®

A Guide to Laser Welding:
Conventional Welding vs Laser Welding



Paragon Medical
AMETEK

Introduction

Welding is a diverse and varied process.

It is also an important one — welded components can be found in virtually every manufactured good. Almost everything, from electronics and precision watch parts to medical devices to jewelry, requires welding of some sort. Welding is the preferred method for joining or repairing metal in any number of applications.

While traditional welding methods — TIG and MIG welding — are suitable for most standard welding requirements, they do have some drawbacks. In many instances, laser welding is an ideal welding method favored over conventional welding methods.

In this eBook, we will discuss the benefits of laser welding over traditional MIG or TIG welding, but first we'll begin with a little history.

A Brief History of Conventional Welding

Rudimentary forms of welding are evident in historical records dating back to the Bronze Age, as early as roughly 3000 B.C. Some of the earliest examples are small gold boxes with welded seams and Egyptian iron tools made with welding.

During the Middle Ages — from roughly 400 A.D. to roughly 1400 A.D. — blacksmithing became a profession and welding, often hammer welding, was fairly widespread. From then until the early 19th century, when two different Englishmen made important discoveries, welding methods remained much the same.

In about 1806, Sir Humphry Davy invented a tool that could produce an electric arc between two carbon electrodes. In 1836, Edmund Davy (cousin of Humphry) discovered acetylene. These discoveries set the foundation for modern conventional welding methods as we know them — oxyacetylene welding, metal inert gas (MIG) welding, and tungsten inert gas (TIG) welding, sometimes known as gas tungsten arc welding (GTAW), all derived from these first two discoveries.

Most advancements in welding from then until the 1960s are improvements on the base methods; dual shield welding, plasma welding, and innershield welding, among others, are all variations on MIG or TIG welding. The invention of the laser in the '60s, however, led to Bell Telephone Laboratories' invention of laser welding.

Conventional Welding

Conventional welding methods — MIG and TIG welding, as well as their numerous variations — are essentially the same. An electrode material in a welding gun is electrically charged, which allows for the creation of an arc between that electrode and the material being welded. Two primary types of welding variations are:

- **Electrode material** — The primary difference between TIG and MIG welding is the electrode material; MIG welding uses consumable wire of various materials, TIG uses non-consumable tungsten
- **Shielding method** — Gas blankets are the most common shielding method but others — such as flux coated and flux-filled electrodes — are also used

As with any process, these traditional welding methods offer both benefits and limitations.

3021 N Delany Road, Waukegan, IL 60087, USA
Email: sales.laserage@ametek.com

Benefits

Conventional welding has a number of benefits. Aside from a welding gun and power supply, conventional welding requires little in the way of specialized tooling or equipment. Additionally, conventional welding reduces the number of surface areas that a process such as bolting introduces. With traditional welding, the chances of galvanic corrosion on a workpiece are minimized.

To continue the comparison to bolting, traditional welding is used to join materials end to end, lapped, or angled. This creates bonds that are more resistant to fatigue and failure, and generally does not weaken the base material at the joints. Bolting and other manual joining methods do not offer any of these traits.

Limitations

There are many limitations to conventional welding methods, as well.

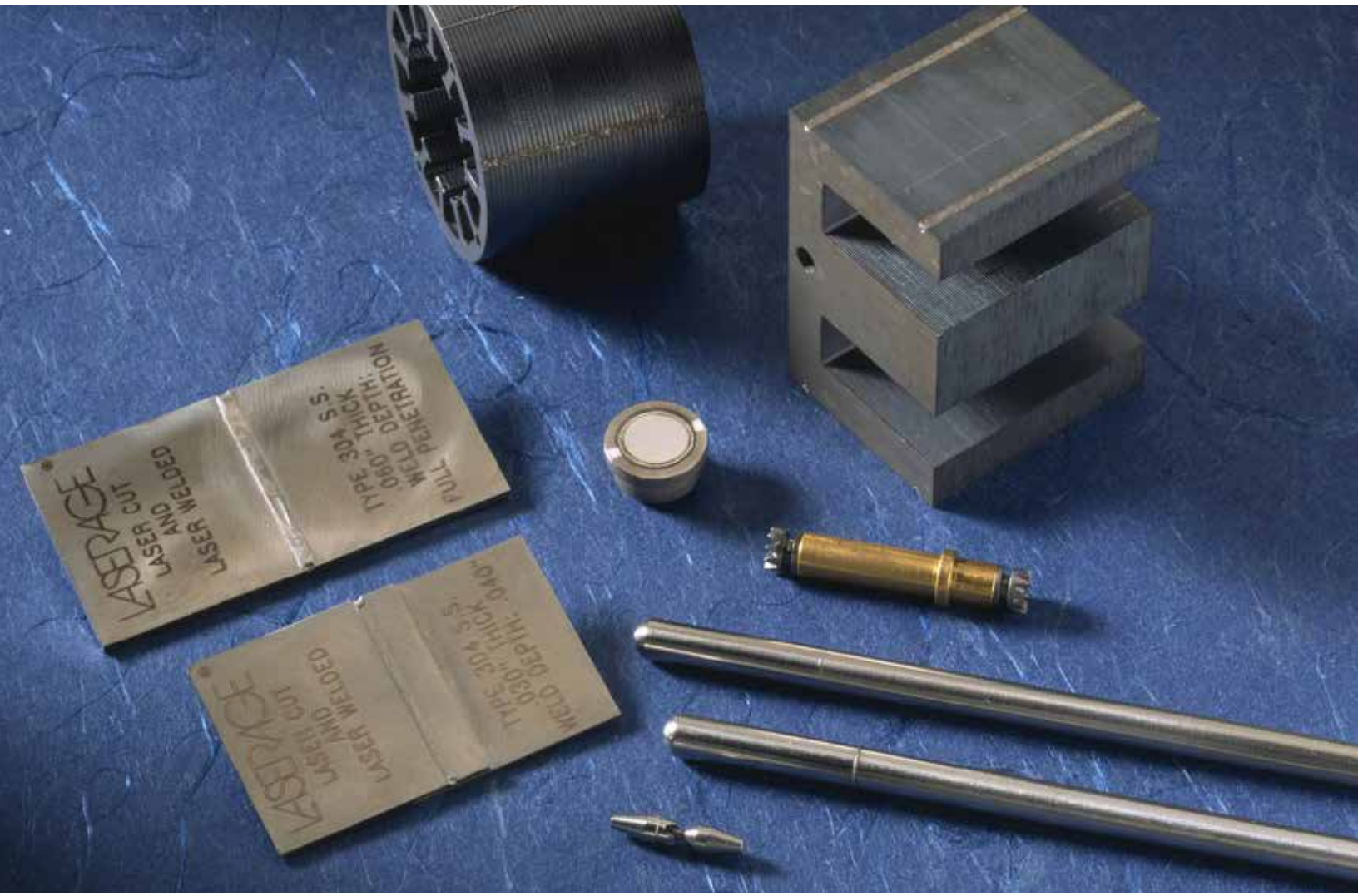
Welding is a process that requires a great degree of skill, not to mention manual dexterity, to perform. Mastery of welding takes years of practice to achieve — one cannot properly learn welding by reading even the most descriptive manual. This can make qualified welders difficult to find and expensive to employ. The skill and finesse that welding requires can also make it a fairly slow process, comparatively.

Conventional welding processes create a level of heat that is high enough to melt the base material but cannot be focused with exacting precision — the area of welded material immediately adjoining the weld itself, called the heat-affected zone, is often also warped by the process. This causes dimensional changes that are often within acceptable tolerances, but not always.

Welding can become difficult or impossible, not to mention dangerous, in conditions that are even mildly wet or windy. While on the topic of danger, it should be noted that conventional welding poses a notable fire risk and that inhalation of the smoke created by the process can be a considerable health hazard.

Finally, while low in number of pieces, the equipment required for welding can be expensive. It can also be unwieldy — power sources, shield gas containers, and electrode wire coils can be difficult to manage.

Laser Welding



At a level of basic functionality, laser welding is not dissimilar from conventional welding. The primary difference — again, speaking functionally — is the heat source: Instead of the arc of a MIG or TIG welder, laser welders use a highly focused laser beam (photons of light) as the heat source.

The three types of lasers most commonly used in laser welding applications are solid-state (nd:YAG) lasers, which use a solid gain medium; gas (CO2) lasers, which use gasses such as carbon dioxide as a gain medium; and fiber lasers, which use rare-earth element-enhanced optical fiber as the gain medium.

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Benefits

One of the major benefits of laser welding is its power — more specifically, its power density. Due to the extremely focused nature of lasers (spot sizes of 0.025mm – 10mm), laser welders can achieve a power density as high as 1 megawatt (MW) per square centimeter.

Because of this high power density, laser welding allows for a number of benefits, including excellent welds, fast heating and cooling rates, and very small heat-affect zones. These factors, in turn, allow for welded components to be handled sooner after welding, expediting the production process, and minimize heat on other components near the weld area.

The high power density of lasers, along with their high focus, also allow them to create welds with better depth-to-width ratios: Laser-made welds penetrate deeper into a material while leaving a smaller surface footprint, ultimately improving the strength of the weld.

Another benefit of laser welding is the innate precision of lasers. Aside from being a factor in power density and depth to width ratio, their precision gives laser welders the ability to perform very small welds with pinpoint accuracy.

A third primary benefit is the ease with which laser welders can be integrated with automation systems. In fact, many laser welders come equipped with CNC controls. The high degree of control offered by automation systems, combined with the high process speed of laser welders, and the strength and precision of the lasers themselves, make laser welding ideal for repetitive, mass production and other high volume applications, such as the medical electrical connector industry. Laser welds are fast, accurate, and highly repeatable.

ADDITIONAL LASER BENEFITS INCLUDE:

- The ability to weld a wide variety of materials, including metals that are traditionally difficult to weld
- The ability to weld dissimilar types of metal together
- A smaller and less common need for filler material
- Lower deformation rates in heat-affected zones due to the tight focus of the lasers
- One-sided welding capabilities due to its excellent depth-to-width ratio
- Its highly controllable nature, which leads to reductions in scrap created during a job
- Excellent aesthetic finishes
- Welding equipment that does not come into contact with the workpiece
- Ease of incorporation with other related processes to streamline production
- Low heat impact on sensitive components

Laser welding and similar laser processing are very powerful and adaptable processes. There are a great number of laser advantages over conventional welding systems. It is not without limitations, however.

The primary limitation of laser welding is its high upfront cost — laser welding systems are not inexpensive. Components being joined must be made precisely to facilitate best welding results. Though used less often, filler material for laser welding applications is also more expensive than for conventional welding processes. The high price tag can often dissuade prospective users from pursuing laser welding as an option before they have a chance to consider full service laser processing companies such as Laserage.

Laser Welding with Laserage

Laserage a brand of AMETEK Paragon Medical offers a suite of high quality, precision laser processing services — scribing, precision tube cutting, drilling and, yes, welding.

In fact, we offer a number of highly specialized laser welding process, such as our Glove Box Welding. Of particular interest to the aerospace & medical industries, Glove Box Welding allows for highly accurate welding within a hermetically sealed space, allowing for contaminant-free components. Additionally, Laserage offers a variety of laser welding capabilities to best match the requirement. CO2, nd:YAG, and fiber lasers are all available for welding application daily. Lasers from 200 – 2,500 watts are at your service and our expert welding engineers are available daily for customer consultations and for assembly application development.

Since our founding in 1979, Laserage has been an industry-leading laser processing services company. With two ISO 13485 and ISO 9001 certified facilities — one in Waukegan, Il and the other in Milpitas, CA — we can guarantee not only excellent results, but expedient ones. We service all your needs from prototype application development to high volume production utilizing fully-automated tooling. Validation services are also available for medical requirement and we offer post-processing value added capabilities.

To learn more about our laser welding capabilities or any of our laser processing services, **contact us today**.

About Laserage

Laserage, a brand of Paragon Medical is widely regarded as the medical industry-leading expert in laser contract manufacturing. Since 1979, we have been leading the way in the field of custom laser processing, providing medical device component fabrication with numerous laser manufacturing capabilities.

Using our own custom designed, state-of-the-art CO2, Nd:YAG, fiber, disk, and Femto laser systems, Laserage can precisely cut, drill, scribe, weld (including hermetic sealing), and heat treat a wide variety of materials to meet any and all specifications. With our two engineering and production locations including Midwest and northern California, we are prepared to serve our customers better than ever.

We take quality very seriously, using the appropriate ISO requirements as the basis for our quality management system in every single aspect of our operations. Laserage's vision is to be recognized as the largest, highest quality, best valued, most responsive full-service laser processing company in the world, for the benefit of our customers, employees, and shareholders.

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E: sales.laserage@ametek.com

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