

## Aluminum Filler Metals: Selection, Characteristics & More

From its strength and versatility to its corrosion resistance, the benefits of aluminum are appealing for a variety of industries. Welding the material, however, is not without its challenges. Because of its low melting temperature and high thermal conductivity, you must take extra care to prevent burn-through on thinner material and to ensure adequate fusion or penetration on thicker material. Using the appropriate equipment—machines that offer pulsed MIG capabilities or TIG capabilities—is important. So is selecting the right filler metal and understanding the weld characteristics each type provides.

There are many aluminum filler metals available in the marketplace, including those for applications found in aerospace or architectural structures to filler metals for heat exchangers, trailer fabrication and more. The filler metals range from pure aluminum to varieties with added copper, silicon or magnesium.

Among the variety of aluminum filler metals, 4043 and 5356 alloys are the most common and the least expensive. Together, those filler metals are used for welding about 80 percent of the time and are available in wires for MIG welding or cut-lengths (often called filler rods or straight lengths) for TIG welding. You should know how to choose between the two alloys, as well as the characteristics each provide to produce good weld quality.

### Aluminum filler metal characteristics

As with any filler metal, 4043 and 5356 aluminum alloys each have unique characteristics. 4043 filler metals tend to have a more fluid weld pool due to the addition of silicon (5 percent), which allows the bead to “wet out” or flow into the base metal more easily. This characteristic produces a more aesthetically pleasing weld, requires less cleanup, reduces leaks and minimizes cracking.

5356 filler metals contain 5 percent magnesium. As with the silicon in a 4043 product, the addition of this alloying element affects the performance of the filler metal. In this case, the magnesium increases the strength without negatively impacting the toughness of the weld. When welding with 5356 aluminum filler metals, the resulting weld tends to be rippled rather than smooth. Due to the 5 percent magnesium, more smut (black soot) could be present at the edges of the weld that you will need to clean.

Both 4043 and 5356 filler metals operate with 100 percent argon shielding gas because it provides good arc initiation and stability. Thicker aluminum applications sometimes require helium, which improves heat transfer to the base metal and helps increase weld penetration. Helium can be expensive, though, and the application often sacrifices arc stability when it is added.

### **How to make the selection**

When you select aluminum filler metals, the goal is to choose an alloy that produces a weld that best meets the requirements of the product and its intended use. Sometimes you may want the strongest weld—other times, you may consider leak resistance, ductility, corrosion resistance or toughness to be more important.

**When you choose between the common 4043 and 5356 aluminum filler metals, there are five important questions to ask:**

1. Will the welded component be exposed to sustained elevated temperature?
2. What is the aluminum base designation?
3. Will the weldment be subjected to post-weld anodizing?
4. Are shear strength, ductility and toughness prime considerations?
5. Will post-weld heat treatment be performed?

**Providing the base metal is compatible, a 4043 aluminum filler metal will be best for the following:**

- Applications that will be subject to long-term elevated temperature exposure (above 150 degrees Fahrenheit).
  - Any application where it is necessary to reduce the risk of termination and shrinkage cracking.
  - Instances where aesthetics are particularly important, since these filler metals provide bright, clean welds.
  - Situations where distortion is of particular concern, as it minimizes this defect.
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**A 5356 aluminum filler metal would be most appropriate for:**

- Welding on 5XXX or 6XXX series of aluminum when tensile strength is most important.
- Achieving good anodized color matching on 5XXX and 6XXX base metals.
- Applications requiring higher ductility and toughness (such as those subject to dynamic loading).
- Applications requiring higher shear strength.

When welding 6XXX series aluminum or 5XXX series aluminum containing less than 3 percent magnesium, you can use either a 4043 or a 5356 filler metal to complete the job. The same holds true for higher shear strength applications; however, it typically takes three fillet passes with a 4043 product to equal the shear strength of one pass using a 5356 filler metal.

**Proper storage and handling**

It is important that you properly store and handle aluminum filler metals. It helps ensure the highest quality welds. Keep the filler metals in a clean, dry area that is of a similar ambient temperature as the weld cell. If you move them from a cold area to a warmer area, it could cause condensation to form on the surface of filler metals and lead to poor weld quality.

If you aren't going to use a spool of wire for a while, cover the spool with the plastic bag the wire shipped in or with another protective cover. Store TIG cut-lengths in their original box to protect against dirt and debris.

**Getting the best results**

In any welding application, your goal is to complete the job with high quality and efficient results. Speed and weld integrity are just as important when you weld aluminum as any other material. Know the basic filler metal characteristics and selection criteria for aluminum to get the best welding performance. Practicing welding this material — especially for welding operators new to the material — is also a good idea. Consider welding scrap materials as a starting point to get a firsthand experience of the different operating characteristics of aluminum filler metals. If you need more information about welding aluminum, look for resources with a local welding distributor or filler metal manufacturer. They often have technical support specialists to offer advice.

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### Additional information: equipment considerations

In addition to proper selection, storage and handling with 4043 and 5356 filler metals—or any aluminum filler metals for that matter—you should have the right welding equipment for the job. This equipment includes:

- *A spool gun or push-pull gun for the MIG welding process.* These guns provide consistent feeding of the aluminum filler metals, minimize wire feeding issues and allow for welding further distances from the wire feeder (often as far as 30 feet away).
- *U-groove drive rolls.* These drive rolls prevent the wire from being pinched or compressed, and they help ensure proper wire feeding.
- *Nylon inlet guides and liners.* Unlike metal components, nylon components won't "shave" the wire as it feeds through from the wire feeder to the contact tip, lessening the opportunity for buildup of debris inside the liner.
- *Contact tips for aluminum wire.* Consumables for aluminum wires typically have an "A" (for aluminum) stamped on them and are sized accordingly for these type of wires. For example, 4043 and 5356 wires are available in 0.047-inch (3/64-inch) diameters (as opposed to the standard 0.045-inch diameter of steel wires), so the corresponding bore on the contact tip for these wires is slightly oversized, allowing for smooth wire feeding and good arc stability.

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