



# The GTAW top 10

How to identify and remedy common GTAW mistakes

By Brad Hemmert

**G**as tungsten arc welding (GTAW) often is specified to meet strict aesthetic, structural, or code/standard requirements. The process is complex, and it is undisputedly the most difficult of all the welding processes to learn. The appearance of a GTAW bead can tell you a lot

about what you're doing right and what you're doing wrong. By learning to identify the common GTAW mistakes based on what you see, you can help prevent these errors from happening in the future.

### Mistake 1: Poor Gas Coverage

Contamination may be caused by lack of shielding gas, which can happen when the shielding gas is not turned on; if there is either too little or too much gas shielding; or if the gas shielding is blown away (see **Figure 1**).

To troubleshoot gas contamination problems, first check the gas cylinder label to be sure you're using the right type of gas for GTAW—generally 100 percent argon (or perhaps an argon/helium blend for thick aluminum). Attempting to weld with an argon/carbon dioxide mix (used for gas metal arc welding) will cause immediate contamination.

Next, set the proper gas flow rate, which should be 15 to 20 cubic feet per hour (CFH). Welders commonly—and incorrectly—assume that a higher gas flow/pressure provides greater protection. In fact, excessive gas flow creates turbulence and swirling currents that pull in unwanted airborne contaminants, which can lead to arc wandering. Generally, err on the lower side of the recommended shielding gas rate to ensure proper shielding coverage without turbulence.

Third, check all the fittings and hoses for leaks. Any breach may pull air into the shielding gas stream, which can contaminate the weld (and you'll waste money if gas escapes). Rub soapy water over the hose and all fittings. If bubbles form, you have a leak and need to replace the defective components.

Finally, assuming you have a full cylinder, the right type of gas, and no leaks, consider that you may have a tank contaminated with moisture. Shielding gas cylinder contamination does not happen frequently, but it is possible. Contact your gas supplier for guidance in resolving this issue.

### Mistake 2: Welding Aluminum in the Wrong Polarity

The GTAW in **Figure 2** was created with the machine's polarity set on direct current electrode negative (DCEN). As you can see, the weld did not break through the aluminum oxide layer. This created a weld with the filler metal mixed in with the partially melted oxide to create the contaminated bead seen here. To defeat this, always weld with the polarity set to alternating current (AC).

GTAW in AC allows the electrode positive (EP) portion of the cycle to blast away the aluminum oxide while the electrode negative (EN) portion melts the base metal (see **Figure 3**). A feature called AC balance control allows you to tailor the EP-to-EN



**FIGURE 1**

*This GTAW is the result of poor gas coverage, which can be caused by a number of factors.*



**FIGURE 2**

*Always weld with the polarity set to alternating current.*

ratio. If you notice a brownish oxidation or flakes that look like black pepper in your weld puddle, simply increase the cleaning action. However, note that too much EP causes the tungsten to ball excessively and provides too much etching.

Last, do not start welding until the puddle has the appearance of a shiny dot. This indicates that the oxide has been removed and it is safe to add filler and move forward. Adding filler to the weld zone before the oxide layer is adequately removed will result in contamination.

### Mistake 3: Weld Graininess

A GTAW bead with a grainy appearance typically is caused by filler metal problems (see **Figure 4**). For instance, a 4043

aluminum filler rod from one manufacturer may have different properties than a 4043 rod from another manufacturer. You may need to adjust filler brand accordingly if the application permits. The rod may also be defective (too much of a certain ingredient). You may even have the wrong type of filler rod, such as 4043 instead of 5356.

Before welding, always check the filler metal type and remove all grease, oil, and moisture from the surface to prevent contamination.

### Mistake 4: Lack of Fusion in the Root

Lack of fusion at the root of a T-joint or a fillet weld can be caused by a number of factors: improper fit-up, holding the torch

too far away from the joint (increasing arc length), or improperly feeding the filler rod. This problem is more prevalent with a transformer-based machine, as the arc tends to wander between the two sides of the joint as it seeks the path of least resistance. In this case, reducing arc length will provide better directional control and help increase penetration. It is also important not to underfill the joint or weld too quickly.

Note that inverter-based machines (especially those with advanced output controls such as adjustable frequency and pulsing) offer more control over the arc. These controls create a narrower, more focused arc cone that provides better directional control over the weld puddle and deeper penetration, and often at increased travel speeds.



**FIGURE 3**

*Using alternating current produces an ideal GTAW.*



**FIGURE 4**

*The grainy appearance of this GTAW bead was probably caused by a problem with the filler metal.*



**FIGURE 5**

*To eliminate craters, continue to feed the filler rod and slowly reduce the current at the end of the weld.*



**FIGURE 6**

*When you don't clean the mill scale off of hot-rolled mild steel, this is typically the end result.*

**Mistake 5: Craters**

Craters, such as the one shown in **Figure 5**, typically occur at the end of the weld and often lead to cracking. Causes include instantly reducing the welding power, which causes the puddle to cool too quickly, and removing the filler rod too quickly at the end of the weld. You can fix crater cracking issues easily by continuing to feed filler rod while slowly reducing current at the end of a weld. Note that some GTAW power sources feature a crater control function that automatically reduces the current at the end of a weld.

**Mistake 6: Dirty Base or Filler Metal**

On the first day of welding school, your instructor should have taught you to clean materials prior to welding (see **Figure 6**). All base and filler metals need to be cleaned, whether it's mill scale, oxide on aluminum, or dirt and grease on filler metals. Grind, brush, and wipe away all potential contaminants. For cleaning aluminum, dedicate a stainless steel brush to the task to prevent contamination from other metals (see **Figure 7**).

**Mistake 7: Poor Color on Stainless**

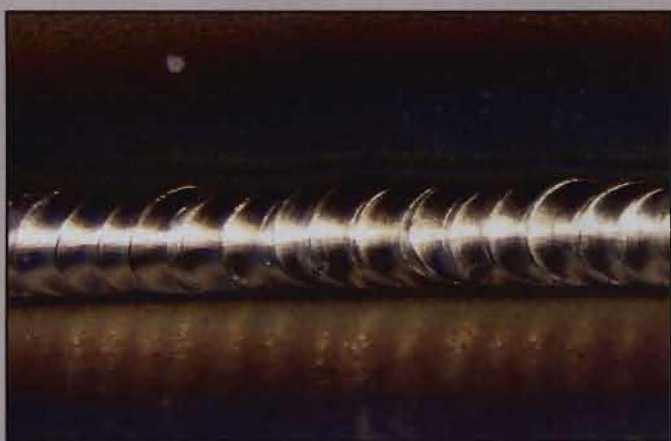
Discoloration on a stainless steel weld is caused by overheating, which not only affects a material's color, but degrades its corrosion resistance and mechanical properties as well (see **Figure 8**). Unfortunately, once this error is made, there is nothing that can be done to fix it except for scraping the part and starting over. To prevent overheating, reduce amperage, slightly increase travel speed, or shorten the arc length (see **Figure 9**). If your welding

**FIGURE 7**

*Properly cleaned mild steel yields a bead that resembles a stack of dimes.*

**FIGURE 8**

*The discoloration in this stainless steel weld is caused by overheating, which weakens corrosion resistance and mechanical properties.*

**FIGURE 9**

*Reducing amperage and increasing travel speed will help avoid overheating and produce good weld color on stainless.*

**FIGURE 10**

*To prevent sugaring, backpurge the weld with argon shielding gas or reduce the welding amperage.*



**FIGURE 11**

*If the amperage is set too high with aluminum, the result is an ill-defined bead, which could lead to burn-through.*



**FIGURE 12**

*A discoloration within the bead is a result of an increased arc length. Practice holding a consistent arc length to improve heat input control.*

equipment features pulsing capabilities, now is the time to learn how to use them. Pulsing reduces heat input, and it offers excellent control of the weld puddle.

### **Mistake 8: Sugaring on Stainless**

**Figure 10** shows sugaring on the back side of a stainless steel weld. Sugaring (oxidation) occurs around the weld when it is exposed to oxygen in the air. The best way to prevent sugaring is to backpurge the weld with argon shielding gas or reduce welding amperage.

### **Mistake 9: Too Much Amperage on Aluminum**

Setting the amperage too high when performing aluminum GTAW creates a wider profile, an ill-defined bead, and can potentially lead to burn-through (see **Figure 11**). To solve this problem, reduce amperage and increase travel speed.

### **Mistake 10: Improper Arc Length Control**

The color change in the middle of the aluminum weld bead in **Figure 12** resulted from an increase in arc length (arc length, the distance between the electrode and the base metal, determines GTAW voltage). Holding an arc that is too long increases overall heat input, increases the potential for

distortion, widens the weld bead while decreasing penetration, and affects weld bead appearance. Practice holding a consistent arc length to improve heat input control and improve weld bead quality. ■

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