



# tips for successful aluminum GTAW

Understanding the metal's unique properties, techniques, and equipment is key

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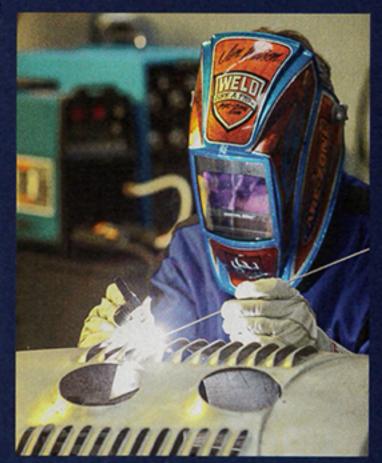
luminum is one of the most abundant elements on earth and one of the most widely used nonferrous metals. Alloyed aluminum is popular in manufacturing industries such as transportation, aerospace, automotive, power transmission, and construction in large part because it is lightweight yet strong, corrosion-resistant, can be machined easily, is a good conductor of electricity, and it has an aesthetically pleasing appearance.

Much like titanium, aluminum has garnered a reputation for being difficult to weld, especially when using gas tungsten arc welding (GTAW). And just like with titanium, all you really need for successful aluminum GTAW is an understanding of the metal's unique properties and the welding preparation techniques and tools you'll need to address those properties.

# 1. Remove the Oxide Layer

A thin layer of oxide coating, also known as a skin, occurs on aluminum naturally and melts at a higher temperature than the metal under it, which makes proper preweld base metal preparation crucial. While your AC GTAW power source does offer cleaning during the electrode-positive weld cycle, you still need to take additional steps to ensure that your metal is as clean as possible and that you've removed as much of the oxide layer as you can before you weld. First, start by wiping your base metal down with a soft, lint-free cloth. Next, attack that oxide layer chemically or mechanically.

Acetone was once the chemical of choice for metal cleaning. It has since been deemed unsafe to breathe even for short periods of time by the U.S. Department of Health's Agency for Toxic Substances and Disease Registry. Other alternatives such as denatured alcohol and heavy-duty degreasers have taken its place. To remove the oxide layer mechanically, use a stainless steel or brass wire brush to scrub the surface of the aluminum. While a stainless steel brush is often recommended, it can cause surface scarring. A brass brush cleans just as well and has softer bristles, which help minimize surface scarring.



### FIGURE 1

Before welding, he sure to remove the layer of oxide from your hase material. This can be done either chemically or mechanically. Remember, it is just as important to clean your filler rod as it is to clean your hase material.

Whichever brush you use, be sure to use it for your aluminum work only. Also, store your aluminum-only brushes separately to ensure you're not introducing contaminants into your weld.

Don't forget to clean your filler rod as well. If you don't take the time to prepare your base metal and filler rod, you'll find discoloration along the outside or within the puddle itself. The weld may look smoky or have a black residue, and the weld bead won't have that aesthetically pleasing, shiny appearance normally associated with aluminum (see Figure 1).



## FIGURE 2

The tools shown, which include a dedicated tungsten grinder, stainless steel and brass brushes, replacement torch parts, and other hand tools, are crucial in any successful aluminum GTAW process.



### FIGURE 3

A properly prepared tungsten electrode makes for a happy aluminum GTAW process. Be sure to grind to a 45-degree angle with a 0.010- to 0.015-in. land, or flat tip, on the end.

# 2. Choose the Right Shielding Gas, Blend

You probably already know that argon is the gas of choice for most GTAW applications, but did you know that helium used to hold that position? In fact, that's why GTAW was at one time referred to as heliarc welding.

Helium provides you with a hotter arc that ionizes at a higher temperature; in other words, more power for your amperage setting and better control. But over the last several years, improvements in welding power source technology and performance, not to mention GTAW torches and flowmeters, have made welding with pure argon possible.

For thick aluminum applications in which you need an intense amount of heat but are limited by your torch's amperage range, an argon/helium blend is the best option. Combining argon and helium can help you achieve your desired penetration, stabilize your arc, and increase your arc voltage range. Premixed cylinders of 75 percent argon/25 percent helium are available, but one drawback is that the gas inside the cylinder stratifies, minimizing the benefits of helium. A gas mixer can fix this by giving you the ability to customize the mix for your welding application, maintain the blend at your torch, and provide a consistent flow rate.

# 3. Learn the Truth About Tungsten

At one time pure tungsten (AWS classification EWP, color code green) and thoriated tungsten (EWTh-2, color code red) were the preferred choices for aluminum GTAW. That is no longer the case, especially because of thorium's radioactive properties. Today rare-earth tungsten (EWG, color code sky blue) is an excellent choice for welding aluminum or any other metal. The tungsten provides good arc starting at low amperage and burnoff rates. A low burnoff rate means the tip geometry lasts longer and the tungsten won't melt as easily,

thereby minimizing contamination of the weld zone. Highly specialized welding applications may call for zirconiated tungsten (EWZr-1, color code brown), but it is expensive and not necessary unless specified in the procedure.

Whichever tungsten you select, be sure to buy from a trusted supplier. Manufacturing techniques can affect everything from the alloy blending process to the extrusion of the electrodes. Poor manufacturing quality may manifest itself as varying diameter; bent electrodes (especially in the smaller diameters); inconsistent finish; and flaking paint, which can contaminate your weld and ultimately render the tungsten electrode color-coding system useless.

To prepare your tungsten properly, use a grinder dedicated to tungsten with a diamond wheel for a consistent taper and a consistent finish on your electrode. You'll want to prepare a 45-degree angle with a 0.010- to 0.015-in. land, or flat tip, on the end. If you don't knock off that sharp point, that tip can easily burn off and drop into your weld (see Figures 2 and 3).

# 4. Select AC

Be sure to select AC for aluminum GTAW to take advantage of the cleaning property of the power source to remove that oxide layer. DC doesn't offer the cleaning properties necessary to break through that oxide layer.

Newer welding machines with AC balance controls allow you to fine-tune the current depending on the thickness of the material, weld penetration, and desired cleaning area, which will affect the bead profile and the appearance of the weld itself.

# 5. Invest in a High-quality Torch

With AC, not only is energy in the form of heat directed from the torch to the workpiece, it also returns to the torch. The thicker the material or the longer the bead, the more energy is returned and the hotter the torch is going to get.

An air-cooled torch works just fine on thin sheet and for short runs. A water-cooled GTAW torch operates cooler in your hand even if you are running upwards of 500 amps, depending on the torch. In other words, you won't have to keep putting your torch down.

For the front end of your torch, a gas lens collet body with a No. 8 ½-in. gas lens nozzle is a good setup for most aluminum welding applications. The gas lens provides improved gas coverage, improved torch cooling because of the additional material (better heat transfer) in the gas lens collet body, and increased gas flow over the components (more surface area to dissipate the heat). As a bonus, the improved heat transfer con-

tributes to longer electrode life.

Be sure you invest in a quality GTAW torch. From the copper alloy to the type of Teflon<sup>®</sup> used to make the gaskets and the silicon rubber used for the torch body, the quality of those materials affects the torch's ability to handle heat and the lifespan of the torch itself. In addition to material quality, the manufacturing process is also important. Look for a torch manufactured with a high-temperature silver brazing process rather than soldered. Also check that the torch adheres to industry standards for fittings.

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