Welding Processes

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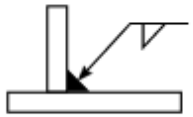
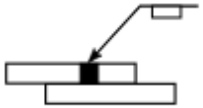
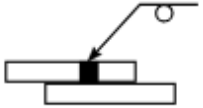
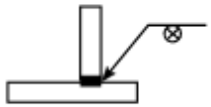
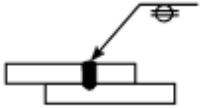
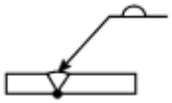
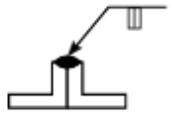
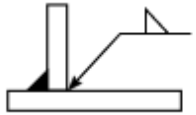
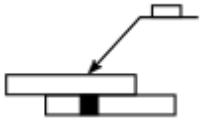
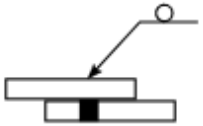
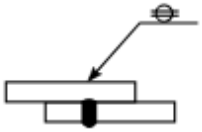
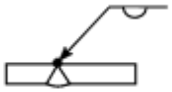
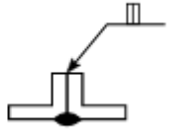
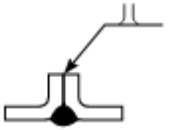
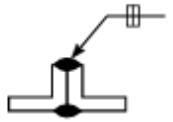
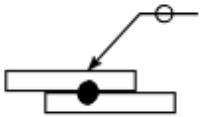
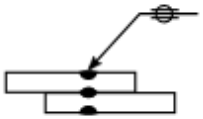
ARROW SIDE	T-joint 		Lap-joint 					Edge-joint 	
OTHER SIDE				NOT USED			NOT USED		
BOTH SIDES		NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED		NOT USED
NO SIDE USED	NOT USED	NOT USED		NOT USED		NOT USED	NOT USED	NOT USED	NOT USED

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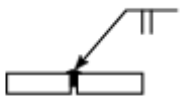
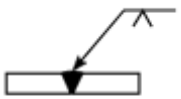
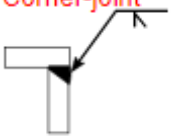
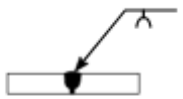
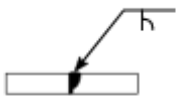
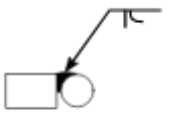
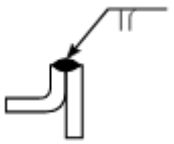
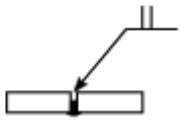
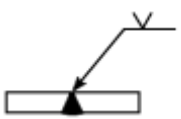
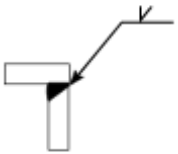
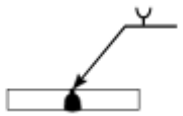
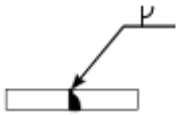
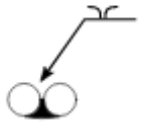
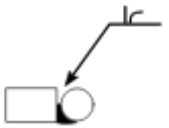
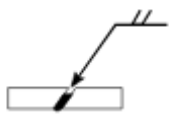
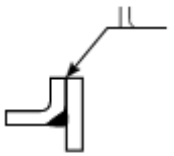
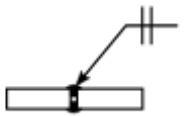
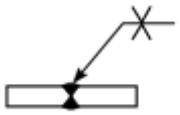
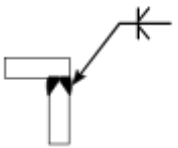
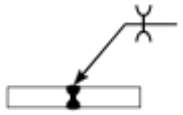
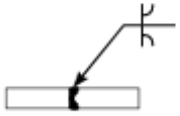
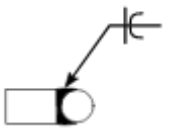
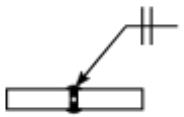
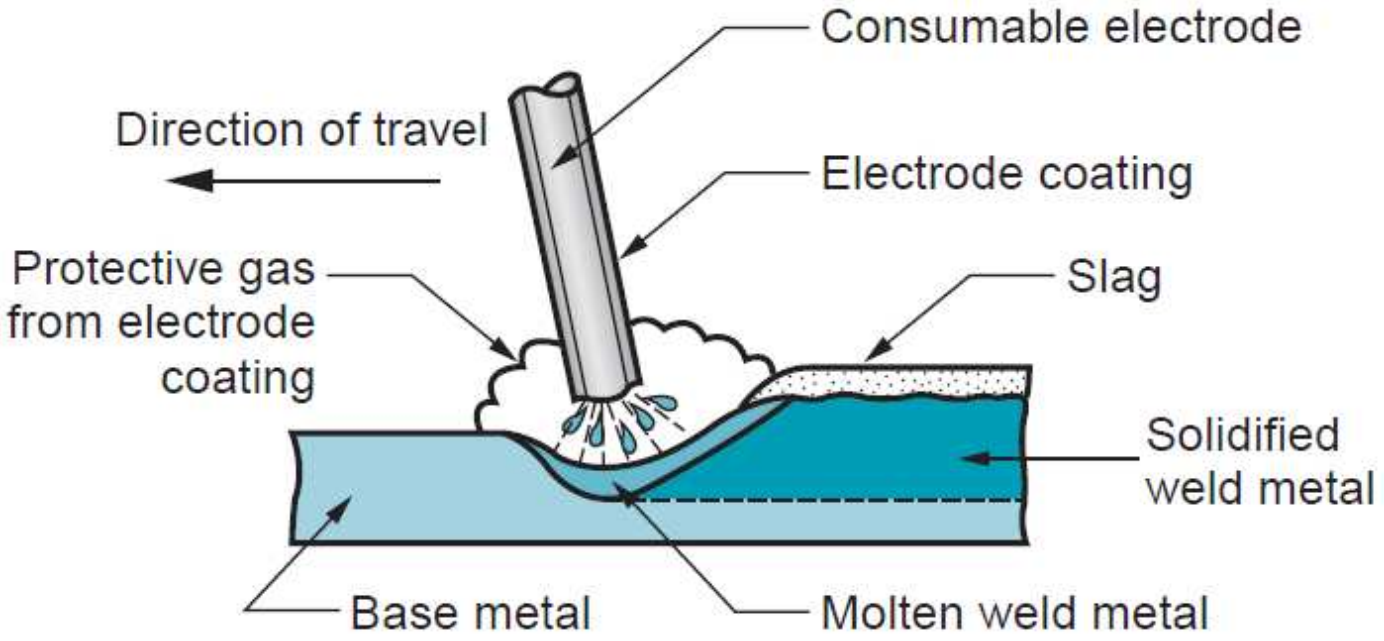
ARROW SIDE		Butt-joint 	Corner-joint 						
OTHER SIDE									
BOTH SIDES									NOT USED
NO SIDE USED		NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED

Arc Welding
Shielded Metal Arc Welding

- Shielded metal arc welding (SMAW) is an AW process that uses a consumable electrode consisting of a filler metal rod coated with chemicals that provide flux and shielding.



E7018-1 H4R

- Electrode
- Tensile in ksi
- Position
- Type of coating and current
- Meets lower temperature impact requirements
- Hydrogen: H4 = less than 4 ml/100 g, H8 = Less than 8 ml/100 g
- Meets requirements of absorbed moisture test

Position

1 Flat, Horizontal, Vertical, Overhead

2 Flat and Horizontal only

Types of Coating & Current

AWS	DIGIT	TYPE OF COATING	WELDING CURRENT
6010	**0**	cellulose sodium	DCEP
6011	**1**	cellulose potassium	AC or DCEP
6022	**2**	titania sodium	AC or DCEN
6013	**3**	titania potassium	AC or DCEP or DCEN
7014	**4**	iron powder titania	AC or DCEP or DCEN
7018	**8**	iron powder low hydrogen	AC or DCEP

Shielded Metal Arc Welding

- The welding stick (SMAW is sometimes called stick welding) is typically 225 to 450mm (9–18 in) long and 2.5 to 9.5mm (3/32–3/8 in) in diameter.
- The filler metal used in the rod must be compatible with the metal to be welded, the composition usually being very close to that of the base metal.
- The coating consists of powdered cellulose (i.e., cotton and wood powders) mixed with oxides, carbonates, and other ingredients, held together by a silicate binder.
- Metal powders are also sometimes included in the coating to increase the amount of filler metal and to add alloying elements.
- The heat of the welding process melts the coating to provide a protective atmosphere and slag for the welding operation.
- It also helps to stabilize the arc and regulate the rate at which the electrode melts.

Shielded Metal Arc Welding

- During operation the bare metal end of the welding stick (opposite the welding tip) is clamped in an electrode holder that is connected to the power source.
- The holder has an insulated handle so that it can be held and manipulated by a human welder.
- Currents typically used in SMAW range between 30 and 300 A at voltages from 15 to 45 V.
- Selection of the proper power parameters depends on the metals being welded, electrode type and length, and depth of weld penetration required.
- Power supply, connecting cables, and electrode holder can be bought for a few thousand dollars.

Shielded Metal Arc Welding

- Shielded metal arc welding is usually performed manually.
- Common applications include construction, pipelines, machinery structures, shipbuilding, job shop fabrication, and repair work.
- It is preferred over oxyfuel welding for thicker sections—above 5 mm (3/16 in)—because of its higher power density.
- The equipment is portable and low cost, making SMAW highly versatile and probably the most widely used of the AW processes.
- Base metals include steels, stainless steels, cast irons, and certain nonferrous alloys. It is not used or seldom used for aluminum and its alloys, copper alloys, and titanium.

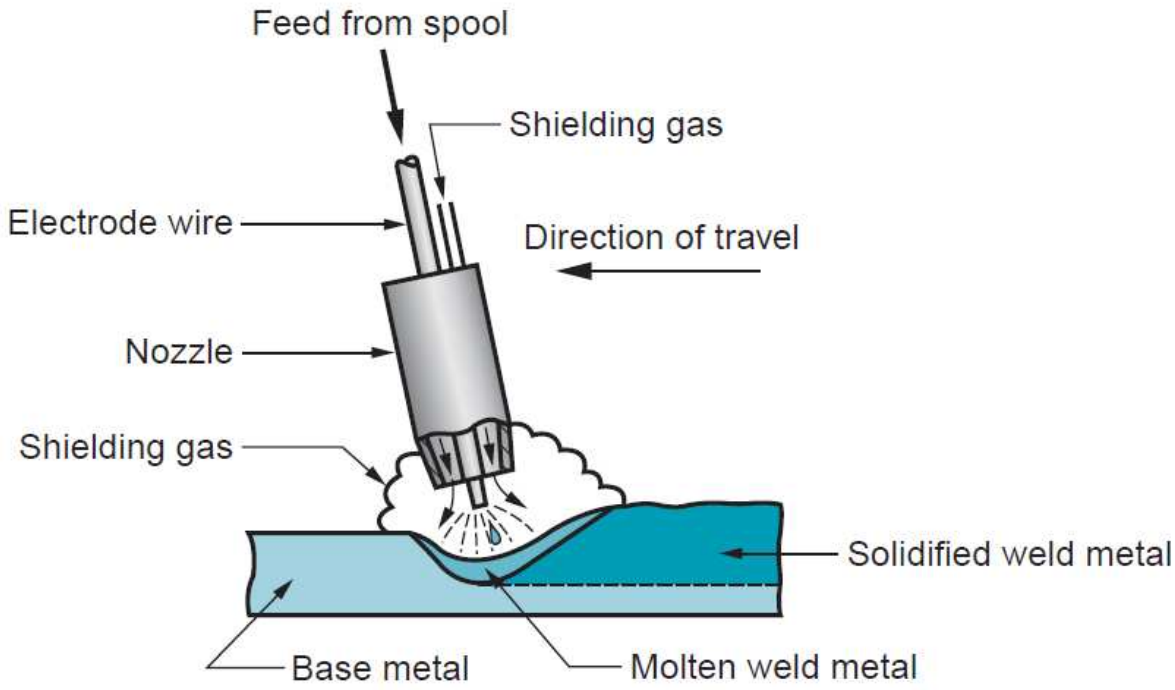
Shielded Metal Arc Welding

- A disadvantage of shielded metal arc welding as a production operation is the use of the consumable electrode stick.
- As the sticks are used up, they must periodically be changed.
- This reduces the arc time with this welding process.
- Another limitation is the current level that can be used.
- Because the electrode length varies during the operation and this length affects the resistance heating of the electrode, current levels must be maintained within a safe range or the coating will overheat and melt prematurely when starting a new welding stick.
- Some of the other AW processes overcome the limitations of welding stick length in SMAW by using a continuously fed wire electrode.

Gas Metal Arc Welding

- Gas metal arc welding(GMAW)is an AW process in which the electrode is a consumable bare metal wire, and shielding is accomplished by flooding the arc with a gas.

Gas metal
arc welding (GMAW).



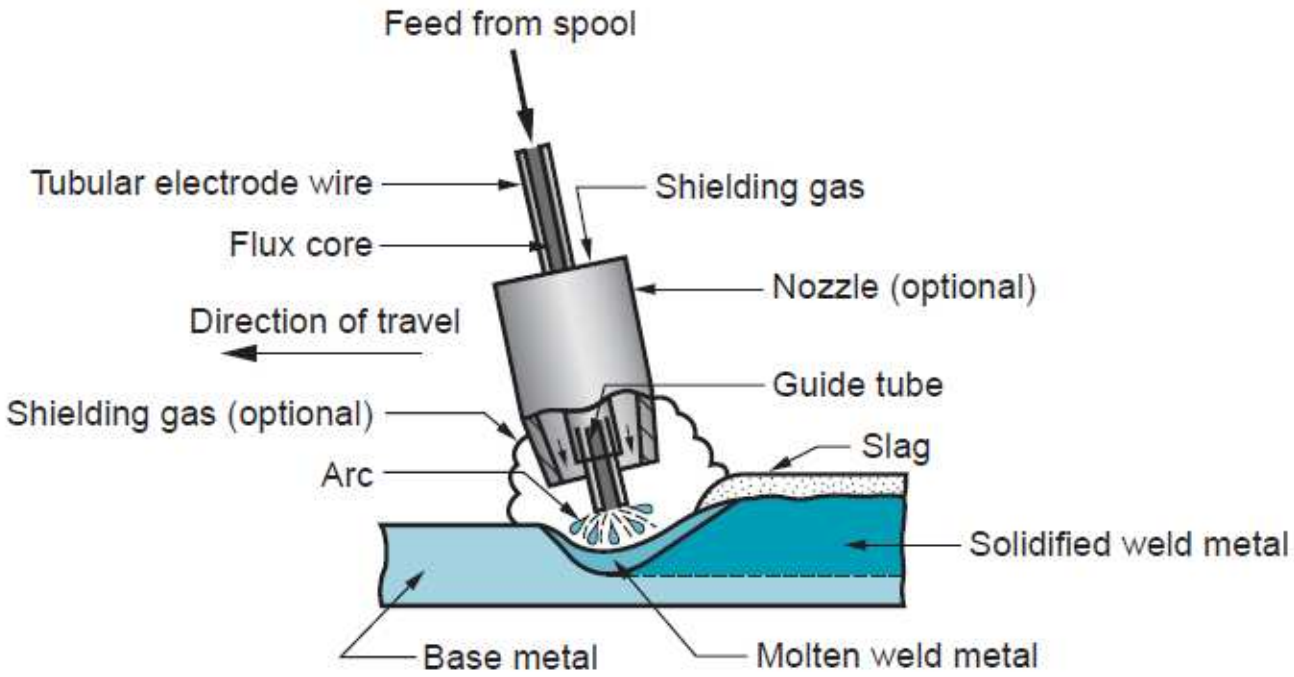
- The bare wire is fed continuously and automatically from a spool through the welding gun.
- Wire diameters ranging from 0.8 to 6.5mm (1/32–1/4 in) are used in GMAW, the size depending on the thickness of the parts being joined and the desired deposition rate.
- Gases used for shielding include inert gases such as argon and helium, and active gases such as carbon dioxide.
- Selection of gases (and mixtures of gases) depends on the metal being welded, as well as other factors.

- Inert gases are used for welding aluminum alloys and stainless steels, while CO2 is commonly used for welding low and medium carbon steels.
- The combination of bare electrode wire and shielding gases eliminates the slag covering on the weld bead and thus precludes the need for manual grinding and cleaning of the slag.
- The GMAW process is therefore ideal for making multiple welding passes on the same joint.
- The various metals on which GMAW is used and the variations of the process itself have given rise to a variety of names for gas metal arc welding.

- When the process was first introduced in the late 1940s, it was applied to the welding of aluminum using inert gas (argon) for arc shielding.
- The name applied to this process was MIG welding (for metal inert gas welding).
- When the same welding process was applied to steel, it was found that inert gases were expensive and CO_2 was used as a substitute.
- Hence the term CO_2 welding was applied.
- Refinements in GMAW for steel welding have led to the use of gas mixtures, including CO_2 and argon, and even oxygen and argon.

Flux-Cored Arc Welding

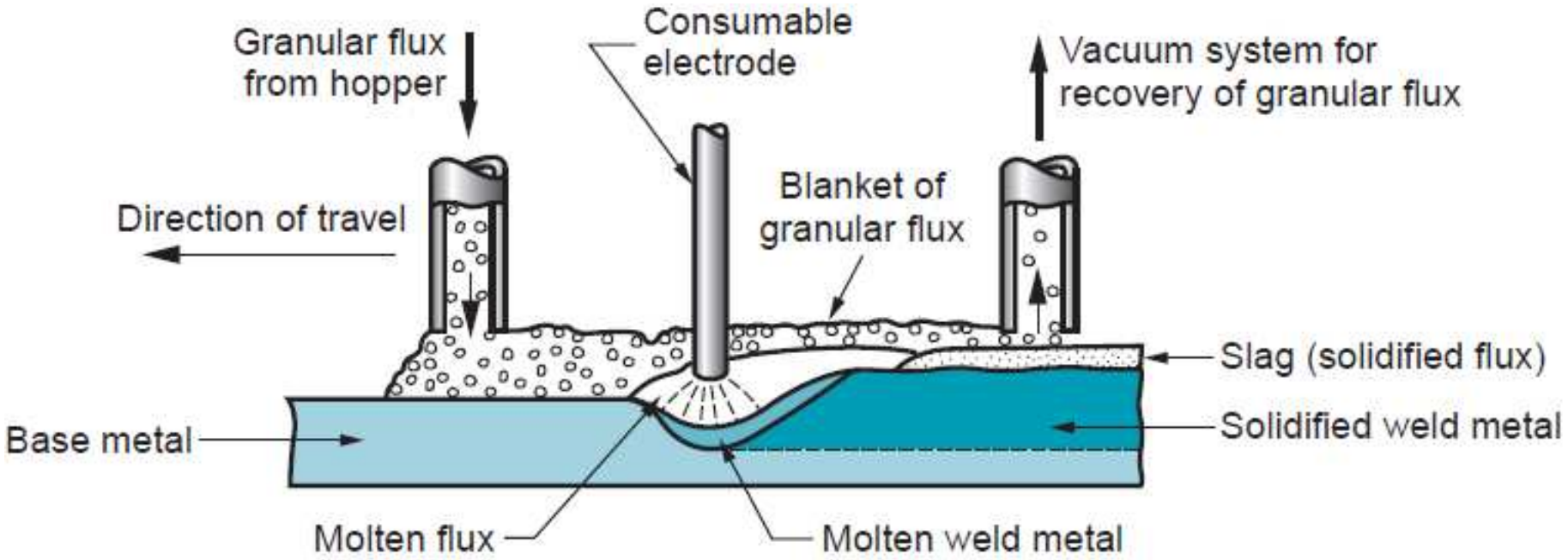
- Flux-cored arc welding (FCAW) is an arc-welding process in which the electrode is a continuous consumable tubing that contains flux and other ingredients in its core.



Flux cored arc welding.

Submerged Arc Welding

- Submerged arc welding (SAW) is an arc-welding process that uses a continuous, consumable bare wire electrode, and arc shielding is provided by a cover of granular flux.



Submerged arc welding (SAW).

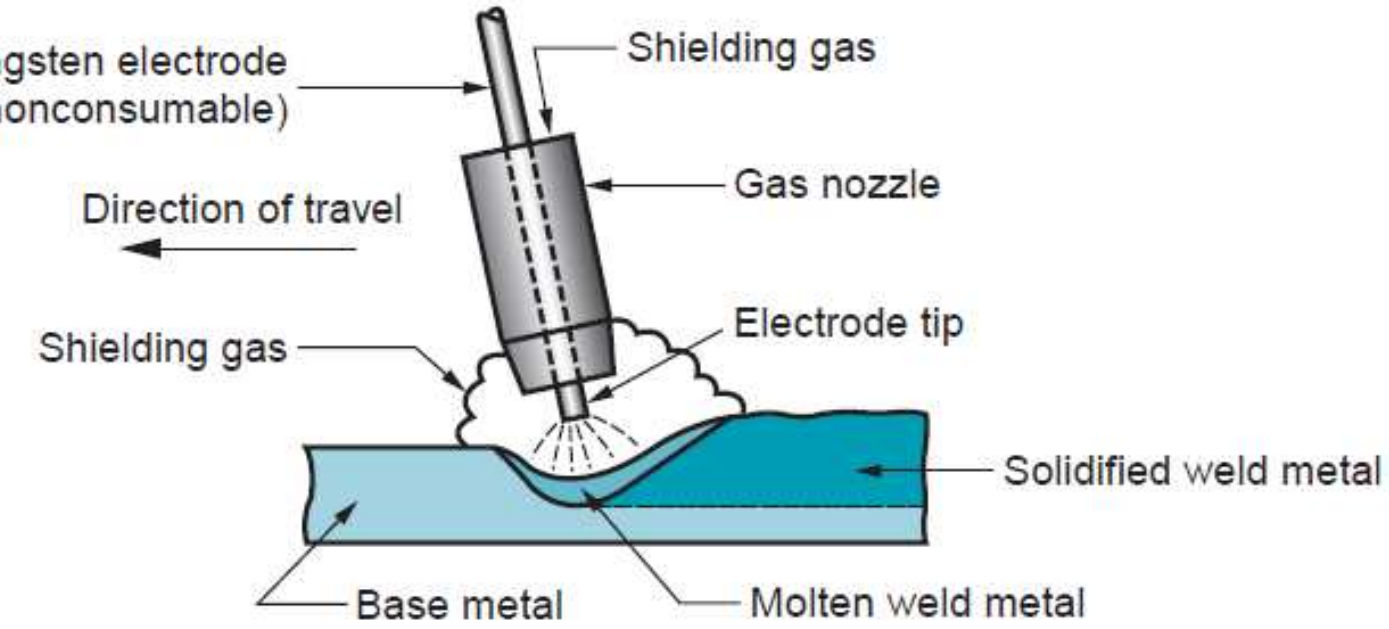
Submerged Arc Welding

- The electrode wire is fed automatically from a coil into the arc.
- The flux is introduced into the joint slightly ahead of the weld arc by gravity from a hopper.
- The portion of the flux closest to the arc is melted, mixing with the molten weldmetal to remove impurities and then solidifying on top of the weld joint to forma glasslike slag.
- The slag and unfused flux granules on top provide good protection from the atmosphere and good thermal insulation for the weld area.
- Granular fusible flux consisting of lime, silica, manganese oxide, calcium fluoride, and other compounds.

AW PROCESSES—NONCONSUMABLE ELECTRODES
Gas Tungsten Arc Welding

- Gas tungsten arc welding (GTAW) is an AW process that uses a nonconsumable tungsten electrode and an inert gas for arc shielding.

Gas
tungsten arc welding
(GTAW).




weld
[HAGOJIBI]

Gas Tungsten Arc Welding

- The term TIG welding (tungsten inert gas welding) is often applied to this process (in Europe, WIG welding is the term—the chemical symbol for tungsten is W, for Wolfram).
- GTAW can be implemented with or without a filler metal.
- Tungsten is a good electrode material due to its high melting point of 3410 °C.
- Typical shielding gases include argon, helium, or a mixture of these gas elements.
- GTAW is applicable to nearly all metals in a wide range of stock thicknesses.
- It can also be used for joining various combinations of dissimilar metals.