ANVILOY® WELD ROD

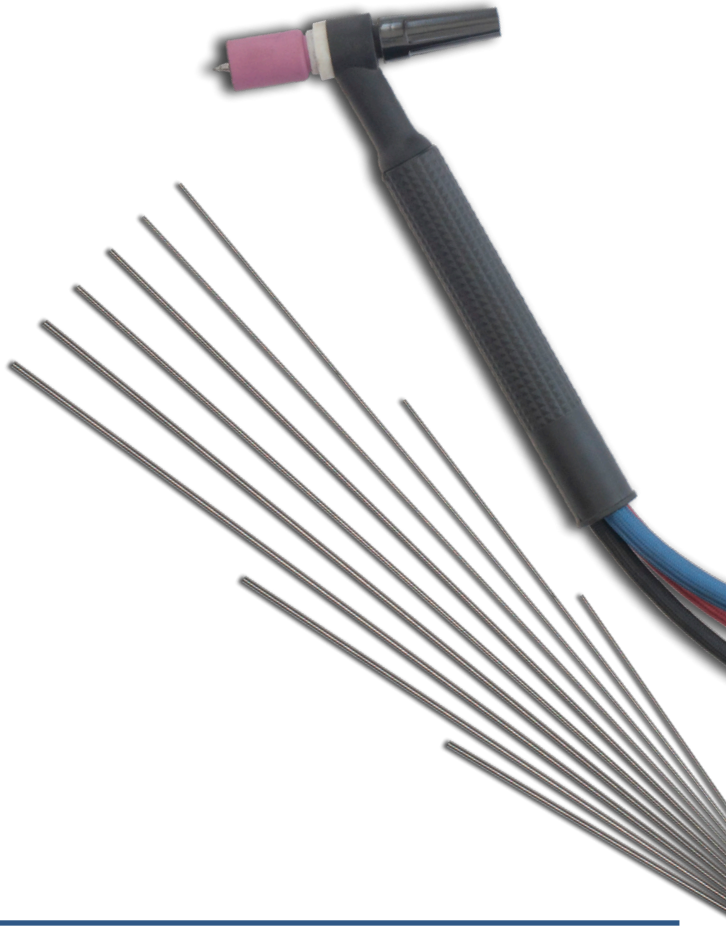
WELDSTONE
COMPONENTS GROUP

Application Instructions

PROCESS RECOMMENDATIONS FOR COATING AND JOINT WELDING WITH ANVILOY® WELD ROD

1. ANVILOY® Products

ANVILOY® is the internationally protected brand name of a product group based on tungsten heavy alloys. These are available in various compositions such as ANVILOY® 1050, 1150, 1350 and 1450. These are adapted to the respective application area. They are available as semi-finished products and finished products. ANVILOY® WELD ROD welding filler metals are usually available from stock as rods or wires in different diameters and lengths.



1.1 Applications for ANVILOY® Products

In the foundry and die casting industries, ANVILOY® solid material solutions primarily include wear protection and improvement of cooling performance. For this purpose, individual ANVILOY® tungsten heavy alloy components and inserts are inserted into the mold, screwed, welded or shrunk in to optimize the performance of the mold.

ANVILOY® WELD ROD, on the other hand, is a welding filler metal which is used for repair and wear protection coating of casting molds made from hot-working tool steel. In a TIG-welding process ANVILOY® WELD ROD is melted in an arc and applied to the steel mold.

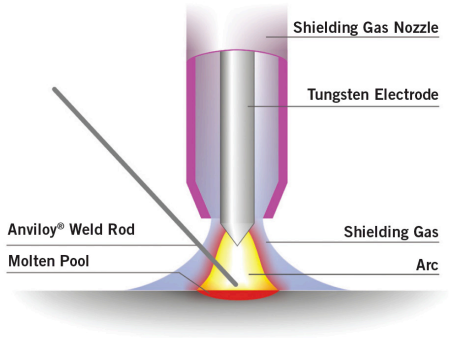
1.2 Properties of ANVILOY® Products

- Increased resistance to thermal wear and heat checks
- Increase in erosion or corrosion resistance, and extend service life significantly
- Reduction of soldering
- Improved heat dissipation in casting tools

2. The TIG-Process

2.1 Process Overview

In the TIG process, an arc burns between a non-melting tungsten electrode and the workpiece. The tungsten electrode is poled negative (cathode) and the workpiece is poled positive (anode). TIG welding with ANVILOY® WELD RODS is performed only with DC-.



2.1.1 Equipment

There is a wide range of TIG welding equipment. The choice depends, to a large extent, on the work to be carried out. When welding with high currents and long power cycles a slightly heavier device with water cooling is recommended. When welding ANVILOY® however, this is not necessary. A smaller device with 240 amps and air-cooled is sufficient. However, it is important that the device provides sufficient process selection options.

2.1.2 Shielding Gas

Good gas protection by properly adjusted gas pre- and after-flow is very important. The gas pre-flow can ensure that no disturbing oxides are produced at the beginning of the TIG process. The gas after-flow ensures that the hot tungsten electrode and the melting bath cool down in an inert atmosphere. In this way, oxidation on the weld and on the tungsten electrode is prevented. The next welding layer can therefore be applied without any problems. After welding, the tungsten electrode must be clean!

Weld with Ar

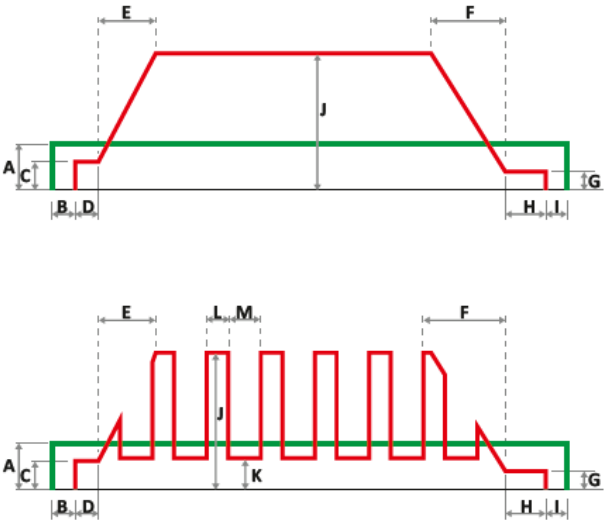
Weld with Ar/ 2% H_2

2.1.3 Up- and Downslope

The increase ensures that the set welding current does not apply directly, but rises slowly. The current from which the ascent begins and the time to reach the set welding current are adjustable. These parameters can be very important when welding small workpieces or sharp edges.The lowering, also called crater filler, ensures that when the TIG process is terminated, the set current does not suddenly disappear, but slowly returns to a minimum setpoint. In this way, a crater hole can be avoided. The time span of the current reduction is determined by the height of the welding current. With high welding current, the time span is longer than with low welding current.

2.1.4 Pulse Welding

The option to be able to weld with pulse current is highly recommended. Welding with two currents can have a positive impact on the heat balance and help the less experienced welder to produce a good weld.



A Gas flow l/min.
B Gas pre-flow time sec.
C Starting welding current Amp.
D Starting time sec.
E Upslope time welding current sec.
F Downslope time welding current sec.
G Crater filling current Amp.
H Crater fill time sec.
I Gas after flow time sec.
J Pulse current Amp.
K Base current Amp.
L Pulse current time sec.
M Base current time sec.

2.1.5 TIG Torch

When choosing the TIG torch, some parameters such as its length and current load capacity are important. If welding is only performed on a welding table, as it is the case with the use of ANVILOY® WELD ROD, a torch with a 4m long hose package should be sufficient. When welding ANVILOY® WELD ROD, it is also important to work with gas lenses. A gas lens provides much better protection for the welding bath. This is very important for the use of ANVILOY® WELD ROD.

Two types of TIG torches are offered on the market: the LINDE system and the BINZEL system. The LINDE system uses slightly more consumables and its service life is slightly shorter than that of the BINZEL system. The LINDE system is also a bit more sensitive to errors, especially if the welder is not working precisely. With the BINZEL system, you can weld with a type of ceramic gas nozzle in different sizes with gas lens and standard clamping nipple. With the LINDE system, you will need two types of ceramic gas nozzles. If possible, use the widest possible gas nozzle for ANVILOY® WELD ROD.

2.1.6 Tungsten Electrodes

For welding ANVILOY® WELD ROD or TIG direct current welding several types of electrodes are suitable. The most common TIG electrode types are:

- E3®: Purple, 1.7% Lanthanum + mixing oxides
- WLa15: Gold, 1.5% Lanthanum
- WLa20: Blue, 2.0% Lanthanum

We recommend using the violet tungsten electrode E3® as it has the highest service life and the best welding results.

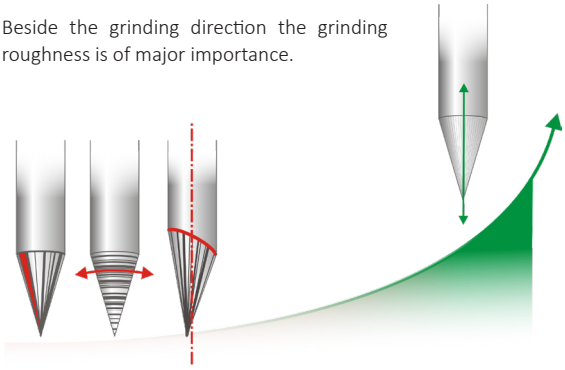
Type Electrode	Color code		Alloying elements		DC-	DC+	AC	Arc stability	Re-ignition	Lifetime	Materials to be welded
E3®		Purple	1.7%	La_2O_3 - ZrO_2	+++	-	+++	++	++++	++++	Fe-SS Aluminium
WR2		Turquoise	1.7%	Rare elements	+++	-	+++	++	++++	++++	Fe-SS Aluminium
WLa20		Blue	2.0%	La_2O_3	+++	-	+	++	+++	+++	Fe-SS
Wla15		Gold	1.5%	La_2O_3	++	-	+	+	++	++	Fe-SS
WCe		Grey	2.0%	CeO_2	+	-	+/-	+	+	+	Fe-SS
WP		Green	100%	Tungsten	--	-	+	-	-	+	Aluminium
WZr 8		White	0.8%	ZrO_2	-	-	++	++	+	++	Aluminium

We strongly advise against the red thoriumcontaining tungsten electrode (WT20), which is radioactive and harmful to the health of the welder.

The violet tungsten electrode E3® is more environmentally friendly, health-friendly and achieves better welding results.

The diameter of the tungsten electrode depends on the current during welding. For the low range from 45 to 150 A, a diameter of 1.6 mm is chosen and a 2.4 mm electrode for the range from 75 to 175 A. Always grind an angle of 60 degrees to the tungsten electrode before welding. This applies to both diameters. If you want to weld with a d2.4 mm tungsten electrode with less than 75 A, then grind a tip of 30 degrees. This will make the arc more stable. When grinding tungsten electrodes, keep the following points in mind:

Beside the grinding direction the grinding roughness is of major importance.



Radial
- Unfavorable flow of electrons
- Unstable arc Gas flow l/min.

Axial
- Favorable flow of electrons
- Stable arc

- Grind the groove as finely as possible.
- Grinding grooves must be in longitudinal direction of the tungsten electrode (axial).
- Grind the tungsten electrode with diamond discs preferably mechanical.
- Do not grind the tungsten electrode on belt or disc grinder.
- The cantilever length of tungsten electrodes outside the gas nozzle is half the diameter of the gas nozzle in the standard version.
- With a gas nozzle opening of 10 mm, the maximum length of the cantilever is 5 mm.
- When using a gas lens, the tungsten electrode sticks out up to 10 mm

2.1.7 Shielding Gases

Two gases can be used for welding ANVILOY® WELD ROD. Argon (Ar) and a mixture of argon with up to 2% hydrogen (H2). The second one can only be used for coat welding- not for joint welding. Hydrogen is a reducing gas and has a strong affinity to oxygen. This means that the hydrogen is directly bound to the oxygen, so that no oxides form on the welds and the weld remains clean and clear. (see Image of the weld with Ar and Ar/2% H2).

If you want to connect ANVILOY® tungsten products to tool steel, **never use argon/hydrogen**. The high carbon equivalent of the tool steel of at least 4.5, will almost certainly cause cracks in the weld.

The height of the gas flow depends on the current and diameter of the gas nozzle. At 90 A with an 8 mm gas nozzle you need 9- 10 l/min. With the same current and a gas nozzle opening of 10 mm, you need 12- 13 l/min. Since the gas column is more stable when using a gas lens, the gas flow may be slightly lower. The gas flow is the same for argon or argon/hydrogen.

ATTENTION: The argon/hydrogen reducing valve has a left thread!

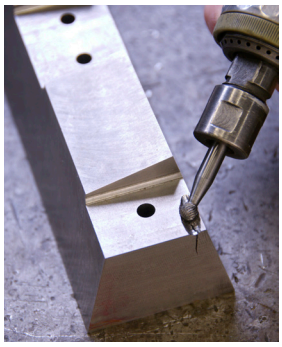
If you weld with a gas nozzle or a double gas nozzle, the weld stays protected longer and oxidizes less. Make sure to use two reduction valves. Cracks in the gas hose causes gas coverage errors. It is possible to work with argon as welding gas and if required with argon/hydrogen on the towing nozzle.

3. Welding with ANVILOY® Weld Rod

3.1 ANVILOY® Weld Rods

ANVILOY® Weld Rod is supplied in diameters of 1.0, 1.6, 2.4, 3.0 and 3.2 mm and is packed in 500 mm long round tubes. It is important to carefully store the ANVILOY ® Weld Rods in these packages to protect them from contamination. Contamination of rods and wires can cause problems during welding. **Therefore, never remove more material from the packaging than you immediately need.**

3.2 Welding practice



ANVILOY® WELD ROD is very easy to weld and is no different from TIG welding with stainless steel, apart from the fact that ANVILOY® WELD ROD is more susceptible to corrosion of the wire tip and the welding bath. It is therefore very important to maintain a gas flow time of approx. 5 seconds to prevent the welding bath from being contaminated at starting. **Therefore, it is also very important that the tip of the ANVILOY® WELD ROD always remains in the shielding gas during welding.** When the welding rod is pulled out of the gas stream, you will see black dots on the welding bath when you re-use it. If this happens too often, further welding is no longer possible and the crater must be cleaned.

Leave the ANVILOY® WELD ROD in the gas after the welding has finished until it no longer glows. After welding, hold the torch over the welding end crater until the gas flow stops so that no oxides can form.

As a rule, a continuous welding current of e.g., 90 amperes is welded. However, it is also possible to weld in pulsed mode. When pulse welding, use two welding currents, one high and one low. The height of the pulse and the base current can be adjusted independently of each other. The duration of the high and low currents can be set independently of each other. This can help a beginner to make beautiful welds using the pulse welding TIG process. Add material during the high welding current and move the torch during the low welding current. With more experience, the welder will be able to shorten the time of low welding current and thus be able to weld faster. When the welding bath is touched during welding with the tungsten electrode tip or the ANVILOY® WELD ROD, the welding process must be stopped, because the tungsten electrode is then contaminated and can no longer guarantee stable arc behaviour. Further welding would lead to welding errors. In this case, cut off the entire contaminated tip of the tungsten electrode and then grind a new 60-degree tip. The contaminated ANVILOY® WELD ROD is also cut off accordingly.

The choice of ANVILOY® WELD ROD diameter depends on the selected current: the lower the welding current, the thinner the ANVILOY® WELD ROD; the higher the welding current, the thicker the ANVILOY®WELD ROD. To avoid disturbing the flow of gas, insert the ANVILOY® WELD ROD into the welding bath as flat as possible. This means that the angle between the material to be welded and the ANVILOY® WELD ROD should be as small as possible.

3.3 Welding Seam Preparation

When welding an ANVILOY® products to a tool steel it is important to choose a good seam shape. As this is usually done with the TIG process this will always be a V-seam with an opening angle of 60 degrees. Without seam preprocessing, the weld will be very thin and because there is a lot of tension in the tool steel, the weld will crack up immediately. To reach with the TIG process right to the bottom of the seam, the opening angle of 60 degrees is very important. How wide and deep the V seam has to be, depends strongly on the size of the parts to be joined.

For small parts, a seam depth of 2 to 2.5 mm is sufficient. If the parts to be joined are larger and more solid, the seam depth should be 3 to 5 mm.

4. Build-up Welding*

4.1 Preparation

During coating, no connection is made between two parts, but a layer of ANVILOY® WELD ROD is applied to a workpiece. This can be done to repair damage, but also to apply an ANVILOY®WEL ROD wear protection layer to parts or areas of the mold to increase the service life. In both cases, it is very important to take good precautions. The surfaces to be welded must be absolutely clean and, above all, free of grease. Depending on the size of the surface, the surface must be removed by 6-15 mm. This is preferably done by milling or grinding. During grinding, there is a risk that residues of these agents will remain in the material. This can cause problems when welding. Always avoid sharp edges. As you want to try to achieve as little mixing as possible with the base material during welding the layer, binding errors can occur quickly with sharp edges.

4.2 Preheating

When welding a joint, but also when welding a coating, the workpiece must be preheated. The preheating temperatures are between 300 and 400 degrees Celsius and must be strictly adhered to. Preheating can be done in 3 ways:

4.2.1 Electrical Preheating

The electric preheating with heating mats is our recommendation for preheating. In most cases, this can also be continued during welding to ensure the correct temperature. This also makes it possible to allow the workpiece to cool down in a controlled manner, which reduces the risk of cracks.

4.2.2 Preheating in an oven

As with electrical preheating, even preheating in an oven can ensure uniform heating of the workpiece. You can also allow the workpiece to cool in the oven in a controlled manner. One drawback, however, is that an oven is expensive and therefore often unavailable. Another disadvantage is that if the workpiece cools down too much during welding, it must return to the oven.

4.2.3 Preheating with an acetylene/oxygen or propane/oxygen flame

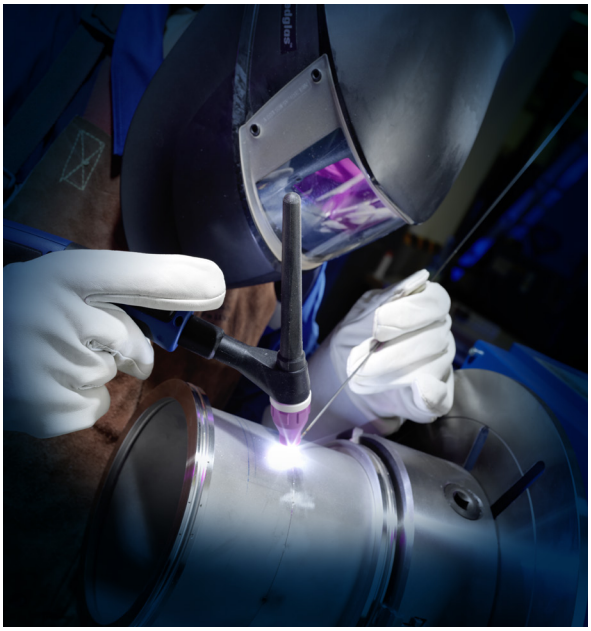
Preheating with an acetylene/oxygen or propane/oxygen burner is the simplest, but also the riskiest way of preheating. The biggest problem will be uniform warming. It is best to place the workpiece on a rotary table, place the torch on the side and heat the workpiece evenly by turning it.

CAUTION: Do not start welding until the entire workpiece has the right temperature! NEVER preheat with a gas burner at the welding point, especially not with a propane/oxygen burner.

With a propane/oxygen burner, the workpiece to be welded absorbs hydrogen, which can lead to hydrogen embrittlement and cracks after welding. Maintain an Interpass Temperature of 350 degrees Celsius during welding. Minimum temperature should be 275 degrees Celsius. This means that larger workpieces which cool down too much have to be reheated in-between.

4.3 Welding Seam

When making a welded connection between an ANVILOY® product and a tool steel, the torch is not pendulum-mounted, but moved with a uniform movement. During the welding process, the ANVILOY® WELD ROD is fed evenly. Do not apply the layer too thickly during welding to avoid connection errors. A too thin layer leads to cracks. As a rule of thumb with 90 Amp. use a d2.4 mm ANVILOY® WELD ROD. Then the weld has the right thickness.

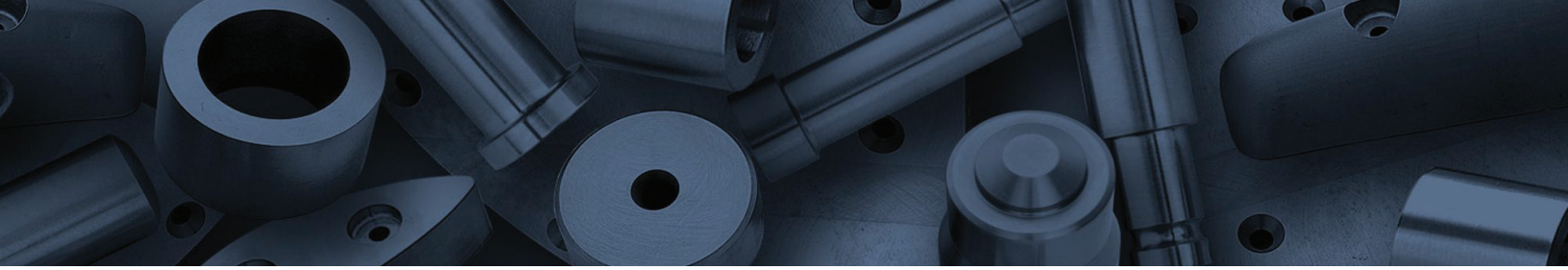


4.4 Weaving Technique

It can be useful to move the torch during welding. It is important that the movement does not exceed the diameter of the opening of the gas nozzle used. The layer thickness during welding depends to a large extent on the chosen welding technique. If you add drop by drop, the layer thickness will be slightly smaller, because the melting bath will drain a little more. If the ANVILOY ® WELD ROD is held in the melting bath, the layer thickness may be higher. With this technique you must be careful to ensure that the melting bath flows well.

4.5 Cooling

A good preheating of the workpiece is very important but cooling down is perhaps even more important. The structure of tool steel is extremely sensitive to cracking. This means that if the cooling down is too fast, cracks will appear. A controlled cooling in an oven at 40 to 50 °C per hour is ideal. If you do not have an oven, pack the workpiece well into a heat blanket immediately after welding, so that the heat is not dissipated too quickly. Your ANVILOY® supplier can supply covers specifically designed for this purpose.



WELDSTONE
COMPONENTS GROUP

Americas

Contact:
Indra Martinez

Weldstone Advanced Metal Solutions
6901 Bryan Dairy Road, Suite 110
Largo, FL 33777, USA

Mob.:+1 727-256-7166
Tel.: +1 727-546-9600
Fax: +1 727-546-9699
E-Mail: indra.martinez@weldstone.com
Internet: www.anviloy.com

Europe, Asia, Australia

Contact:
Andreas Endemann, Thomas Hoehn

Weldstone Components GmbH
Am Ruebgarten 2
D-57299 Burbach
Germany

Tel.: +49 8031-94 13 99-0
Fax: +49 8031-94 13 99-09
E-Mail: hello@weldstone.com
Internet: www.weldstone.com