

This article serves as just the tip of the iceberg of the enormous possibilities created by the newest micro welding machines. Lower and lower price points are definitely making this technology available to the individual as well as educational programs. It was truly my pleasure to work with Sessin on condensing his research and documentation into a more brief introductory article. I hope that this information sparks as many ideas and new designs as it has for me. – James Thurman, Technical Article Editor

“Micro TIG: Art Welding” by Sessin Durgham

A Pulse Arc Welder for the metalsmith is a scaled down version of an industrial Tungsten Inert Gas (TIG) welder used for high voltage welds on large objects. The inert gas (pure argon) is discharged from the welding stylus and covers the tungsten electrode at the moment of ignition. Argon displaces atmosphere and oxygen and insures smooth strong welds. That same welding technology is now available to the metal artist in micro mode and able to be dialed down to nano settings. The newest machines boast pre-settings for all metals and have highly advanced functions embedded in the software such as pulse modulation, agitation and weld shaping.

The welding stylus is stationary for hands free holding of parts to be welded with little risk of burns or electric shock to the user. A microscope is mounted and focused on the weld zone and at the instant a weld is ignited, the scope shields the user’s eyes from the harmful plasma arc. Adding a good welder and good welding skills to one’s studio does not replace the torch but rather compliments the torch, opening new avenues of design possibilities while streamlining existing processes. I would like to emphasize the phrase ‘welding skills’. Good torch skills come from practice and more patience. It is the same with good welding skills. Welding skills take just as much work and you must now think like a welder. Not unlearning the torch but rather realizing when to weld and when to solder. Alex Horst uses both welder and torch to produce his fine work. He uses spot welds to hold parts in place before coming in with torch and solder.



FIGURE 1: Alex Horst: mokume pendant

Many of the traditional limitations, precautions, remedies and workarounds used for torch soldered items are being washed away by micro welding technologies. Some of these workarounds include: clips, binding wire and fixturing devices such as third hands, soldering clay and pushpins into firebricks. All manner of creative balancing acts devised by the determined smith can be completely eliminated by simply holding and welding parts together with near perfect alignment. If a project is completely welded, the item will have no fire scale, surface scale, no discoloration or loss of surface polish, and can even be welded adjacent to heat sensitive patinas as Jeff Georgantes has done in Figure 2.



FIGURE 2: Jeff Georgantes

Jeff disconnected the welding handle and used it like a pencil. In this case, welding glasses or auto darkening goggles must be used with low power settings and minimal magnification as to reduce the danger of eye damage. Jeff refers to this as 'going rogue'. The new machines all have swing arm options so large items can be placed under articulating swing arms to take advantage of the shielding protection of the microscope.

Color match: Another great advantage to a weld is color match. If welding 18k yellow gold use the same 18k yellow filler material. If the metal is sterling, use sterling filler wire leaving no gray lines of silver solder to disrupt a design. So it is now possible with good welding skills to repair a silver vessel or a repoussé tear with no solder stain. These repairs can now truly be called restorations as the item has been restored to its original glory without using a discoloring solder alloy or foreign filler material.

Enameling: Welded fabrication for the enamelist is a phrase rarely heard for the simple reason that enamelists have not gotten a hold of this technology that I know of. I was unable to get any data or photos at this time. For the most part, enamelists use simple forms such as flat and domed shapes or raised vessels. In some cases, skilled fabricators will use IT solder with some success and much failure as IT solder flows around 1490F and the enamel fuses between 1400-1500F so failures are common. Enamel artists rely on cold connections, bezel setting and many ingenious and creative solutions (too many to count) to execute their creations.

Figure 3 and 4 is a copper vessel substrate that I welded as part of my testing of the two major welding machines. This vessel is completely welded using 'autogenous welds'; entirely welded using shared welds and no filler material flux and of course no solder. Because it is completely welded it is now possible to fire vitreous enamels at 1500F and as many firings as necessary without any joint failure. I must now do some follow up enameling.



FIGURES 3 & 4: Sessin Durgham copper vessel

Chain makers: It is possible to make a whole chain without using one pallion of solder or any filler material. The welded links will suffer no fire scale and will not become annealed. Lindsay Minihan's chain in figure #5 is made of 14 and 16 gauge wire which took two shots per joint to weld. Smaller gauge wires 20 gauge and smaller take one shot to weld. Chain making is a great way to get to know your machine and it's weld capabilities while building welding skills.



FIGURE 5: Lindsay Minihan Argentium silver chain

A properly welded joint will not affect the whole item as happens in torch soldering, but will only affect the joint or molten weld area from .5mm to 1.5mm. This is known as the heat affected zone (HAZ). The item suffers no fire scale or oxide surface and needs no flux or pickle as the welds can be as small as .5mm and extremely hot (7000F) in a short duration of time (6 to 8 milliseconds). The tiny molten puddle cools in milliseconds so the item does not have time to conduct thermal energy away from the weld. Thus no damage done to adjacent metal and other sensitive materials. Argon displaces atmosphere and oxygen to create an oxide-free weld thus no flux is necessary.

Porosity: Yes, welds have a reputation of being porous. This is where good welding skills along with new technology come into play. A very hot molten spot and very fast cool down can create embrittlement and large crystal structure. The new machines have embedded weld modulation, agitation and even weld shaping that will hold the molten puddle or curve the cool down period to create smooth dense welds. A skilled user can create joints that rival the strength and aesthetic of a good solder joint with no unsightly solder to discolor later.

Weld versus Solder: A decision must be made whether to torch solder or weld. For example, if an item is being fabricated and it calls for very long continuous seams, a soldered joint may be your best course of action. In some cases, there is nothing better than the capillary action and liquid flow of a long soldered seam. The welder can aid the long solder seam in this case by replacing clips, binding wire and third hands by merely spot welding the part together before soldering such as Alex Horst employs when making his jewelry (please refer back to Figure 1). If the geometry of the piece allows easy clean up with easy to reach joints, like Lindsay's chain in Figure 5, it may be better to weld. Plus you will have no solder stains to interrupt the silver color of the links. Solder versus weld will become clear to each artist as welding skills develop.

Steel: Of course, steel is no problem to weld and steel is one of the first metals that comes to mind when the word "welding" is spoken. Steel is no problem for Micro TIG machines. Stainless steel may be one of the easiest metals to weld. High carbon steel can also be welded but may become brittle at the weld zone. Filler material can aid in strengthening the weld. Air-cooled tool steel welding rod is a good choice but for non-functional items like jewelry, silver wire can also be used a filler material to bond with steel. The earrings in Figure 6 created by Ji Hwang are welded using steel acupuncture needles. Then steel springs and garnet beads are threaded onto the steel needle and the ends are balled up using several high voltage welds. These welds create some flash so she protects the beads by covering them with paper to catch the flash/sparks during the welding process. None of the garnet beads were harmed. The micro TIG welders can even be used to repair damaged steel tools such as a favorite hammer and I was able to repair a vintage anvil with tool steel welding rod.



FIGURE 6: Ji Hwang acupuncture needle earrings with garnets

Reactive metals: Titanium, niobium, and zirconium are impossible to torch solder. Most of the titanium and niobium jewelry produced has an emphasis on color, texture shape and contrasting metal surfaces. Creative cold connection seems to be the most commonly used technique for joining reactive metals. Their complete inability to be torch soldered is their greatest limitation. Ironically, the reactive family of metals are by far the easiest of all of metals to weld. Smooth shiny porous free welds can be achieved with monotonous regularity with intermediate welding skills. Titanium and niobium can even be welded to bronze and silver after anodizing without losing their color. Pat Pruitt uses reactive metals to create his dramatic look. Figure 7 is a bolo carved of zirconium and welded together.



FIGURE 7: Pat Pruitt zirconium bolo tie

Figure 8 is a vessel by Brian Meek made of glass with forged and shellformed niobium. Brian actually made the components years before and waited for welding technology to catch up to him so he could finish the project. He also used his welder to create the prototype for his titanium birdcage saw frame design for Knew Concepts, making it the most rigid jeweler's saw ever. The possibilities are endless for a metalsmith using reactive metals with a welder.



FIGURE 8: Brian Meek vessel

Learning Curve: You have probably heard the phrase 'welding skills' several times in this article. Getting a good welder does not insure good welds or success. Some small success will be realized right away and more advanced success is possible with practice and due diligence. There are not a lot of hands-on training classes available yet. There are lots of online videos and the manufacturers have very good instructions on their websites. Jeff Herman has some very good technical projects on his website. Metalwerx has a welder and hosted a class that I taught. Rio Grande hosted two classes recently. Dartmouth College has a welder and hosted a one day welding event. University of Kansas in Lawrence has a welder so it is starting to catch on.

It is an exciting time to be a metalsmith as we now have another entirely new way to connect parts. A welder is a worthy investment that removes many of the obstacles that have traditionally hindered artistic production.

Happy welding!

Sessin Durgham is an award-winning designer and recently designed the Founder's Award presented to Eddie Bell at the 25th Anniversary of Santa Fe Symposium as well as the ceremonial mace for Northern Arizona University (his alma mater). He has also won both a Saul Bell Award and Spectrum Award. Currently, he is a member of the Technical Support team and a welding teacher at Rio Grande. Sessin holds a BFA in Jewelry and Metalsmithing and presented a technical paper on pulse arc welding at 2014 Santa Fe Symposium.