WOLFRAM INDUSTRIE

TUNGSTEN TECHNOLOGY GROUP

We Make Our Tungsten From Tungsten.

Fully developed and manufactured in Germany

1. Highest material purity
2. Consistent product quality
3. Lasting strength properties
4. Short delivery times
5. Reliable deliveries
6. Individually customizable

WS2® WITSTAR®

Applications: TIG, plasma applications, lighting and illumination technology

The WS2 alloy is our response to WTh alloys. As to what it contains: That remains our secret! We can only reveal so much: During production, up to 2% by weight of a rare earth mixture is added to the tungsten powder. This mixture combines all features that a TIG or plasma welder desires: the best ignition properties, high arc stability, low burnup; it can also be used for all materials and is ideal for manual and automatic welding.

INOSTAR®

Applications: TIG, plasma applications, lighting and illumination technology

After nearly three years in development, the latest addition to the family was welcomed in fall of 2013: The Inostar® alloy. It contains up to 2% by weight of a rare earth mixture, although this mixture is different to that of WS2. This new mixture made it possible to further improve the already outstanding properties of the WS2 alloy: Ignition is even better. Burnup is even lower. Endurance is even longer. Which is why we see it mainly being used for high-purity compounds such as those required in medicine, pharmaceuticals, and food technology. Sensitive metals such as titanium can also be welded with ease.

ALUSTAR®

Applications: TIG welding of aluminum alloys

Alustar® is an alloy that has been specially designed for welding aluminum. The composition enables longer endurance and better focusing of the arc. Perfect calotte formation and reduced reworking are positive side effects.

WCe – Tungsten cerium

Applications: TIG welding, resistance welding

For may welders around the world, the gray WCe20 is the new “red”. With a proportion of up to 2% by weight of cerium (IV) oxide, this alloy type is about to take the top spot from WTh material in TIG and plasma welding. This electrode type is universally applicable and can provide better ignition performance than thoriated electrodes.

WLa – Tungsten lanthanum

Applications: TIG, plasma applications, resistance welding

Besides WTh alloys, WLa alloys have the widest range. With a lanthanum (III) oxide content of up to 2% by weight, this mixture offers a very broad range of uses: Electrodes for TIG, orbital, plasma and resistance welding, and much more. It is also true that the higher the oxide content, the better the electrode ignites. In addition, due to its low alloy content, the WLa10 electrode is also suitable for AC welding of aluminum and magnesium. This is why this alloy type is the favorite in Europe as a replacement for the WTh20.

WP – Pure tungsten

Applications: TIG, plasma applications, resistance welding

Only tungsten powder with a very high purity – of at least 99.95% without any additional alloying elements – is used to manufacture WP elements. After a short mixing time, the powder is poured into a mold and compacted, then sintered into a bar and shaped to its final form by rounding, drawing, or grinding, etc. The electron work function is high at 4.5 eV, which is why the temperature increases at the tip and the structure recrystallizes. The endurance is comparatively low. WP is generally only used for AC welding, e.g. of aluminum and magnesium alloys.

WTh – Tungsten thorium

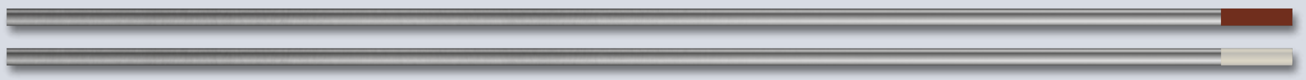
Applications: TIG welding, plasma applications

Many welders in Europe and Asia still swear by “their red” WTh20, which has been on the market for decades despite the risks from the slightly radioactive electrodes. For alloys of the type WTh, up to 4% by weight of thorium dioxide is added during manufacture. Ignition capability increases as the oxide content increases compared to pure tungsten.

Thoriated tungsten is used wherever a stable electron mission occurs: In plasma spraying, electrons (beam) sources, and also when welding (see above).

The electrode also responds “good-naturedly” to high current strengths. However, caution is required when handling: In bodies, for example, vapors or fine dust that occur during welding or subsequent grinding work can be harmful to health. The use of appropriate protective measures (extraction systems) is crucial in this case.

WZr – Tungsten zirconium



Applications: TIG welding (welding of Al and Mg alloys)

For the WZr alloy type, up to 0.8% by weight of zirconium oxide is added to the tungsten powder. The alloy is used almost exclusively for TIG electrodes. Because of its low alloy content, the material is suitable to welding compounds whose welds must be free of foreign material. Furthermore, the alloy can also be used for welding aluminum and magnesium using alternating current. It stands out compared to WP due to a more stable arc.

Special materials

WG – Doped tungsten

Applications: Thermally loaded wire, lighting technology

Pure tungsten – mainly as a fine wire – tends to form coarse grains (grain diameter = wire diameter). There is a risk that the wire will fail due to grain boundary sliding. Therefore, we also offer tungsten doped with potassium, aluminum, and silicon – or WG for short. This “doping” acts to stabilize the grain boundaries, and lowers the probability of grain boundary sliding. The wire resists the thermal loads for longer. The alloy is mainly produced in wire form and used, for example, as an electron source in scanning electron microscopes.

WLaZr25 – Tungsten lanthanum zirconium

Applications: Lighting and illumination technology, plasma applications

This alloy is characterized by its extremely high proportion of lanthanum oxide, which gives WLaZ25 a very high resistance to creep and high temperatures. In addition, the ignition properties are positively affected by an additionally lowered electron work function. Consequently, the material is ideally suited to cathodes subject to high thermal loads.

WRe – Tungsten rhenium

Applications: Filaments in electron tubes/light sources

Besides doping with potassium, aluminum, and silicon, the addition of the rather rare – and therefore expensive – metal rhenium has a stabilizing effect on the structure. At the same time, the heat resistance and the ductility of the tungsten are increased. Wires manufactured from this material are mainly used as filaments in electron tubes and light sources. Furthermore, such wires are also used as thermocouples because they can reliably measure temperatures of up to 2500 °C.

Additional information about types of electrodes

Most applications of tungsten as an electrode material use an oxide-reinforced tungsten instead of pure tungsten. Adding thorium oxide, lanthanum oxide, or cerium oxide reduces the electron work function, which increases arc ignitability and stability. Additional quality features include a fine-grained microstructure and a homogeneous distribution of the oxides. As for which tungsten is best suited to a particular application: That depends on application-specific parameters and is best determined through testing.

Generally speaking, it should be noted that tungsten is prone to strong oxidation at a temperature above 400 °C, which means that a shielding gas atmosphere or vacuum is required. An atmosphere with a high carbon content also has a negative impact, and can lead to the formation of brittle carbides and premature failure.

Applications for electrode materials

	Electrode materials								Special materials		
	WS	WS2	Inostar	WLa10 WLa15 WLa20	WCe20	Alustar	WZr3 WZr8	WTh10 WTh20 WTh30 WTh40	WG	WLaZr25	WRe
TIG welding	+	++	++	++	++	++	++	++	o	+	o
Orbital welding	o	+	+	++	o	o	o	o	o	o	o
Plasma technology applications	o	++	+	+	+	o	o	++	+	+	o
Resistance welding	++	+	+	++	++	o	o	o	o	o	+
Lighting and illumination technology	o	++	o	++	o	o	o	o	++	++	++

Suitability: ++ very good, + good, o limited

Principle of TIG welding

Decisive factors

- Modern inverter power sources with HF ignition and accurate power setting
- Tungsten electrode: Size and composition
- Electrode preparation: Cut, angle, seat of tip
- Distance between electrode and workpiece, and distance between electrode tip and gas nozzle
- Shielding gas: Quantity, composition, gas backing where necessary
- Ambient conditions: Draft, extraction

GAS

Gas nozzle

The gas nozzle used for welding should be neither too large nor too small in order for it to cover both the electrode and the cooling weld with shielding gas.

Shielding gas

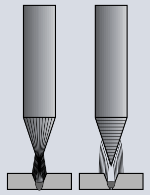
Depending on the application, the noble gases argon and helium are used. In certain cases, mixtures such as argon/helium, argon/hydrogen, or argon/nitrogen are used. For general welding, argon of purity class 4.6 is used. In special cases, gas of class 4.8 or higher is recommended.

Gas quantity

The shielding gas flow must be properly dispensed. If too little gas is used, there is insufficient shielding gas coverage of the weld and electrode. Any residual oxygen adhering to the material leads to oxidation and a poor weld. If too much gas is used, the high flow speed causes turbulence in the gas flow. As a result, small parts of the ambient air are sucked in, which cause oxidation of the weld and the weld metal. Experience shows that approximately 8 l/min provides good results. Gas backing should be observed for large or sensitive parts.

ELECTRODE TIP

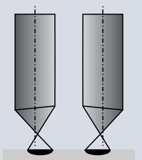
We recommend sharpening the electrode in the longitudinal direction (see fig.). This type of grinding improves ignition and results in a more stable arc. Besides the poorer arc, radial grinding also involves the risk that small parts of the electrode break off during welding and start to melt.



How grinding direction affects the form of the arc and weld penetration.

Centering

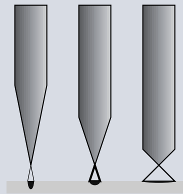
The tip should be ground as centrally as possible. If this is not the case, the arc can become unstable and fail to ignite where it should (fig.). The latter is crucial in automated TIG welding.



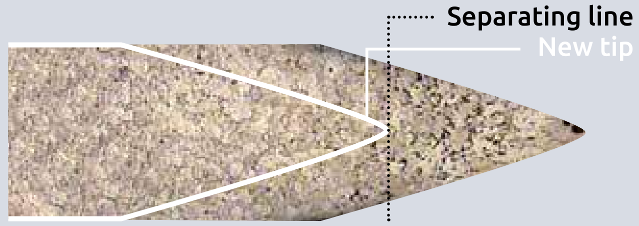
Profile of the arc with a non-centered tip.

Angle

In conjunction with the diameter of the electrode, the grind angle has a decisive influence on the formation of the weld seam and weld penetration. The figure shows the relationship between weld penetration profile and the grind angle with constant current and gas: For a pointed electrode, the energy is concentrated on a small area, resulting in a deeper penetration. By contrast, a blunt grind angle means the same energy acts on a significantly larger area. Consequently, the weld penetration is significantly flatter. The arc and its weld penetration profile are a reflection of the grind angle. In order to improve endurance and reduce the load on the tip, it is recommended to blunt the electrode tip after grinding. The resulting tip should have a diameter of around 10% of the electrode diameter, i.e. for a 2.4 electrode, the tip diameter should be 0.24 mm.

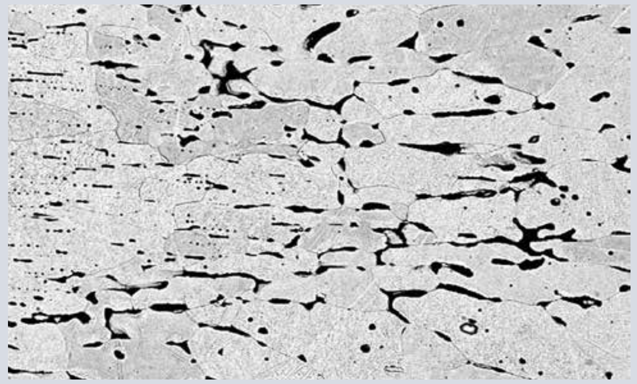


Weld penetration profiles depending.



Microstructure of the electrode tip after use.

As can be seen in the figure, the microstructure of the electrode tip is permanently altered by thermal stress. In soft parts of the top, there is grain coarsening, coagulation of the oxides, pore formation, and scouring.
It is necessary to properly cut off at least 2/3 of the tip before sharpening again in order to remove this section and restore the optimum welding properties.



Transition region between the structure of the base material and the weld of the electrode tip subject to thermal load.

Suggested electrode type depending on the workpiece

	WP	WS2	Inostar	WLa 10	WLa 15	WLa 20	WCe 20	Alustar	WZr3 WZr8	WTh 10	WTh 20	WTh 30	WTh 40
Non-alloyed steel	-	++	+	++	++	+	+	o	o	+	+	+	+
Alloyed steel	-	++	++	o	+	++	++	o	o	o	+	++	++
Copper, alloys	-	++	+	o	+	+	+	o	o	-	+	-	-
Nickel, alloys	-	++	++	o	+	++	++	o	o	+	+	++	++
Aluminum, alloys	++	++	+	+	o	o	o	++	++	+	-	-	-
Magnesium, alloys	++	++	+	+	o	o	o	++	++	-	-	-	-
Titanium, alloys	-	++	+	-	+	+	+	-	-	-	+	++	++
Zirconium	-	++	+	o	+	+	+	-	-	-	+	++	++
Tantalum	-	+	+	o	o	++	+	-	-	-	o	++	++
Tungsten	-	+	+	o	o	++	+	-	-	-	o	++	++

Suitability: ++ very good, + good, o limited, - poor
Note: It is not recommended to use thoriated electrodes, since radioactive dust is released during welding and grinding, which can be incorporated. Further information can be found in BGI 746.

Further information and guidance for safe handling can be found on our website.

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