Making Soldering a Technique of the Past

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Laser welding systems have been actively used in the North American jewelry marketplace since 1992. An alternative to soldering or micro-plasma welding, laser welders have gained industry acceptance for their wide range of uses and ability to produce stronger connections with a high level of accuracy, resulting in a significant savings in time, labor and materials.

Laser is a acronym for "Light Amplification by the Stimulated Emission of Radiation." This technology produces a sharply focused light beam that melts a very small area of metal and can be used to join similar or dissimilar alloys. Although Nd:YAG laser systems have been available to the industrial marketplace for many years, it has only been in the last five to seven years that technological advancements have made them practical for many companies. These technological advancements have increased the output efficiency of today's lasers and decreased the size of the power supply, while significant improvements in the laser's cooling system design have led to a more compact, portable workstation.

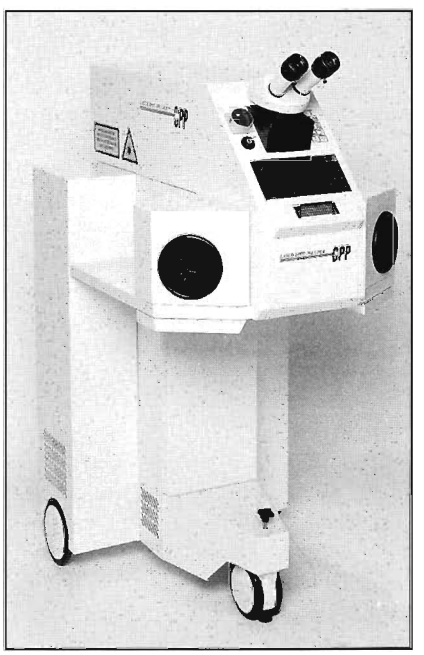
Laser welding differs greatly from traditional electronic resistance welding, which requires electrodes (probes) to make contact with the parts to be welded and passes extremely high electric currents through the alloys to melt and fuse the metal together. The resistance welding process takes time, leaves scars or blemishes at the weld point and requires specially shaped electrodes to weld hard-to-reach areas. In some cases, size and shape limitations prevent resistance welding from being used at all.

Sharp, focused laser light beams allow for rapid melting and cooling of similar or dissimilar alloys. The welding process can be performed extremely quickly (normally in milliseconds) and does not scar or blemish the welding surface, hence eliminating the need for acid baths. In fact, by adjusting the laser's beam diameter, a smooth, near polished finish can be achieved with the laser. Since very little heat is generated at the weld point, users can easily weld .5 to 1.0 mm away from the most complicated and intricate jewelry pieces, and because no electrodes or contact points are required, the laser's light beam offers precise welding of complex and difficult-to-reach jewelry pieces.

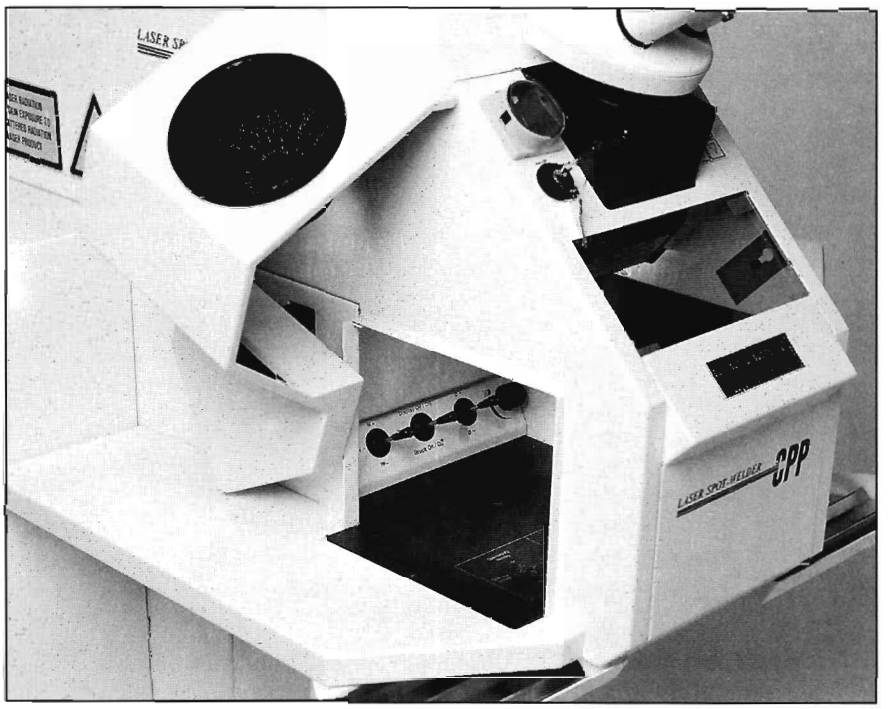
The laser also enables operators to add additional alloy to jewelry pieces where needed. "Filler materials" of similar alloys, such as platinum, can be welded to castings, a technique commonly used to fill porosity holes. Filler materials are also used to increase the support structure of a complex assembly, mount settings to shanks, or resize rings.

The weld resulting from this laser operation is considerably stronger than a solder joint. Laser welded connections are 260% stronger than solder, 43% stronger than micro plasma welds, and 95 % as strong as the original alloy according to a study published in the September 1991 issue of *Quintessence* (research conducted by Heinz van Bethem).

In addition, laser welding leaves no seams or markings after cleaning or finishing processes. Laser welding reconfigure the molecular structure of either similar or dissimilar metals at the point of welding, allowing the two separate alloys to become one. Hence, there are no markings once the pieces have been filed, polished or treated with finishing techniques. Eliminating the solder material from the welding process maintains the integrity of the alloy and provides superior strength characteristics when evaluated under most bend test stress evaluations. (reference the Santa Fe Symposium article on laser welding vs. Soldering)* Also, the cosmetic appearance of the finished jewelry piece is generally superior to soldering. Added benefits include the reduced cost of materials such as expensive solder compounds.



Jewelry manufacturers currently using laser welders are often amazed at the wide range of applications and ability to produce a higher quality product in less time with fewer materials. For example, porosity cavities can be easily identified with the 20x stereo-microscope, cleaned out with the laser beam, and filled with a filler rod of the same alloy within minutes -- and the user never has to remove stones or complex inlay settings. Lasers can also be used to re-tip prong settings, repair bezel settings, resize rings, and repair bracelets without removing stones. Sponge-type porosity, normally identified in the final polishing process, can be filled and repaired by using a laser. And lasers are indispensable in today's popular stone-in-place casting methods, permitting castings to be rapidly assembled and porosity to be filled while posing very little hazard to the stones.



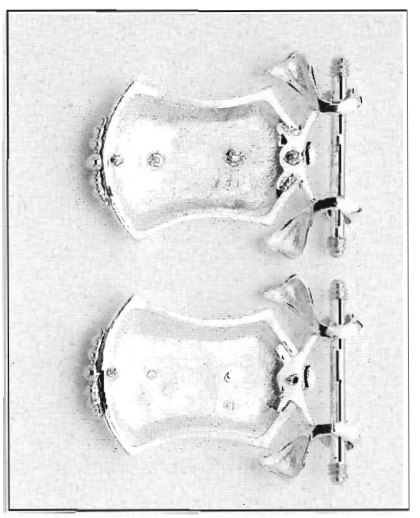
How the Laser System works

One of the key elements in making laser welding applicable to jewelry manufacturing was the development of the "free-moving" concept. In this approach, the laser generates a stationary infra-red light pulse which is targeted through the microscope's cross-hair. The laser pulse can be controlled in size and intensity. Because the heat generated remains localized, operators can handle jewelry items with their fingers, welding small areas with pin-point accuracy without causing any harm to the operator's fingers or hands. This "free-moving" concept enables users to eliminate costly fixturing devises and increase the range of assembly and repair applications.

In laser welding systems, the operator controls the beam diameter (weld spot), power level, and pulse length depending on the type of alloy and joint being welded. A stereo-microscope with internal cross-hairs makes it easy for the operator to align and weld the jewelry piece at the correct location. The laser pulse is then activated with a foot pedal. Most systems also offer the option of a cover gas, normally Argon, to reduce any discoloration, oxidation or contamination.

Most operators can learn to use laser welding machines in a few hours, although to become fully proficient and benefit from the machine's potential, users must have a good understanding of the metallurgical properties of the alloys being welded. An experienced jewelry technician can normally make the transition to manipulating the jewelry item in the laser welding machine within 10 to 15 minutes.

When first starting to work with the laser welders, operators should experiment with five or six different alloys commonly used. It is also recommended to source different types of alloys in casting and strip/stamping form. This gives the operator a better understanding of the composition and thermal conductivity of the metals. Since close attention must be paid to the thickness or thinness,



shape, and fit of the parts to be welded, operators should test-weld some parts together at different settings (voltage, pulse length, beam diameter), then cut a cross section of the piece to check the weld depth. This exercise provides the operator with a "feel" for the different alloys and how they react to various power levels.

Many laser welding systems come equipped with a color video monitor to assist with training and quality control. The monitor enables other supervisors and operators to see what the operator views through the stereo-microscope and gain first-hand knowledge of favorable methods and techniques for proper laser welding.

The monitor also helps individuals understand the manual dexterity requirements for the machine. Traditional soldering methods required goldsmiths to secure the jewelry piece in some form of fixture or clamping devise. The solder torch (heat) was applied at various points around the stationary piece. Thanks to the "free-moving" concept, this process differs somewhat in laser welding systems. Welding is now performed with a stationary laser pulse, which is targeted through a stereo-microscope cross-hair. Operators hold jewelry pieces in their hands and rotate the piece to obtain the correct welding angle. This concept requires good eye-hand coordination while using the 20x microscope.

Laser spot-welders pose little hazard to operator's fingers or hands while in the welding chamber. Occasionally, an operator's fingers may experience a deflected laser pulse, but little damage is done; it is similar to a pin-prick or touching something hot in the kitchen. To ensure the safety of your laser welding system, always ask the manufacturer before you buy if the machine is FDA certified to the safety standards established by the Laser Institute of America. Since most laser spot-welders range in power from 40 to 85 joules of energy, they are normally categorized as a Class 4, the highest powered Nd:YAG laser available. When the welding chamber is fully enclosed the system meets the Class 1 safety standards which is the safest laser to operate.

Into the Future

During the last few years, the price of many laser welding systems has decreased, making them more affordable to jewelry manufacturers, small design studios, repair shops, and retail jewelers. Prices of laser welding systems have stabilized over the last 12 to 18 months, and many lasers are now very competitively priced while offering more features and flexibility for the user. Frequently, those who have purchased the laser systems find that time, labor, and material savings they realized far outweigh the original purchase price. "Laser welders have made our work so much easier that I could not imagine working without one" is a comment often heard from jewelry manufacturers.

When evaluating a laser system's payback timetable, most manufacturers need to consider the following questions:

* How is the laser going to improve production output?
* By what percentage will the laser reduce scrapped parts or salvage bad castings?
* Can the laser allow for more efficient use of labor?
* How often will the laser help repair damaged or defective jewelry pieces?
* How much money can be saved by reducing the amount of purchased solder material?
* Will the laser help in the assembly of complex, difficult to solder jewelry pieces?
* Will the laser provide a competitive advantage over the competition?

These and many more issues are all important considerations when evaluating the capital investment of a laser welding system. Most manufacturers consider lasers a good investment not only for the short term benefits, but also for its future potential. Many jewelry manufacturers like the idea of having state-of-the-art technology in their facilities. Laser welding systems will not only enhance the manufacturer's image in the eyes of their clients, but also provide them with the tools and technology required for the future.

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