Encyclopedia of Lanthanum Tungsten Electrode

中钨智造科技有限公司

CTIA GROUP LTD

CTIA GROUP LTD

Global Leader in Intelligent Manufacturing for Tungsten, Molybdenum, and Rare Earth Industries

INTRODUCTION TO CTIA GROUP

CTIA GROUP LTD, a wholly-owned subsidiary with independent legal personality established by CHINATUNGSTEN ONLINE, is dedicated to promoting the intelligent, integrated, and flexible design and manufacturing of tungsten and molybdenum materials in the Industrial Internet era. CHINATUNGSTEN ONLINE, founded in 1997 with www.chinatungsten.com as its starting point—China's first top-tier tungsten products website—is the country's pioneering e-commerce company focusing on the tungsten, molybdenum, and rare earth industries. Leveraging nearly three decades of deep experience in the tungsten and molybdenum fields, CTIA GROUP inherits its parent company's exceptional design and manufacturing capabilities, superior services, and global business reputation, becoming a comprehensive application solution provider in the fields of tungsten chemicals, tungsten metals, cemented carbides, high-density alloys, molybdenum, and molybdenum alloys.

Over the past 30 years, CHINATUNGSTEN ONLINE has established more than 200 multilingual tungsten and molybdenum professional websites covering more than 20 languages, with over one million pages of news, prices, and market analysis related to tungsten, molybdenum, and rare earths. Since 2013, its WeChat official account "CHINATUNGSTEN ONLINE" has published over 40,000 pieces of information, serving nearly 100,000 followers and providing free information daily to hundreds of thousands of industry professionals worldwide. With cumulative visits to its website cluster and official account reaching billions of times, it has become a recognized global and authoritative information hub for the tungsten, molybdenum, and rare earth industries, providing 24/7 multilingual news, product performance, market prices, and market trend services.

Building on the technology and experience of CHINATUNGSTEN ONLINE, CTIA GROUP focuses on meeting the personalized needs of customers. Utilizing AI technology, it collaboratively designs and produces tungsten and molybdenum products with specific chemical compositions and physical properties (such as particle size, density, hardness, strength, dimensions, and tolerances) with customers. It offers full-process integrated services ranging from mold opening, trial production, to finishing, packaging, and logistics. Over the past 30 years, CHINATUNGSTEN ONLINE has provided R&D, design, and production services for over 500,000 types of tungsten and molybdenum products to more than 130,000 customers worldwide, laying the foundation for customized, flexible, and intelligent manufacturing. Relying on this foundation, CTIA GROUP further deepens the intelligent manufacturing and integrated innovation of tungsten and molybdenum materials in the Industrial Internet era.

Dr. Hanns and his team at CTIA GROUP, based on their more than 30 years of industry experience, have also written and publicly released knowledge, technology, tungsten price and market trend analysis related to tungsten, molybdenum, and rare earths, freely sharing it with the tungsten industry. Dr. Han, with over 30 years of experience since the 1990s in the e-commerce and international trade of tungsten and molybdenum products, as well as the design and manufacturing of cemented carbides and high-density alloys, is a renowned expert in tungsten and molybdenum products both domestically and internationally. Adhering to the principle of providing professional and high-quality information to the industry, CTIA GROUP's team continuously writes technical research papers, articles, and industry reports based on production practice and market customer needs, winning widespread praise in the industry. These achievements provide solid support for CTIA GROUP's technological innovation, product promotion, and industry exchanges, propelling it to become a leader in global tungsten and molybdenum product manufacturing and information services.

Tel: 0086 592 512 9696

sales@chinatungsten.com

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

Directory

Chapter 1 Introduction

1.1 Definition and overview of lanthanum tungsten electrode

Lanthanum tungsten electrode is a tungsten alloy electrode material doped with lanthanum oxide (La_2O_3) in a tungsten matrix, which is mainly used for high-precision industrial applications such as tungsten inert gas shielded welding (TIG welding), plasma welding and cutting. Tungsten is an ideal choice for electrode materials as a metal with a high melting point (about 3422°C), corrosion resistance, high density, and excellent thermal and electrical conductivity. By doping tungsten with a small amount of lanthanum oxide (typically between 0.8% and 2.2%), the electron work can be significantly improved, thereby improving the arc initiation performance, arc stability and burn resistance of the electrode. Lanthanum tungsten electrode has become the preferred material to replace traditional thorium-tungsten electrodes due to its excellent welding performance and non-radioactive characteristics, especially in modern industries that pursue environmental protection and safety.

Lanthanum tungsten electrodes are divided into several grades according to the different lanthanum oxide content, such as WL10 (containing 0.8%-1.2% lanthanum oxide), WL15 (containing 1.3%-1.7% lanthanum oxide) and WL20 (containing 1.8%-2.2% lanthanum oxide). Each of these grades corresponds to different application scenarios and performance requirements. For example, WL15 is popular because of its conductivity close to 2.0% thorium-tungsten electrode, which can be directly replaced by welders without the need to adjust equipment parameters. The ends of lanthanum tungsten electrodes are usually marked with different colors, such as black for WL10, golden yellow for WL15, and sky blue for WL20 to facilitate differentiation and selection.

Lanthanum tungsten electrodes are usually produced using powder metallurgy process, which is made by homogeneously mixing high-purity tungsten powder with lanthanum oxide through pressing, sintering, forging and drawing processes, with diameters ranging from 0.25 mm to 6.4 mm and lengths from 75 mm to 600 mm to meet a variety of welding needs. Its unique physical and chemical properties, such as high recrystallization temperature, good ductility and creep resistance, make it excellent in both DC and AC welding, especially in demanding scenarios such as low-current arc initiation and pipe welding.

1.2 The importance of lanthanum tungsten electrodes in welding and industry

Lanthanum tungsten electrodes occupy an important position in modern welding and industrial fields, especially in processes such as TIG welding, plasma welding and cutting, and its performance directly affects welding quality and production efficiency. TIG welding is a welding method that uses tungsten electrodes to generate an arc under the protection of an inert gas (such as argon or helium), and is widely used in the welding of high-performance materials such as stainless steel, aluminum alloy, nickel-based alloy, titanium alloy, etc. These materials are commonly used in the aerospace, nuclear industry, shipbuilding and medical device construction and require high weld quality and process stability. Lanthanum tungsten electrodes play an irreplaceable role in these fields due to their following characteristics:

Excellent arc initiation performance: The low electron work of lanthanum tungsten electrodes (2.6-2.7 eV for WL10 and 2.8-3.2 eV for WL15 and WL20) makes it easy to start arcing at low currents, making it particularly suitable for sheet welding and precision welding tasks. Compared with pure tungsten electrodes, lanthanum tungsten electrodes are more stable at low voltages, reducing the risk of arc initiation failure.

Arc stability: Lanthanum tungsten electrode doped with lanthanum oxide can form a stable arc, reduce arc drift and spatter, and ensure the uniformity and surface quality of the weld. This is critical for industries that require high-quality welds, such as the aerospace and nuclear industries.

Low burn rate: Lanthanum tungsten electrode has a low burn loss rate under the action of high temperature arc, which prolongs the service life of the electrode and reduces the replacement frequency and downtime. For example, a well-known test in 1998 showed that the burn-out rate of 1.5% lanthanum tungsten electrode (WL15) was significantly lower than that of 2.0% thorium tungsten electrode and 2.0% cerium tungsten electrode in 70 A and 150 A DC environments.

Non-radioactive: Compared with the traditional thorium-tungsten electrode (containing thorium oxide, radioactive, with a radiation dose of 3.60×10^5Curie/kg), the lanthanum tungsten electrode does not contain radioactive substances and meets the requirements of modern environmental protection and occupational health and safety. This makes it more competitive in markets with strict environmental regulations, such as Europe and the United States.

Versatility: Lanthanum tungsten electrodes are not only suitable for DC welding, but also perform well in AC welding, especially when welding aluminum, magnesium and their alloys, with the ability to maintain a stable arc and low electrode consumption. This makes it a versatile electrode material that can be adapted to a wide range of welding scenarios.

In industrial applications, lanthanum tungsten electrodes are also widely used in plasma cutting, electrical discharge machining (EDM), and electronic device manufacturing. For example, in plasma cutting, lanthanum tungsten electrodes are able to withstand the impact of high-temperature plasma arcs and provide stable cutting performance; In electronic devices, its high conductivity and corrosion resistance make it an ideal material for certain high-precision electrodes. These properties have led to a growing demand for lanthanum tungsten electrodes in the global welding and industrial markets.

1.3 Background of research and application

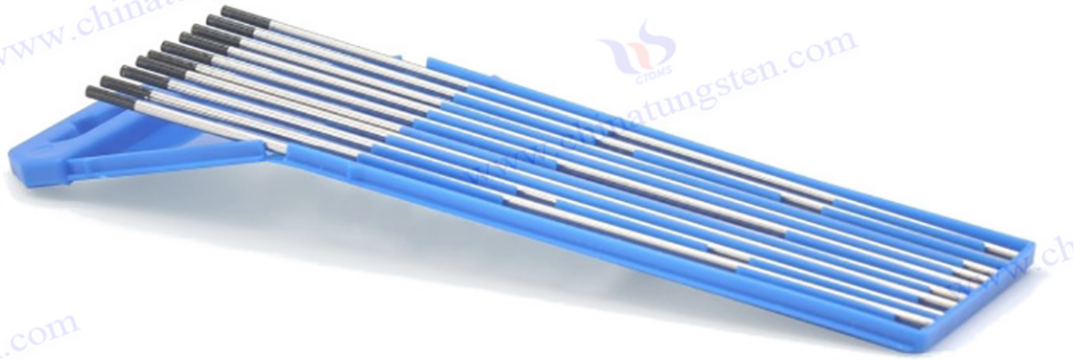
The development and application of lanthanum tungsten electrodes originated from the need for high-performance welding materials. At the beginning of the 20th century, tungsten was widely used in welding electrodes due to its high melting point and excellent electrical conductivity, but pure tungsten electrodes had limitations in arc initiation performance and arc stability. With the progress of rare earth materials research, scientists have found that the performance of tungsten electrodes can be significantly improved by doping rare earth oxides (such as cerium oxide, lanthanum oxide, thorium oxide, etc.). In the 80s of the 20th century, thorium-tungsten electrodes became the mainstream because of their excellent welding performance, but their radioactivity gradually attracted attention, especially under the strict environmental protection regulations of European and American countries, the use of thorium-tungsten electrodes was restricted.

In order to find non-radioactive alternative materials, lanthanum tungsten electrodes and cerium tungsten electrodes came into being. Lanthanum tungsten electrodes began to enter the market in the late 80s of the 20th century, and their grades with 1.5% lanthanum oxide content (WL15) quickly gained popularity due to their performance close to that of thorium tungsten electrodes. Field tests in 1998 further confirmed the superiority of lanthanum tungsten electrodes: in 70 A and 150 A DC environments, the 1.5% lanthanum tungsten electrode not only exhibited comparable conductivity to the 2.0% thorium-tungsten electrode, but also had a lower burn-out rate and better arc stability. This result has led to the widespread use of lanthanum tungsten electrodes worldwide.

In terms of application, the promotion of lanthanum tungsten electrode is closely related to the development of TIG welding technology. Since its invention in the United States in 1930, TIG welding has been widely used in the aerospace, nuclear, marine and electronics industries due to its high precision, no spatter and adaptability to a variety of metals. In 1957, tungsten argon arc welding began to be used in China, and the introduction of lanthanum tungsten electrodes further improved the welding quality, especially in the manufacture of nuclear power plant pressure vessels, aerospace components and medical equipment, where its high-quality welds and low defect rates were widely recognized.

In recent years, with the progress of automated welding technology, lanthanum tungsten electrodes have been increasingly used in welding robots and automation equipment. For example, in the automotive industry, welding robots use lanthanum tungsten electrodes for spot and arc welding, which greatly improves production efficiency and weld seam consistency. In addition, the development of new welding processes such as friction stir welding and laser composite welding also provides new possibilities for the application of lanthanum tungsten electrodes. The research area focuses on optimizing the doping process of lanthanum tungsten electrodes, improving their high-temperature performance, and developing more environmentally friendly production technologies to cope with the rising cost of raw materials and the challenges of environmental regulations.

The global market demand for lanthanum tungsten electrodes continues to grow, especially in the Asia-Pacific region, where the consumption of lanthanum tungsten electrodes has increased significantly due to the rapid development of manufacturing in countries such as China and India. Domestic enterprises such as Chinatungsten Online Technology Co., Ltd. have accumulated rich experience in the production of lanthanum tungsten electrodes, and the product quality has reached international standards. At the same time, the demand for lanthanum tungsten electrodes in the international market has also promoted the formulation of relevant standards, such as ISO 6848:2015 and GB/T 31908-2015, which provide a normative basis for their production and application.



CTIA GROUP LTD WL10 electrode

Chapter 2 Types of Lanthanum Tungsten Electrode

As a high-performance welding and cutting electrode material, lanthanum tungsten electrode has diversified classification methods due to its doped lanthanum oxide (La_2O_3) characteristics. According to international standards (e.g. ISO 6848:2015) and practical application requirements, lanthanum tungsten electrodes are mainly classified according to lanthanum oxide content and application scenarios. This chapter describes the lanthanum tungsten electrodes by lanthanum content (WL10, WL15, WL20), the types of lanthanum electrodes by application scenario, and the performance of lanthanum tungsten electrodes compared to other common tungsten electrodes.

2.1 Classification by lanthanum content

The performance of lanthanum tungsten electrodes is closely related to its lanthanum oxide content, and different levels of lanthanum oxide give the electrodes different electrical, thermal and mechanical properties. According to the international standard ISO 6848:2015 and the Chinese national standard GB/T 14841, lanthanum tungsten electrodes are mainly divided into three common grades: WL10, WL15 and WL20, which correspond to different lanthanum oxide content and application requirements. For easy identification, the ends of these electrodes are usually painted with a specific color, WL10 is black, WL15 is golden yellow, and WL20 is sky blue.

2.1.1 WL10 (Black Painted Head)

WL10 lanthanum tungsten electrode contains 0.8%-1.2% lanthanum oxide (La_2O_3), which is the lowest lanthanum oxide tungsten electrode grade. Its electron work is about 2.6-2.7 eV, which is lower than that of pure tungsten electrodes (about 4.5 eV), so it has good arc initiation performance, especially in low-current DC welding. The arc stability of WL10 electrode is better than that of pure tungsten electrode, but slightly inferior to WL15 and WL20, which is mainly suitable for scenarios with low requirements for electrode consumption.

Features and Benefits:

Low current arcing: WL10 can easily start arcing at low current (10-50 amps) and is suitable for thin plate welding (e.g. 0.5-2 mm stainless steel or aluminum alloy).

Cost-effective: Due to the low lanthanum oxide content, WL10 is relatively low to produce, making it suitable for small and medium-sized enterprises with limited budgets.

Durability: WL10 has a low burn-out rate and a long electrode life at low to medium currents.

Applications:

DC welding of precision electronic components, such as circuit board manufacturing.

Welding of thin-walled pipes, such as stainless steel pipes in chemical equipment.

TIG welding of small workpieces, such as bicycle frames or medical devices.

Limitations:

In high current (>150A) or AC welding, WL10 has slightly inferior arc stability and is prone to arc drift.

It is not suitable for long-term high-load welding tasks, because its burning resistance is weaker than WL15 and WL20.

2.1.2 WL15 (Golden Color)

WL15 lanthanum tungsten electrode contains 1.3%-1.7% lanthanum oxide and is one of the most commonly used lanthanum tungsten electrode grades. Its electron evolution work is about 2.8-3.0 eV, which is close to 2.0% thorium-tungsten electrode (about 2.6 eV), so it is widely regarded as a non-radioactive alternative to thorium-tungsten electrodes. WL15 excels in both DC and AC welding, with excellent arc stability and low burn-out rate, especially at medium to high currents.

Features and Benefits:

Versatility: The WL15 is suitable for DC and AC welding and is capable of welding a wide range of metals, including stainless steel, aluminum, nickel and titanium.

Arc Stability: In the current range of 50-200 amps, the WL15 is able to maintain a stable arc and reduce spatter and weld defects.

Long life: Compared with WL10, WL15 has stronger anti-burning performance, and the electrode tip is not easy to deform at high temperatures, which is suitable for long-term welding.

Applications:

Aerospace industry, e.g. TIG welding of aircraft fuselages and engine components.

Equipment manufacturing for the nuclear industry, such as precision welding of pressure vessels.

Welding of high-strength steels and aluminum alloys in the automotive industry.

Limitations:

At very low currents (<10A), the arc starting performance of WL15 is slightly inferior to that of WL10.

The production cost is slightly higher than WL10, but lower than WL20.

2.1.3 WL20 (Sky Blue Paint)

WL20 lanthanum tungsten electrode contains 1.8%-2.2% lanthanum oxide, which is the grade with the highest lanthanum oxide content. Its electronic work is about 2.8-3.2 eV, and it has excellent arc initiation performance and arc stability, which is especially suitable for high current and complex welding environments. The WL20 excels in high-load welding and plasma cutting, and is able to withstand higher arc temperatures and stronger electrode consumption.

Features and Benefits:

High current adaptability: WL20 is suitable for high current welding of 100-300 amps, the arc is concentrated and stable, and it is suitable for thick plate welding.

Excellent burn resistance: Under high-temperature arcing, the tip of the WL20 consumes slowly, extending the electrode life.

Suitable for complex environments: WL20 excels in AC welding and plasma cutting, especially when welding light metals such as aluminum and magnesium.

Applications:

Heavy machinery manufacturing, such as thick plate welding for ships and bridges.

Plasma cutting, which is used to cut carbon steel, stainless steel, and non-ferrous metals.

High-precision welding, such as nuclear reactor components and aero engine blades.

Limitations:

Production costs are higher, and the increase in lanthanum oxide content leads to higher raw material and processing expenses.

Under low current conditions, the arc starting performance of WL20 has no obvious advantage over WL10 and WL15.

2.2 Classification by application scenario

Lanthanum tungsten electrodes have various application scenarios, and can be divided into DC welding, AC welding and special purpose lanthanum tungsten electrodes according to the type of welding current (DC or AC) and process requirements (such as welding or cutting). Different application scenarios have different performance requirements for electrodes, which affect the selection and use of their grades.

2.2.1 Lanthanum tungsten electrode for DC welding

Direct current welding (DC TIG) is the most common application scenario for lanthanum tungsten electrodes, usually in either DC positive (DCEN) or DC reverse (DCEP) mode. DC welding is widely used in the welding of stainless steel, carbon steel, nickel alloy and titanium alloy due to its characteristics of arc concentration, low heat input and high weld quality. The advantages of lanthanum tungsten electrodes in DC welding are their low electron work and excellent arc stability.

Applicable grades: WL10 is suitable for low-current thin plate welding, WL15 and WL20 are suitable for medium-high current and thick plate welding.

Performance characteristics:
Excellent low-current arc starting, WL10 performs best in the range of 10-50 amps.
Concentrated arc to reduce the heat-affected zone (HAZ) and suitable for precision welding.
The electrode tip can be ground into a sharp shape (e.g., 30°-60° cone angle) to enhance arc directivity.

Typical Applications:
Welding of aerospace components such as titanium wing frames.
Pipe welding of chemical equipment such as stainless steel reactors.
Nuclear industry, e.g. packaging welding of zirconium alloy fuel rods.

2.2.2 Lanthanum tungsten electrode for AC welding

AC welding (AC TIG) is mainly used for welding light metals such as aluminum and magnesium because its alternating current can effectively remove oxide film (such as Al_2O_3) from the metal surface. Lanthanum tungsten electrodes excel in AC welding, especially in high-frequency AC mode, maintaining a stable arc and reducing electrode burnout.

Applicable grades: WL15 and WL20 are the first choice for AC welding due to their high lanthanum oxide content for enhanced arc stability and burn resistance.

Performance characteristics:
In AC mode, the electrode tip forms a hemispherical shape with an even arc distribution, which is suitable for wide welds.
With low burn-out rate, WL20 performs well in 100-200 amp AC welding.
Resistant to oxide film interference, suitable for clean welding of aluminum alloys.

Typical Applications:
Aluminum alloy body manufacturing, such as welding of cars and train cars.
Aerospace aluminum structures such as aircraft enclosures and fuel tanks.
Welding of magnesium alloy components in shipbuilding.

2.2.3 Lanthanum tungsten electrodes for special purposes (e.g. plasma cutting)

In addition to TIG welding, lanthanum tungsten electrodes are also widely used in special applications such as plasma cutting, electrical discharge machining (EDM), and electronic device manufacturing. These applications require higher temperature resistance, burn resistance, and electrical conductivity of the electrode, and grades with a high lanthanum oxide content are often selected.

Plasma cutting:

Lanthanum tungsten electrodes (e.g. WL20) are able to withstand high temperature plasma arcs (up to 20,000°C) and provide stable cutting performance.

Applications: Cutting materials such as stainless steel, carbon steel, copper, and aluminum, commonly found in the shipbuilding and construction industries.

Electric Discharge Machining (EDM):
Lanthanum tungsten electrodes are suitable for mold making and precision parts machining due to their high conductivity and corrosion resistance.
Application: EDM of aerospace molds and automotive stamping dies.

Electronic Equipment:
Lanthanum tungsten electrodes are used as electrode materials for certain high-precision electronic components, such as vacuum tubes and cathode ray tubes.
Applications: Semiconductor manufacturing and display production.

2.3 Comparison of lanthanum tungsten electrodes with other tungsten electrodes

Lanthanum tungsten electrodes differ significantly from other tungsten electrodes such as thorium tungsten, cerium tungsten, pure tungsten, zirconium tungsten and yttrium tungsten electrodes in terms of performance, application and safety. The following is a detailed comparison from the aspects of electronic work escape, arc initiation performance, arc stability, burning resistance, environmental protection and applicable scenarios.

2.3.1 Lanthanum tungsten electrode vs thorium tungsten electrode

Thorium tungsten electrodes (WT20, red coated heads) contain 1.8%-2.2% thorium oxide (ThO_2), which is representative of traditional high-performance tungsten electrodes, but its use is severely limited due to the radioactivity of thorium oxide (radiation dose of about 3.60×10^5Curie/kg).

Electron work outcome: The thorium-tungsten electrode is about 2.6 eV, which is slightly lower than that of WL15 and WL20 (2.8-3.2 eV), and the arc initiation performance is slightly better than that of lanthanum tungsten electrode.
Arc stability: The arc stability of the two is comparable in DC welding, but in AC welding, lanthanum tungsten electrode (WL20) is more resistant to oxide film interference.
Burn resistance: Lanthanum tungsten electrodes (WL15 and WL20) have a lower burn loss rate than thorium-tungsten electrodes at high currents, and the electrode life is longer.
Safety: Lanthanum tungsten electrodes are non-radioactive and OSHA and EU RoHS compliant, while thorium-tungsten electrodes may release radioactive dust during processing and use.
Applicable scenarios: Lanthanum tungsten electrode is an ideal substitute for thorium tungsten electrode, suitable for aerospace, nuclear industry and other fields with high safety requirements; Thorium tungsten electrodes are still used for low-cost welding in some developing countries.

2.3.2 Lanthanum tungsten electrode vs cerium tungsten electrode

Cerium tungsten electrode (WC20, grey coated tip) contains 1.8%-2.2% cerium oxide (CeO_2) and is another non-radioactive tungsten electrode that is widely used in low to medium current welding.

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

Electron work outcome: Cerium tungsten electrode is about 2.7-2.8 eV, which is comparable to WL15 and has similar arc initiation performance.
Arc stability: Lanthanum tungsten electrodes (WL15 and WL20) are better than cerium tungsten electrodes in high current (>150 amps) and AC welding.
Burn resistance: The burning rate of lanthanum tungsten electrode is lower than that of cerium tungsten electrode, especially in long-term and high-load welding.
Safety: Both are non-radioactive and have comparable safety.
Applicable scenarios: Cerium tungsten electrodes are suitable for low-current thin plate welding (such as pipes and electronic components); Lanthanum tungsten electrodes are more suitable for high-current and complex metal welding.

2.3.3 Lanthanum tungsten electrode vs pure tungsten electrode

Pure tungsten electrode (WP, green coating head) does not contain any rare earth oxides, and its performance is relatively basic, mainly used for AC welding.

Electron work escape: The pure tungsten electrode is about 4.5 eV, which is much higher than the lanthanum tungsten electrode, and the arc initiation is difficult, especially at low currents.
Arc stability: The arc stability of pure tungsten electrode is acceptable in AC welding, but it is easy to drift in DC welding.
Burn resistance: Pure tungsten electrode has a high burn loss rate and short electrode life, making it not suitable for high-current welding.
Safety: Both are non-radioactive and have comparable safety.
Applicable scenarios: Pure tungsten electrodes are mainly used for AC welding of aluminum and magnesium; Lanthanum tungsten electrodes are suitable for a wider range of DC and AC welding scenarios.

2.3.4 Lanthanum tungsten electrode vs zirconium tungsten electrode

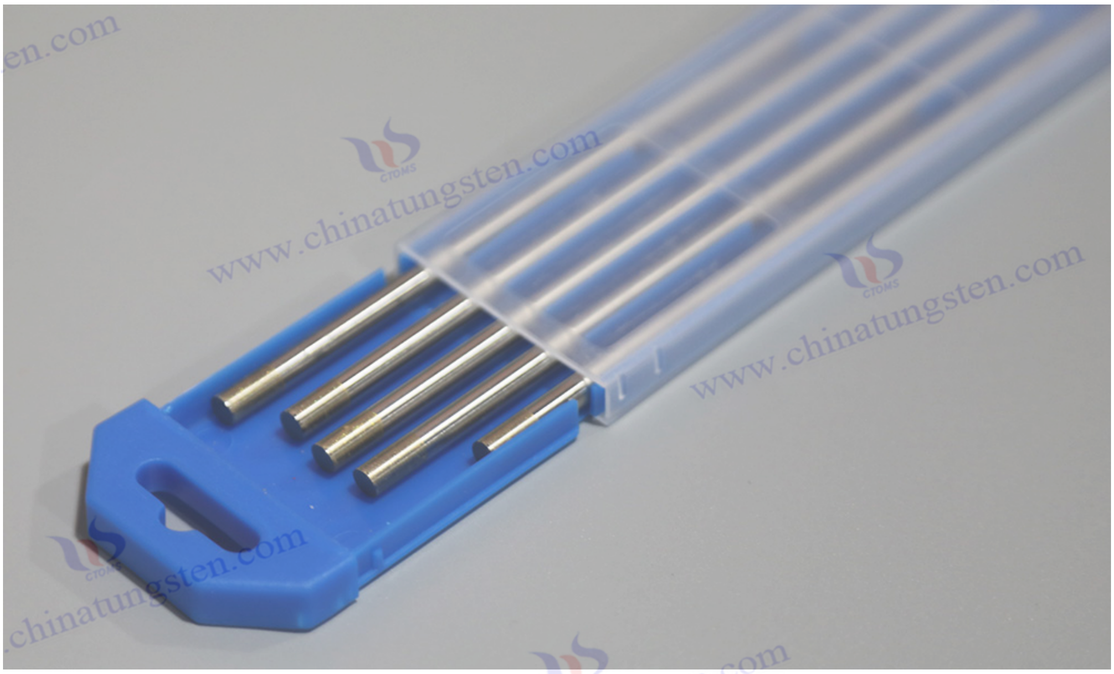
Zirconium tungsten electrodes (WZ8, white coated head) contain 0.7%-0.9% zirconia (ZrO_2) and are mainly used for AC welding.

Electron work escape: Zirconium-tungsten electrode is about 4.2 eV, which is higher than that of lanthanum tungsten electrode, and the arc initiation performance is poor.
Arc stability: Zirconium-tungsten electrode has better arc stability than pure tungsten electrode in AC welding, but inferior to lanthanum tungsten electrode (WL20).
Burn resistance: Zirconium tungsten electrodes have a low burnout rate in AC welding, but do not perform well in DC welding.
Safety: Both are non-radioactive and have comparable safety.
Applicable scenarios: Zirconium tungsten electrodes are specially designed for AC welding of aluminum and magnesium; Lanthanum tungsten electrodes are more versatile and suitable for a wide range of metals and current types.

2.3.5 Lanthanum tungsten electrode vs yttrium tungsten electrode

Yttrium-tungsten electrodes (WY20, dark blue coated tip) contain 1.8%-2.2% yttrium oxide (Y_2O_3)

and are mainly used for DC welding and plasma cutting.
Electron work outcome: Yttrium-tungsten electrode is about 2.8-3.0 eV, which is comparable to WL15 and WL20, and the arc initiation performance is similar.
Arc stability: Yttrium-tungsten electrode has excellent arc stability in high-current DC welding, but its AC welding performance is inferior to that of lanthanum tungsten electrode.
Burn resistance: Yttrium-tungsten electrodes have comparable burn resistance to WL20, but are more resistant to high temperatures in plasma cutting.
Safety: Both are non-radioactive and have comparable safety.
Applicable scenarios: Yttrium-tungsten electrodes are suitable for high-current DC welding and plasma cutting, such as heavy machinery manufacturing; Lanthanum tungsten electrodes are more suitable for general welding and AC scenarios.



CTIA GROUP LTD WL15 electrode

Chapter 3 Characteristics of Lanthanum Tungsten Electrode

The excellent performance of lanthanum tungsten electrodes is due to their unique physical, chemical, electrical and mechanical properties that make them excellent in demanding applications such as tungsten inert gas shielded welding (TIG welding), plasma welding and cutting. This chapter will discuss in detail the physical properties (including melting point, boiling point, density, hardness, thermal conductivity and conductivity), chemical properties (oxidation resistance, corrosion resistance and chemical stability), electrical properties (electron work outlet, arc initiation and arc stability), mechanical properties (burn resistance, wear resistance, toughness and brittleness) of lanthanum tungsten electrodes, and attach a material safety data sheet (MSDS) summary to fully demonstrate the performance characteristics of lanthanum tungsten electrodes.

3.1 Physical properties of lanthanum tungsten electrode

The physical properties of lanthanum tungsten electrode determine its stability and applicability in high-temperature and high-current environments. Doped with lanthanum oxide (La_2O_3), the lanthanum tungsten electrode retains the high melting point and high density of the tungsten matrix while optimizing the thermal and electrical conductivity, making it more suitable for welding and cutting applications.

3.1.1 Melting and boiling points of lanthanum tungsten electrodes

The melting and boiling points of lanthanum tungsten electrodes mainly inherit the high-temperature characteristics of tungsten. Pure tungsten has a melting point of about 3422 °C (6192 °F) and a boiling point of about 5555 °C (10031 °F), the highest of any metal. The doping of 0.8%-2.2% lanthanum oxide has little effect on the melting point and boiling point, and the melting point of lanthanum tungsten electrode is usually between 3400-3420 °C and the boiling point is between 5500-5550 °C. The addition of lanthanum oxide slightly lowers the melting point (lanthanum oxide has a melting point of about 2315°C), but due to its low content (< 2.2%), the effect on the overall high-temperature performance is negligible.

This high melting point allows lanthanum tungsten electrodes to withstand high-temperature arcs (up to 6000-20000°C) in TIG welding and plasma cutting without melting or significant deformation. In practice, the tip of the lanthanum tungsten electrode may form a tiny molten area at high currents, but thanks to the thermal stabilization of lanthanum oxide, the electrode can quickly cool down and maintain its shape, ensuring the quality of the weld.

3.1.2 Density and hardness of lanthanum tungsten electrode

The density of the lanthanum tungsten electrode is close to that of pure tungsten, about 19.25-19.30 g/cm^3, which is slightly lower than that of pure tungsten at 19.35 g/cm^3, due to the doping of lanthanum oxide (density of about 6.51 g/cm^3) reduces the overall density. The high density ensures the structural stability of the electrode, making it less susceptible to deformation or fracture under arc impact.

In terms of hardness, the Vickers hardness of lanthanum tungsten electrodes is usually between 400-450 HV, which is slightly higher than that of pure tungsten electrodes (about 350-400 HV). The grain refinement of lanthanum oxide enhances the hardness of the tungsten matrix, making it more resistant to mechanical wear. There is a slight difference in hardness between grades, e.g. WL20 (2.0% lanthanum oxide) is slightly harder than WL10 (1.0% lanthanum oxide) because the higher content of lanthanum oxide increases the grain boundary strengthening effect.

The high density and hardness give the lanthanum tungsten electrode a long service life in high-load welding, especially when welding cemented carbide or high-strength steel, and is able to resist mechanical wear at the electrode tip.

3.1.3 Thermal conductivity and conductivity of lanthanum tungsten electrode

The thermal conductivity and conductivity of lanthanum tungsten electrodes are the key to maintaining stable performance in welding. Pure tungsten has a thermal conductivity of about 173 W/(m·K) (room temperature) and an electrical conductivity of about 18.5 MS/m (or 5.4 μΩ·cm).

After doping with lanthanum oxide, the thermal conductivity decreased slightly, about 160-170 W/(m·K), and the electrical conductivity was about 17.5-18.0 MS/m. This is because the crystal structure of lanthanum oxide introduces a small amount of grain boundary scattering, which slightly reduces the conduction efficiency of heat and electricity.

Despite this, the thermal conductivity and conductivity of lanthanum tungsten electrodes are much higher than those of most other electrode materials (e.g., copper-based electrodes, which have a thermal conductivity of about 400 W/(m·K) but have a lower melting point. The high thermal conductivity allows the electrode to dissipate heat quickly, reducing burnout caused by overheating the tip; The high conductivity ensures efficient current transmission and reduces energy losses. The WL15 and WL20 are particularly outstanding at high currents (100-300 amps) and are able to maintain stable arc temperature and current density.

3.2 Chemical properties of lanthanum tungsten electrodes

The chemical properties of lanthanum tungsten electrodes determine their stability and durability in complex environments. The doping of lanthanum oxide significantly improves the oxidation resistance and corrosion resistance of the tungsten matrix, making it suitable for a variety of welding environments.

3.2.1 Oxidation resistance of lanthanum tungsten electrodes

Pure tungsten reacts with oxygen at high temperatures (>500°C) to form tungsten trioxide (WO_3), resulting in oxidation of the electrode surface and degradation of performance. After being doped with lanthanum oxide, the oxidation resistance of lanthanum tungsten electrode was significantly improved. Lanthanum oxide (La_2O_3) has high chemical stability at high temperatures, forming a protective oxide layer on the electrode surface, slowing down the reaction rate of tungsten with oxygen. Experiments show that the oxidation weight gain rate of WL20 is only 50%-60% of that of pure tungsten electrode in an oxidation atmosphere of 800°C.

This oxidation resistance allows lanthanum tungsten electrodes to maintain surface integrity during long-term, high-current welding, reducing the risk of oxide contamination of the weld. Especially in plasma cutting, where the electrode is exposed to high-temperature plasma arcs and oxygen, the antioxidant properties of the lanthanum tungsten electrode ensure its long-term stability.

3.2.2 Corrosion resistance of lanthanum tungsten electrodes

Lanthanum tungsten electrodes exhibit excellent corrosion resistance in a variety of chemical environments. Tungsten itself has good corrosion resistance to acids, alkalis and salt solutions, while the doping of lanthanum oxide further enhances its stability in the environment of moisture, salt spray and certain corrosive gases such as hydrogen sulfide. For example, in chloride-containing environments, lanthanum tungsten electrodes have a corrosion rate of about 20%-30% lower than pure tungsten electrodes, thanks to the chemical inertness of lanthanum oxide.

In welding applications, lanthanum tungsten electrodes are commonly used in the welding of stainless steels and nickel-based alloys, which may release corrosive gases or slag. The corrosion resistance of lanthanum tungsten electrode ensures that its surface is not easy to be eroded, maintains the stability of the arc, and prolongs the life of the electrode.

3.2.3 Chemical stability of lanthanum tungsten electrodes

The chemical stability of lanthanum tungsten electrodes is reflected in their low reactivity at high temperatures and complex chemical environments. The melting point (2315°C) and chemical inertness of lanthanum oxide make it difficult to decompose or volatilize in high-temperature arcs, maintaining the stability of electrode composition. In contrast, the thorium oxide (ThO_2) in the thorium-tungsten electrode may release a small amount of radioactive gas at high temperatures, while the lanthanum tungsten electrode does not have this risk and meets strict environmental requirements.

The chemical stability of lanthanum tungsten electrodes during welding is also reflected in their low reactivity to inert gases (e.g., argon, helium), ensuring a clean arc environment and avoiding weld contamination. This makes it particularly suitable for high-precision welding, such as in the nuclear industry and aerospace.

3.3 Electrical properties of lanthanum tungsten electrodes

The electrical properties of lanthanum tungsten electrodes are its core advantages in welding and cutting, which determine its arc initiation performance, arc stability and overall welding efficiency. The doping of lanthanum oxide significantly optimizes the electrical properties of tungsten electrodes.

3.3.1 Electron work of lanthanum tungsten electrode

The work function refers to the minimum energy required for electrons to escape from the surface of the material, which is a key parameter affecting the arcing performance of the electrode. The electron work of pure tungsten is about 4.5 eV, while the work of electron evolution is significantly reduced by the doping of lanthanum oxide in lanthanum tungsten electrodes:

WL10 (1.0% lanthanum oxide): 2.6-2.7 eV
WL15 (1.5% lanthanum oxide): 2.8-3.0 eV
WL20 (2.0% lanthanum oxide): 2.8-3.2 Ev

The low electron work of lanthanum oxide is due to the formation of rare earth oxide particles in the tungsten matrix, which reduce the surface barrier and promote electron emission. Compared to thorium-tungsten electrodes (about 2.6 eV), WL15 and WL20 have slightly higher electron escape work, but in practical applications they are sufficient to provide excellent arc initiation performance while avoiding the risk of radioactivity.

3.3.2 Arc starting performance of lanthanum tungsten electrode

Arc initiation performance refers to how easily an electrode can initiate an arc when a voltage is applied. The low electron work of the lanthanum tungsten electrode makes it easy to start arcing at low voltages and currents (10-50 amps), making it particularly suitable for thin plate welding and precision welding. The WL10 performs best in low-current DC welding, while the WL15 and WL20 also maintain fast arcing at medium to high currents (50-300 amps).

In AC welding, lanthanum tungsten electrodes, especially WL20, are able to respond quickly to changes in current direction, reducing the risk of arc initiation failure. Experiments show that the arc starting time of WL15 is 30%-40% shorter than that of pure tungsten electrode under the condition of 70 ampere DC, which significantly improves the welding efficiency.

3.3.3 Arc stability of lanthanum tungsten electrode

Arc stability refers to the ability of an arc to maintain uniform combustion and avoid drift or interruption during the welding process. The arc stability of the lanthanum tungsten electrode is due to the uniform distribution of lanthanum oxide and the low electron work of escape. In DC welding, WL15 and WL20 are able to form a concentrated and stable arc, reducing spatter and weld defects. In AC welding, the arc stability of WL20 is better than that of pure tungsten and zirconium tungsten electrodes, especially when welding aluminum alloys, it can effectively remove the oxide film and maintain a uniform arc shape.

A key indicator of arc stability is arc voltage fluctuation. The test shows that the voltage fluctuation rate of WL20 in 150 amp AC welding is only ±0.5V, which is better than pure tungsten electrode (±1.2V) and cerium tungsten electrode (±0.8V), ensuring high quality welds.

3.4 Mechanical properties of lanthanum tungsten electrodes

The mechanical properties of lanthanum tungsten electrodes determine their durability under high loads and over long periods of use, including burn resistance, wear resistance, toughness and brittleness.

3.4.1 Burn-off resistance of lanthanum tungsten electrode

Burn resistance refers to the ability of an electrode to resist tip ablation and mass loss under the action of high-temperature arcing. The anti-burning performance of lanthanum tungsten electrodes is better than that of pure tungsten and cerium tungsten electrodes, mainly due to the grain refinement of lanthanum oxide and the high recrystallization temperature (about 1800-2000°C, about 200°C higher than pure tungsten). WL20 exhibits the best resistance to burn loss at high currents (200-300 amps), with a tip consumption rate approximately 20%-30% lower than that of thorium-tungsten electrodes.

In plasma cutting, lanthanum tungsten electrodes are particularly resistant to burning, which can withstand plasma arcs up to 20,000°C, prolong the life of the electrode and reduce the frequency of replacement. For example, when cutting 10 mm thick stainless steel, the average lifetime of a WL20 electrode can be 1.5-2 times that of a pure tungsten electrode.

3.4.2 Abrasion resistance of lanthanum tungsten electrodes

Abrasion resistance refers to the ability of an electrode to resist wear and tear under mechanical contact or arc impact. The high hardness of lanthanum tungsten electrode (400-450 HV) and the grain boundary strengthening effect of lanthanum oxide make it better than pure tungsten electrode.

During the welding process, the electrode tip may be in slight contact with the workpiece or fixture, and the surface of the lanthanum tungsten electrode is not prone to scratches or abrasion, maintaining the integrity of the tip shape.

In high-frequency spot welding or plasma cutting, the wear resistance of the lanthanum tungsten electrode ensures its stability over multiple cycles. For example, the wear rate of WL15 in 100 amp DC welding is only 60%-70% of that of pure tungsten electrodes, which significantly improves the durability of the electrodes.

3.4.3 Toughness and brittleness of lanthanum tungsten electrodes

The toughness and brittleness of lanthanum tungsten electrodes are important aspects of their mechanical properties. Pure tungsten has high brittleness and is prone to grain boundary cracking, especially at high temperatures. After being doped with lanthanum oxide, the toughness of lanthanum tungsten electrode is improved, and the grain refinement reduces the tendency of crack propagation. The fracture toughness ($K_{1}c$) of WL20 is about 10-12 MPa·$m^{1/2}$, which is higher than that of pure tungsten (8-10 MPa·$m^{1/2}$).

However, lanthanum tungsten electrodes may still exhibit some brittleness at extremely high temperatures (>2500°C) or after prolonged use, especially with high lanthanum oxide content (e.g., WL20). Therefore, in production, toughness and brittleness are often balanced by optimizing the sintering and forging processes to ensure that the electrodes are not prone to breakage in practical applications.

3.5 Lanthanum tungsten electrode MSDS from CTIA GROUP LTD

The following is a summary of the Safety Data Sheet (MSDS) of lanthanum tungsten electrode materials provided by CTIA GROUP LTD, which covers its chemical composition, hazard identification, protective measures and handling information based on publicly available information and industry standards.

Material Safety Data Sheet (MSDS) Summary:

Chemical composition:
Tungsten (W): 97.8%-99.2% by mass
Lanthanum oxide (La_2O_3): 0.8%-2.2% (mass fraction, depending on grade).
Impurities: ≤0.1% (including trace elements such as iron, silicon, carbon, etc.)

Hazard Identification:
Health hazards: Lanthanum tungsten electrode is non-radioactive and harmless to the human body under normal use. Processing (e.g., cutting, grinding) may produce tungsten dust, which may cause respiratory irritation if inhaled for a long time.
Environmental hazards: There is no significant environmental hazard, but the waste should be recycled and disposed of in accordance with local regulations to avoid pollution.
Physical hazards: During high-temperature welding, the electrode may release a small amount of

oxide gas, so ensure ventilation.
Protective measures:
Personal Protection: Wear a dust mask (N95 or higher) and protective eyewear during processing. Use a welding mask and heat-resistant gloves when welding.
Ventilation requirements: When used in a closed environment, ensure local exhaust or use of ventilation equipment.
Storage conditions: Store in a dry, cool place, avoid humidity and high temperatures.

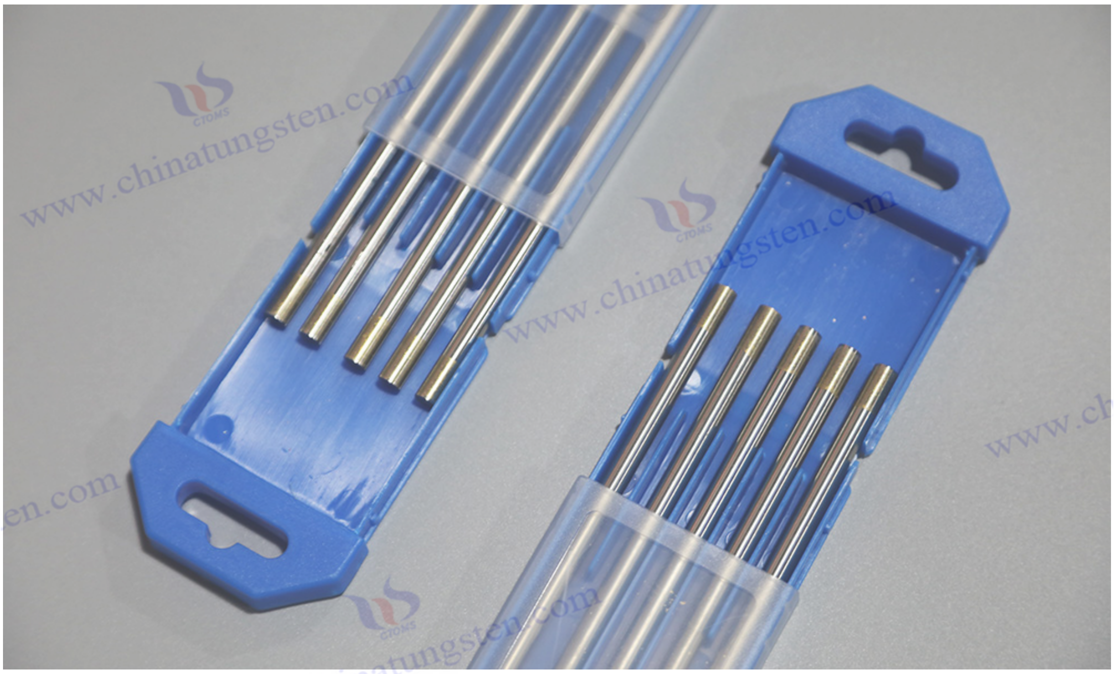
First Aid Measures:
Inhalation: If dust is inhaled, move to a ventilated place and seek medical attention if necessary.
Skin contact: Wash the contact area with soap and water.
Eye contact: Rinse with plenty of water for at least 15 minutes and seek medical attention if necessary.

Handling & Disposal:
Waste lanthanum tungsten electrodes should be sent to a professional recycling institution for disposal to avoid discarding them at will.
Comply with the requirements of international standards (e.g. RoHS) and Chinese environmental regulations (e.g. GB/T 26572).

Shipping Information:
Non-dangerous goods, can be transported as conventional goods, but need to be moisture-proof and shockproof packaging.

Regulatory Information:
Complies with ISO 6848:2015 and GB/T 14841 standards.
No special permits are required, and processing and use are subject to occupational health and safety regulations (e.g. OSHA).

Supplier information
Supplier: CTIA GROUP LTD
Tel: 0592-5129696/5129595



CTIA GROUP LTD WL15 electrode

Chapter 4 Uses of Lanthanum Tungsten Electrode

Lanthanum tungsten electrodes are widely used in modern industry due to their excellent arc initiation performance, arc stability, non-radioactivity and low burn-out rate, covering welded, non-welded and special high-demand fields. Its versatility and high performance make it the material of choice for tungsten inert gas shielded welding (TIG welding), plasma welding and cutting, electrical discharge machining (EDM), as well as aerospace, nuclear industry, and medical device manufacturing. This chapter will discuss in detail the applications of lanthanum tungsten electrodes in welding (including TIG welding, plasma welding and applicable metal types), non-welding applications (plasma cutting, EDM and electronics), special applications (aerospace, nuclear industry and medical device manufacturing) and specific application cases, showing their importance and diverse uses in industry.

4.1 Lanthanum tungsten electrodes are used in the field of welding

Welding is the most important application field of lanthanum tungsten electrode, and its performance is particularly prominent in tungsten inert gas welding (TIG welding) and plasma welding. The low electron work (2.6-3.2 eV), excellent arc stability and burn-out resistance of lanthanum tungsten electrodes enable them to meet the needs of high-precision, high-quality welds, especially in scenarios where weld appearance and mechanical properties are critical, such as aerospace, energy, and chemical equipment manufacturing.

4.1.1 Applications in TIG (argon arc welding).

Tungsten inert gas shielded welding (TIG welding, also known as argon arc welding) is the core application field of lanthanum tungsten electrode. TIG welding utilizes tungsten electrodes protected by an inert gas such as argon or helium to create an electric arc that heats the workpiece and filler material to form a high-quality weld. The process is widely used for high-precision and high-quality welding tasks due to its spatter-free, aesthetically pleasing welds and adaptability to a wide range of metals. The advantages of lanthanum tungsten electrode in TIG welding are reflected in the following aspects:

Excellent arc initiation performance: Lanthanum tungsten electrodes (especially WL10 and WL15) can easily start arcing at low currents (10-50 A) and are suitable for thin plate welding (e.g. 0.5-2 mm stainless steel or aluminum alloy). Its low electron escape work ensures fast ignition and reduces the risk of arc initiation failure.

Arc stability: WL15 and WL20 can maintain a concentrated and stable arc in the current range of 50-300 amps, reduce arc drift and spatter, and ensure the uniformity and surface quality of the weld. Especially in the DC positive electrode (DCEN) mode, the arc has strong directivity and concentrated heat input, which is suitable for precision welding.

Low burn-out rate: Lanthanum-tungsten electrode has a low burn-out rate under high-temperature arc, and the tip shape is stable, which prolongs the life of the electrode. For example, in 150 amp DC welding, the burn-off rate of WL20 is about 30%-40% lower than that of pure tungsten electrodes, which reduces the frequency of electrode replacement and improves production efficiency.

DC & AC Universal: Lanthanum tungsten electrodes perform well in both DC (DC) and AC (AC) welding. WL20 can quickly remove the surface oxide film (Al_2O_3) when welding aluminum alloys in AC, forming a uniform weld.

Typical Application Scenarios:

Pipe welding: In the petrochemical and natural gas industries, lanthanum tungsten electrodes are used for TIG welding of stainless steel and nickel-based alloy pipes to ensure that the welds are defect-free and meet the requirements of high-pressure and corrosive environments.

Sheet welding: In the electronics industry and medical equipment manufacturing, WL10 is used for welding stainless steel or titanium alloy sheets with a thickness of 0.5-1 mm to ensure the strength and beauty of the weld.

Automated welding: In automobile manufacturing, welding robots use WL15 to perform TIG welding of high-strength steel and aluminum alloys, improving production efficiency and weld consistency.

The popularity of TIG welding has promoted the wide application of lanthanum tungsten electrodes, especially in the European and American markets, WL15 has become the mainstream choice because of its performance close to that of thorium tungsten electrodes, accounting for 20%-30% of the global TIG electrode market.

4.1.2 Plasma welding

Plasma Arc Welding (PAW) is a welding technology that uses confined arc to generate a high-temperature plasma beam, with an arc temperature of 15000-25000°C, and a more concentrated heat input, which is suitable for high-precision and high-efficiency welding. Lanthanum tungsten electrodes are favored in plasma welding for their resistance to high temperatures and burning.

Performance Advantages:

High temperature stability: WL20 can withstand the high temperature and strong impact of the plasma arc, and the tip is not easy to melt or deform, prolonging the life of the electrode.

Arc concentration: The arc beam of plasma welding is narrow (about 0.1-2 mm in diameter), and the lanthanum tungsten electrode can provide a stable current focus, which is suitable for deep penetration welding and microhole welding.

Low contamination: The chemical stability of the lanthanum tungsten electrode ensures that it does not release contaminants under the protection of inert gas, keeping the weld seam clean.

Process characteristics:

Plasma welding is divided into micro-plasma (1-30 amps) and conventional plasma (30-1000 amps). WL10 is suitable for micro-plasma welding for thin sheets of 0.1-1 mm thickness, while WL15 and WL20 are suitable for conventional plasma welding for metals 2-10 mm thick.
Plasma welding often adopts the DC cathode mode, and the low electron escape work of the lanthanum tungsten electrode ensures fast arc initiation and stable arcing.

Typical Application Scenarios:

Aerospace: Plasma welding is used for precision components of titanium and nickel-based alloys, such as turbine blades and combustion chambers, requiring welds to be free of porosity and cracks.

Electronics industry: Micro-plasma welding is used in the manufacture of semiconductor packages and miniature connectors, and lanthanum tungsten electrodes guarantee high precision and a low heat-affected zone.

Pressure vessels: In the chemical and energy industries, plasma welding is used for deep penetration welding of thick-walled stainless steel vessels, and lanthanum tungsten electrodes improve welding efficiency and quality.

Plasma welding has extremely high requirements for electrode performance, and the excellent performance of lanthanum tungsten electrode makes it gradually replace thorium-tungsten electrode in this field, especially in areas with strict environmental regulations.

4.1.3 Applicable metal types (stainless steel, aluminum alloys, nickel alloys, etc.).

The versatility of lanthanum tungsten electrodes makes them suitable for welding a wide range of metals, including but not limited to stainless steel, aluminum alloys, nickel alloys, titanium alloys, copper alloys, and carbon steel. The following are the characteristics of its application in the main metal types:

Stainless steel:
Features: Stainless steels (including austenitic, ferritic, and martensitic stainless steels) have good corrosion resistance and high temperature strength, and are widely used in chemical, food processing, and medical equipment manufacturing. Lanthanum tungsten electrodes (WL15 and WL20) provide a stable arc in DC cathode mode, reducing the heat-affected zone and avoiding intergranular corrosion.

Application: TIG welding of 304 and 316 stainless steel pipes, weld fabrication of pressure vessels.

Advantages: The low burn-out rate and arc stability of the lanthanum tungsten electrode ensure that the weld seam is beautiful and free of oxide inclusions.

Aluminum alloy:
Features: Aluminum alloys (such as 6061, 7075) have high thermal conductivity and surface oxide film (Al_2O_3), which needs to be removed by AC TIG welding. The WL20 performs best in AC mode, quickly removing oxide film and maintaining a uniform arc.

Applications: Welding of aerospace aluminum structures (e.g. aircraft shells), car bodies and ship decks.

Advantages: The low burn-out rate and oxidation resistance of lanthanum tungsten electrode in AC welding improve the weld quality.

Nickel alloys:
Features: Nickel-based alloys (such as Inconel 625, Hastelloy C-276) have excellent high-temperature strength and corrosion resistance, and are widely used in the aerospace and nuclear industries. Lanthanum tungsten electrodes provide a concentrated arc in DC welding and are suitable for high-precision welds.

Application: Welding of gas turbine blades, nuclear reactor pipes.

Advantages: The burn resistance and chemical stability of lanthanum tungsten electrodes reduce weld defects.

Titanium alloy:
Features: Titanium alloys (such as Ti-6Al-4V) have high strength and low density, but are sensitive to oxygen and require strict inert gas protection. WL15 excels in DC low-current welding, reducing heat input and avoiding oxidation.

Application: Welding of aerospace wing skeletons, medical implants.

Advantages: The low electron escape work and arc stability of the lanthanum tungsten electrode ensure a porosity-free weld.

Copper alloys and carbon steels:

Features: Copper alloys (such as brass, bronze) have high thermal conductivity and require high current welding; Carbon steel (such as Q235) has low cost and a wide range of applications. WL20 is suitable for high current welding of copper alloys, and WL10 is suitable for low current welding of carbon steel.

Application: Welding of copper alloy heat exchanger and carbon steel structural parts.

Advantage: The versatility of lanthanum tungsten electrodes meets the needs of different currents and metals.

The versatility of lanthanum tungsten electrodes makes them indispensable materials in the welding industry, especially in multi-metal combination welding such as stainless steel and nickel alloys, where its performance stability is widely recognized.

4.2 Lanthanum tungsten electrodes are used in non-welding fields

In addition to welding, lanthanum tungsten electrodes also have important applications in non-welding fields, including plasma cutting, electrical discharge machining (EDM), and electronics manufacturing. These fields require high temperature resistance, electrical conductivity and corrosion resistance of electrodes, and lanthanum tungsten electrodes are ideal for their excellent properties.

4.2.1 Plasma cutting

Plasma cutting is a processing technology that uses a high-temperature plasma arc (temperature up to 20,000°C) to melt and blow off metal, and is widely used to cut carbon steel, stainless steel, aluminum, copper and other materials. Lanthanum tungsten electrodes, especially WL20, excel in plasma cutting due to their resistance to high temperatures and burning.

Performance Advantages:

High temperature resistance: WL20 is able to withstand the high temperature impact of the plasma arc, and the tip consumption rate is low, extending the electrode life.

Arc stability: Lanthanum tungsten electrode provides a stable plasma arc to ensure a flat cutting edge and reduce burrs.

Oxidation resistance: In oxygenated plasma gases such as air or oxygen, lanthanum tungsten electrodes have a low oxidation rate and maintain surface integrity.

Application Scenarios:

Shipbuilding industry: cutting stainless steel and carbon steel plates 10-50 mm thick for hull and deck manufacturing.

Construction industry: cutting steel structure beams and columns to meet the precision requirements of building frames.

Automobile manufacturing: cutting aluminum alloy body parts to improve production efficiency.

Practical example: In a shipyard's plasma cutting line, a 20 mm thick stainless steel plate was cut with a WL20 electrode, and the electrode life was about 50% longer than that of a pure tungsten electrode, and the cutting speed was increased by 15%, significantly reducing production costs.

Plasma cutting has extremely high requirements for the durability of the electrode, and the excellent performance of lanthanum tungsten electrode makes it gradually replace thorium tungsten electrode in this field and become the industry standard.

4.2.2 Electric discharge machining (EDM)

Electrical Discharge Machining (EDM) is a high-precision machining technology that ablates materials by electrical sparks, and is widely used in mold making and complex parts machining. Lanthanum tungsten electrodes are suitable as electrode materials for EDM due to their high conductivity, corrosion resistance and wear resistance.

Performance Advantages:

High electrical conductivity: The conductivity of the lanthanum tungsten electrode (approx. 17.5-18.0 MS/m) ensures efficient EDM discharge and fast processing speed.

Abrasion resistance: The high hardness of WL15 and WL20 (400-450 HV) makes it less susceptible to wear in multiple discharges and maintains the electrode shape.

Corrosion resistance: In EDM's electrolytes such as kerosene or deionized water, the chemical stability of lanthanum tungsten electrodes avoids surface corrosion.

Application Scenarios:

Mold manufacturing: used for precision machining of stamping molds and injection molds, such as molds for auto parts.

Aerospace: Machining complex geometries of turbine blades and engine nozzles.

Medical devices: Manufacture of high-precision components for surgical knives and orthopedic implants.

Practical example: In an aerospace mold factory, WL15 electrodes are used for EDM machining of nickel-based alloy molds, with a machining accuracy of ±0.01 mm, and the electrode consumption is 30% lower than that of copper electrodes, which improves the surface quality and production efficiency of the mold.

The application of lanthanum tungsten electrodes in EDM has driven the development of high-precision machining technology, especially in the aerospace and medical fields.

4.2.3 Electrode materials in electronic devices

Lanthanum tungsten electrodes are used as electrode materials in the manufacture of electronic devices due to their high conductivity, high temperature resistance, and chemical stability, especially in vacuum tubes, cathode ray tubes (CRTs), and certain semiconductor devices.

Performance Advantages:

High electrical conductivity: The high conductivity of lanthanum tungsten electrodes ensures efficient current transmission and is suitable for high-frequency electronic applications.

High temperature resistance: In a vacuum or inert gas environment, lanthanum tungsten electrode can withstand high temperatures (1000-2000°C) and maintain stable performance.

Chemical stability: Lanthanum tungsten electrodes do not react easily with gases or materials in electronic devices, prolonging device life.

Application Scenarios:

Vacuum tube: Lanthanum tungsten electrodes are used as cathode materials to emit electrons to generate electric current, which is used in high-power amplifiers and radar equipment.

Cathode Ray Tube: The WL15 electrode is used in the electron gun of the CRT display to provide a stable electron beam.

Semiconductor manufacturing: Lanthanum tungsten electrodes are used in certain plasma etching equipment, processing silicon wafers and integrated circuits.

Practical example: In a semiconductor equipment manufacturer, the WL20 electrode is used in a plasma etching machine with nanometer accuracy, and the electrode life is 40% longer than that of traditional copper-based electrodes, reducing maintenance costs.

Although the application of lanthanum tungsten electrode in electronic equipment is small-scale, its high performance makes it irreplaceable in the high-tech field.

4.3 Special applications of lanthanum tungsten electrodes

The non-radioactivity and excellent properties of lanthanum tungsten electrodes make them ideal for special applications in demanding fields such as aerospace, nuclear industry, and medical device manufacturing, where material properties, safety, and reliability are critical.

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

4.3.1 Aerospace industry

The aerospace industry has extremely stringent performance requirements for welding and cutting materials, and welds must be high-strength, defect-free and resistant to high-temperature corrosion. The applications of lanthanum tungsten electrodes in this field are mainly focused on TIG welding, plasma welding and cutting.

App Features:

Titanium alloy welding: WL15 is used for TIG welding of Ti-6Al-4V titanium alloy to manufacture aircraft wing skeleton and engine parts, the weld is non-porosity, and the fatigue resistance is excellent.

Nickel-based alloy welding: WL20 is used for plasma welding of Inconel 718 nickel-based alloys to manufacture gas turbine blades, and the welds are resistant to high-temperature oxidation.

Aluminum alloy cutting: WL20 is used for plasma cutting aluminum alloy body panels, the cutting edge is flat, reducing subsequent processing.

Advantage:

Non-radioactive and meets the strict safety standards of the aerospace industry.

Low burnout rate and arc stability improve welding and cutting efficiency.

It is suitable for automated welding to meet the needs of mass production of aerospace components.

Practical example: An aviation manufacturing company used WL15 electrodes to weld the titanium alloy frame of a Boeing 787 aircraft, and the weld passed ultrasonic testing (UT) and X-ray testing (RT), with a pass rate of 99.5%, which significantly improved production efficiency.

4.3.2 Nuclear industry

The nuclear industry places high demands on the reliability and safety of welding materials, which must withstand high temperatures, pressures and radiation environments. Lanthanum tungsten electrodes are widely used in nuclear reactor pressure vessels, fuel rod encapsulation, and pipeline welding.

App Features:

Zirconium alloy welding: WL10 is used for TIG welding of zirconium alloy fuel rods, low current arcing reduces heat input and avoids the growth of material grains.

Stainless steel welding: WL20 is used for plasma welding of 316L stainless steel pressure vessels, and the deep penetration weld ensures tightness.

Nickel alloy pipes: WL15 is used for TIG welding of Hastelloy alloy pipes, the welds are corrosion-resistant, and meet the requirements of nuclear waste storage.

Advantage:

It is non-radioactive, avoiding the radiation risk that can be introduced by thorium-tungsten electrodes.

The high arc stability ensures that the weld seam is defect-free and meets the strict inspection standards of the nuclear industry.

Corrosion resistance and chemical stability are suitable for the complex chemical conditions of the nuclear environment.

Practical example: In the construction of a nuclear power plant in China, the WL20 electrode is used for TIG welding of the reactor cooling pipe, and the weld has passed the helium leak detection test, and the leakage rate is less than 10^{-9} Pa·m³/s, which meets nuclear safety requirements.

4.3.3 Manufacture of medical equipment

The application of lanthanum tungsten electrodes in this field is mainly focused on precision welding of titanium alloys and stainless steels, as well as EDM machining, due to the extremely high requirements for cleanliness and precision of welding and processing materials in medical device manufacturing.

App Features:

Titanium Implants: WL10 is used for TIG welding of titanium alloy orthopedic implants (such as hip prostheses) with low heat input to avoid deterioration of material properties.

Stainless steel surgical instruments: WL15 is used for micro-plasma welding of stainless steel surgical knives, the weld seam is smooth, and there is no need for secondary polishing.

EDM machining: WL20 is used to manufacture miniature medical device molds, such as syringe needle molds, with a machining accuracy of ±0.005 mm.

Advantage:

Non-radioactive and highly chemically stable, avoiding contamination of medical equipment.

The low burn-out rate and arc stability improve the accuracy of welding and machining.

It is suitable for the machining of tiny workpieces and meets the tight tolerances of medical devices.

Practical example: A medical device manufacturer used WL15 electrodes to weld the titanium alloy shell of a pacemaker, and the weld passed the biocompatibility test, and the product had a pass rate of 99.8%, meeting the ISO 13485 medical device quality standard.

4.4 Lanthanum tungsten electrode application case analysis

The following two specific cases analyze the actual performance of lanthanum tungsten electrodes in high-precision welding and high-temperature environments, and demonstrate their advantages in industrial applications.

4.4.1 Application of lanthanum tungsten electrode in high-precision welding

Case background: When manufacturing turbine engine blades, an aerospace company needs to perform TIG welding on Inconel 718 nickel-based alloy, which requires the weld to be free of porosity, cracks, and excellent fatigue resistance. The traditional thorium-tungsten electrode was disabled due to radioactivity issues, and the customer chose WL20 lanthanum tungsten electrode.

Implementation process:
Equipment and parameters: using DC cathode TIG welding machine, current 150-200 amperes, argon protection, electrode diameter 2.4 mm, tip grinding into 45° cone angle.
Material: Inconel 718 sheet, 3 mm thick, filled with the same alloy wire.
Process: Pulse TIG welding, pulse frequency 2 Hz, peak current 180 A, base value current 80 A, shielding gas flow rate 12 L/min.

Results and Analysis:
Weld quality: The weld passes X-ray inspection (RT) and fluorescence penetrant testing (PT), there are no porosity or cracks, the weld width is uniform (about 2.5 mm), and the surface is smooth.
Electrode performance: After 8 hours of continuous welding, the tip burnout of WL20 electrode is only 0.2 mm, which is much lower than that of pure tungsten electrode (0.5 mm). The arc stability is excellent, and the voltage fluctuation rate is ± 0.4V.
Improved efficiency: Compared with cerium tungsten electrodes, WL20 has a 30% reduction in electrode replacement frequency and a 15% increase in welding efficiency.
Safety: Non-radioactive, meets OSHA safety standards for the aerospace industry, and requires no additional protection for operators.

Conclusion: The excellent performance of WL20 lanthanum tungsten electrode in high-precision welding ensures the quality and production efficiency of the weld, and becomes an ideal choice for nickel-based alloy welding.

4.4.2 Performance of lanthanum tungsten electrode in high temperature environment

Case Background: A shipyard needed to use a plasma cutter to cut a 20 mm thick stainless steel sheet (316L) for hull fabrication. The cutting environment temperature is high (about 40°C) and continuous operation is required, so the customer chose WL20 lanthanum tungsten electrode.

Implementation process:
Equipment and parameters: using air plasma cutting machine, current 200 A, cutting speed 0.5 m/min, plasma gas for compressed air, electrode diameter 3.2 mm.
Material: 316L stainless steel plate, thickness 20 mm.
Process: Piercing cutting, the distance between the nozzle and the workpiece is 4 mm, and the cutting path is a combination of straight lines and curves.

Results and Analysis:

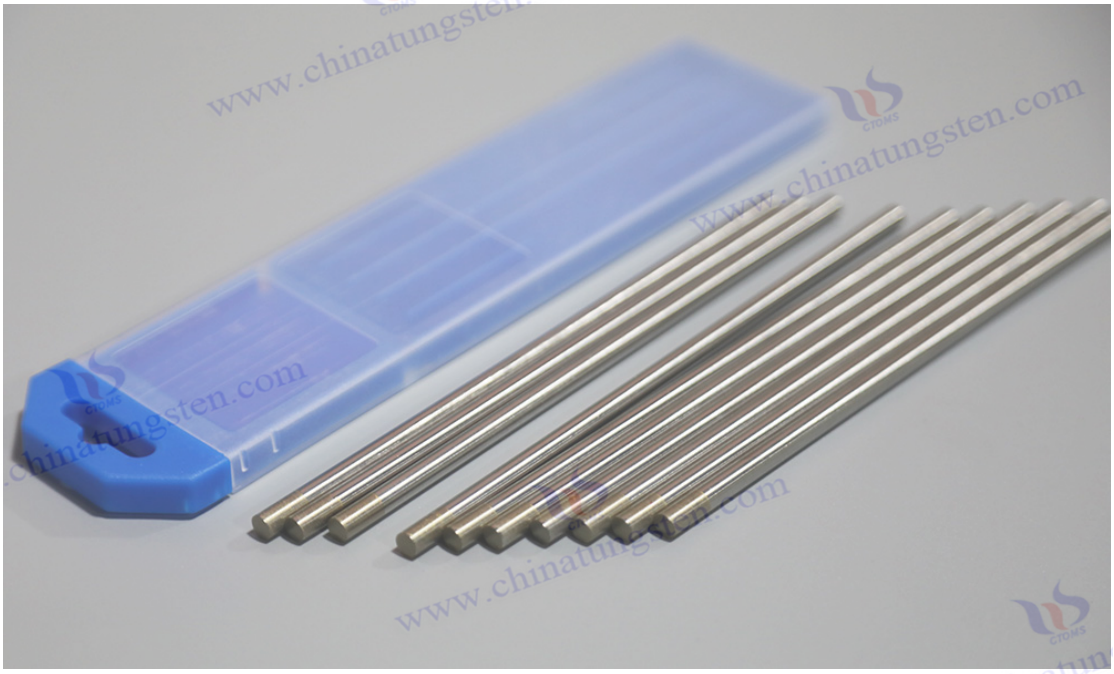
Cutting quality: The cutting edge is flat, the burr height is < 0.3 mm, and the cutting width is about 2.8 mm, which meets the accuracy requirements of hull assembly.

Electrode performance: After 10 hours of continuous cutting, the tip burn loss of WL20 electrode is 0.3 mm, and the life is about 40% longer than that of thorium tungsten electrode. Excellent arc stability with no interruptions or drifts.

High temperature resistance: In a high temperature environment of 40°C, the oxidation resistance of lanthanum tungsten electrode ensures that there is no obvious oxide layer on the surface and maintains the arc efficiency.

Cost-effective: The extended electrode life reduces replacement costs, and the cost per cut is 20% lower than using pure tungsten electrodes.

Conclusion: The burn-out resistance and arc stability of WL20 lanthanum tungsten electrode in high temperature environment make it perform well in plasma cutting, and significantly improve the cutting efficiency and economy.



CTIA GROUP LTD WL15 electrode

Chapter 5 Preparation and Production Technology of Lanthanum Tungsten Electrode

The preparation and production process of lanthanum tungsten electrode is a key link to ensure its high performance and consistency, involving raw material preparation, production process, key technology, quality control and environmental protection measures. Lanthanum tungsten electrodes are made through a powder metallurgy process, combined with high-precision processing and strict quality management, to meet the needs of demanding applications such as welding and cutting. This chapter will discuss in detail the preparation of raw materials for lanthanum tungsten electrodes (tungsten powder, lanthanum oxide and other additives), production processes (mixing, pressing, sintering, forging, drawing and surface treatment), key production technologies (uniform doping, high-temperature sintering, precise dimensional control and surface coating), quality control systems (raw materials, production processes and finished product inspection), technology development trends (green manufacturing and automation), and environmental protection measures (exhaust gas, wastewater and solid waste management). to fully demonstrate the complexity and technological advancement of its production process.

5.1 Preparation of raw materials for lanthanum tungsten electrode

The performance of lanthanum tungsten electrodes is directly dependent on the quality and purity of the raw material. Tungsten powder and lanthanum oxide are the main raw materials, while other additives are used to optimize the production process or performance. The selection and handling of raw materials is the basis for the production of high-quality lanthanum tungsten electrodes.

5.1.1 Selection and purification of tungsten powder

Tungsten powder is the main component of lanthanum tungsten electrode, accounting for 97.8%-99.2% of its mass. High-purity tungsten powder is the key to ensuring electrode conductivity, thermal stability, and mechanical properties.

Selection Criteria:
Purity: The purity of tungsten powder is usually required to reach more than 99.95% (i.e., impurity content $< 0.05\%$) to reduce the influence of impurities such as iron, silicon, and carbon on the electrode performance. Common impurities such as iron (Fe<50 ppm) or oxygen (O<100 ppm) can reduce the resistance of the electrode to burning.
Particle size: The particle size of tungsten powder is generally controlled at 1-5 microns, and excessive particles will lead to uneven sintering and affect the ultimate electrical density; Particles that are too small increase production costs.
Morphology: Spherical or near-spherical tungsten powder is preferred, because it has good fluidity, which is conducive to the subsequent mixing and pressing process.

Purification process:
Chemical purification: Starting from tungstate or tungsten concentrate, tungsten oxide (WO_3) is reduced to tungsten powder by hydrogen reduction method. The reduction process takes place in a hydrogen atmosphere of 800-1000°C in two stages ($WO_3 \rightarrow WO_2 \rightarrow W$) to ensure a low oxygen content.

Physical purification: Gasflow classification or sieving is used to remove large particles and impurities to further improve the purity and uniformity of tungsten powder.
Quality inspection: Inductively coupled plasma optical emission spectroscopy (ICP-OES) is used to analyze the chemical composition of tungsten powder to ensure that the impurity content meets the standard (e.g., GB/T 3458-2006).

5.1.2 Preparation and doping of lanthanum oxide

Lanthanum oxide (La_2O_3) is the active component of lanthanum tungsten electrode, and its content (0.8%-2.2%) directly affects the electron work and arc stability of the electrode. The preparation and doping of lanthanum oxide is a critical step in the production process.
Preparation process:
Raw material extraction: Lanthanum oxide is extracted from rare earth minerals (such as monazite or bascarsite) to prepare high-purity lanthanum oxide (purity>99.99%) by solvent extraction and precipitation.
Particle size control: The particle size of lanthanum oxide powder is usually controlled at 0.5-2 microns to ensure uniform mixing with tungsten powder. Excessively large particles can lead to uneven doping, affecting electrode performance.
Drying and calcination: Lanthanum oxide needs to be calcined at 600-800 °C after preparation to remove water and volatile impurities and improve its chemical stability.

Doping method:
Dry doping: Lanthanum oxide powder is mixed with tungsten powder in a high-energy ball mill, the ball milling time is usually 4-8 hours, and the rotation speed is 200-400 rpm to ensure that the lanthanum oxide is evenly distributed.
Wet doping: Lanthanum oxide is dissolved in nitric acid or other solvents to form a solution, mixed with tungsten powder and dried. This method can further improve the doping uniformity, but the pH of the solution (usually 4-6) needs to be tightly controlled to avoid oxidation of tungsten powder.
Doping ratio: According to the electrode grade (WL10, WL15, WL20), the mass fraction of lanthanum oxide is controlled at 0.8%-1.2%, 1.3%-1.7% and 1.8%-2.2%, respectively.

Challenge: Lanthanum oxide can volatilize at high temperatures (e.g. 2000°C) and the atmosphere (e.g. hydrogen or vacuum) needs to be controlled during the sintering process to reduce losses.

5.1.3 Selection of other additives

In addition to tungsten powder and lanthanum oxide, small amounts of additives may be added to the production to optimize the process or performance. These additives need to be compatible with tungsten and lanthanum oxide without affecting the conductivity and chemical stability of the electrode.

Common additives:
Binders: such as polyvinyl alcohol (PVA) or polyethylene glycol (PEG), which are used to improve the strength of the pressed body, usually in 0.1%-0.5% dosage.
Dispersants: such as sodium silicate, are used to improve the mixing uniformity of tungsten powder

and lanthanum oxide, and the addition amount is < 0.1%.

Trace rare earth oxides, such as cerium oxide (CeO_2) or yttrium oxide (Y_2O_3), are added (<0.2%) in some special formulations to further optimize arc performance.

Selection Criteria:

The additives need to be completely volatilized or decomposed in high-temperature sintering to avoid residues in the electrode affecting performance.

Meet the requirements of environmental protection and avoid the use of additives containing harmful substances such as lead and cadmium.

The dosage should be strictly controlled to ensure that the active effect of lanthanum oxide is not affected.

Application example: In the production of WL20 electrodes, the addition of 0.3% PVA as a binder can improve the strength of the pressed green body and reduce the crack rate during the sintering process.

5.2 Production process of lanthanum tungsten electrode

Lanthanum tungsten electrodes are produced using a powder metallurgy process with core processes including mixing and pressing, sintering, forging and drawing, and surface treatment. Each step requires precise control to ensure the performance and consistency of the electrode.

5.2.1 Mixing and Pressing

Mixing and pressing is the first step in the production of lanthanum tungsten electrodes, the purpose of which is to homogeneously mix tungsten powder, lanthanum oxide and other additives to form a green body with a certain strength.

Mix:

Equipment: High energy ball mill or V-mixer, mixing time 4-8 hours, speed 200-400 rpm.

Process: Mix in an inert gas (e.g. nitrogen) or vacuum to avoid oxidation of tungsten powder. After mixing, the homogeneity of the powder is checked by a laser particle size analyzer to ensure that the lanthanum oxide is evenly distributed (deviation <5%).

Challenge: The density of lanthanum oxide (6.51 g/cm³) is much lower than that of tungsten powder (19.35 g/cm³), which is prone to stratification and requires optimization of mixing parameters.

Suppress:

Equipment: hydraulic press or isostatic press with pressure 100-300 MPa.

Process: The mixed powder is loaded into a mold and pressed into a cylindrical body (diameter 10-50 mm, length 50-100 mm). The isostatic pressing process increases the density of the green body (up to 60%-70% of the theoretical density) and reduces sintering shrinkage.

Quality control: check that there are no cracks on the surface of the green body, the density is uniform, and the dimensional deviation is < 0.1 mm.

5.2.2 Sintering process

Sintering is a key step in heating the pressed green body to a high temperature so that its particles combine to form a dense body, which directly affects the density and mechanical properties of the electrode.

Equipment: High temperature vacuum sintering furnace or hydrogen protection sintering furnace.

Process Parameters:

Temperature: 1800-2200°C, temperature increase in stages (500°C/h to 1200°C, 200°C/h to target temperature), keep warm for 2-4 hours.
Atmosphere: hydrogen (reducing atmosphere, prevents oxidation) or vacuum (pressure< 10^{-3} Pa, reduces lanthanum oxide volatilization).
Results: After sintering, the density of the electrode body reached 95%-98% of the theoretical density, and the grain size was controlled at 10-20 microns.

Technical Highlights:
Control the heating rate to avoid cracking of the green body.
Optimize the sintering temperature to ensure uniform lanthanum oxide distribution and avoid grain boundary segregation.
High-temperature molybdenum boat or tungsten boat is used as the body carrier to prevent pollution.

Challenge: High-temperature sintering may lead to partial volatilization of lanthanum oxide, which needs to be controlled by adding trace protective agents (e.g. alumina) or optimizing the atmosphere.

5.2.3 Forging and drawing

Forging and drawing are the steps in which the sintered body is machined into an elongated electrode rod, which determines the final size and mechanical properties of the electrode.

Forging:
Equipment: Rotary forging machine or hammer forging machine.
Process: The sintered green body is heated to 1200-1500 °C, and a bar with a diameter of 5-10 mm is formed through multi-pass forging (deformation of 10%-20% per pass). Forging increases the density (>99%) and toughness of the electrode.
Quality control: Check that there are no cracks on the surface of the bar and no holes inside (by ultrasonic testing).

Drawing:
Equipment: Multi-mode drawing machine with diamond mold.
Process: The forged bar is gradually drawn to the target diameter (0.25-6.4 mm), the diameter reduction rate of each pass is 10%-15%, and the middle needs to be annealed (1000-1200°C, hydrogen protection) to relieve the processing stress.
Results: The tolerance of the electrode diameter was <± 0.02 mm, and the surface roughness was

Ra<0.8 μm.

Challenge: The amount of lubricant (e.g. graphite emulsion) needs to be controlled during the drawing process to avoid surface contamination; High-temperature annealing needs to prevent lanthanum oxide from volatilizing.

5.2.4 Surface Treatment

Surface treatment is the final step in the production of lanthanum tungsten electrodes and aims to improve the surface quality and usability of the electrodes.

Polished:
Equipment: Center less grinding machine or electrochemical polishing equipment.
Process: Through mechanical polishing (grinding wheel particle size 200-400 mesh) or electrochemical polishing (electrolyte is sulfuric acid solution), the surface roughness of the electrode Ra < 0.4 microns, and the arc stability is improved.
Function: Polishing removes surface oxide layers and minor defects, and reduces arc drift during arc starting.

Cleaning:
Process: Ultrasonic cleaning (cleaning solution is deionized water or ethanol) is used to remove surface oil and residual lubricant.
Quality control: No residue on the surface after cleaning, cleanliness is ensured by microscopic inspection.

Coloring of the ends: Paint the terminals according to the grade (WL10 black, WL15 golden yellow, WL20 sky blue) in accordance with ISO 6848:2015 for easy user identification.

5.3 Key production technologies for lanthanum tungsten electrodes

The production of lanthanum tungsten electrodes involves a number of key technologies, which directly determine the performance consistency and market competitiveness of the electrode.

5.3.1 Uniform doping technology

Uniform doping is a key technology to ensure the uniform distribution of lanthanum oxide in the tungsten matrix, which directly affects the electrical and mechanical properties of the electrode.

Technical Approach:
High-energy ball milling: Nanoscale dispersion of lanthanum oxide is achieved by optimizing ball mill parameters (ball ratio of 10:1, speed of 300 rpm, time of 6 hours).
Wet doping: Lanthanum oxide is dissolved in nitric acid to form a solution, mixed with tungsten powder and spray dried, and the particle uniformity is increased by 20%.
Plasma doping: Lanthanum oxide is deposited on the surface of tungsten powder by plasma spraying technology, which is suitable for the production of high-performance electrodes.

Technical Advantages:
Improve the consistency of electron work of the electrode with a deviation of <5%.
Reduces grain boundary segregation and improves the electrode's anti-burn performance.
Improve arc stability and ensure weld quality.

5.3.2 High-temperature sintering technology

The high-temperature sintering technology is the core of the formation of a dense electrode body, which directly affects the density and grain structure of the electrode.

Technical Approach:
Vacuum sintering: sintering in a vacuum environment of 10^{-3} Pa reduces lanthanum oxide volatilization, and the density of the green body reaches more than 98%.
Hydrogen protection sintering: sintering in pure hydrogen (purity>99.999%) to prevent oxidation of tungsten powder, and the grain size is controlled at 10-15 microns.
Hot Isostatic Pressing (HIP): Secondary sintering at 2000°C at 100 MPa to further eliminate micropores and improve electrode strength.

Technical Advantages:
The density and mechanical strength of the electrode were improved, and the fracture toughness reached 12 $MPa \cdot m^{1/2}$.
Grain size is controlled to optimize the electrode's burn resistance.
Reduce internal defects and ensure consistent electrode performance.

Challenge: High-temperature sintering requires precise control of the atmosphere and temperature to avoid lanthanum oxide volatilization or oversized grains.

5.3.3 Precise dimensional control technology

Precise dimensional control technology ensures that the diameter and length of the electrode meet tight tolerances (± 0.02 mm), which directly affects its suitability in automated welding.

Technical Approach:
Precision drawing: Using diamond mold and laser caliper, the electrode diameter is monitored in real time, and the tolerance is controlled at ±0.01 mm.
Automatic cutting: The electrode rod is cut to a standard length (75-600 mm) with a length deviation of <± 0.5 mm.
In-line inspection: Inspect electrode surface defects through the CCD vision system to ensure dimensional consistency.

Technical Advantages:
Improve the compatibility of electrodes with welding equipment, suitable for automated welding robots.
Reduce electrode installation errors and improve welding accuracy.
Meet the requirements of international standards such as ISO 6848:2015.

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

5.3.4 Surface coating technology

Surface coating technology is used to improve the oxidation resistance and arc stability of the electrode, although it is less commonly used in lanthanum tungsten electrodes, but it has been tried in some high-end products.

Technical Approach:
Ceramic coating: A thin layer of alumina (Al_2O_3) or zirconia (ZrO_2) with a thickness of 0.1-0.5 microns is deposited on the surface of the electrode to improve oxidation resistance.
Plasma spraying: Lanthanum oxide or yttrium oxide is sprayed on the surface of the electrode to enhance the burn resistance of the tip.
Chemical Vapor Deposition (CVD): Deposits tungsten carbide (WC) coatings to improve surface hardness and wear resistance.

Technical Advantages:
Extend electrode lifetime by 10%-20%, especially in plasma cutting.
Improve surface oxidation resistance and reduce mass loss at high temperatures.
Improved arc initiation performance and reduced arc drift.

Challenge: The coating process is costly and needs to balance performance improvement with economy.

5.4 Quality control of lanthanum tungsten electrodes

Quality control runs through all aspects of lanthanum tungsten electrode production to ensure that products meet international standards (such as ISO 6848:2015 and GB/T 14841) and customer requirements.

5.4.1 Raw material quality inspection

Test content:
Tungsten powder: Purity (>99.95%) was detected by ICP-OES, and particle size (1-5 microns) was detected by laser particle size analyzer.
Lanthanum oxide: X-ray fluorescence spectroscopy (XRF) was used to analyze the purity (>99.99%), and scanning electron microscopy (SEM) was used to check the particle morphology.
Additives: Gas chromatography-mass spectrometry (GC-MS) detects volatile components to ensure no harmful substances.

Standard: Comply with GB/T 3458 (tungsten powder) and GB/T 14635 (rare earth oxide) standards.

5.4.2 Production process monitoring

Mixing & Compression: In-line X-ray diffraction (XRD) is used to monitor the homogeneity of lanthanum oxide distribution with a deviation of <5%.
Sintering: Real-time monitoring of the temperature (±10°C) and atmosphere (oxygen content < 10 ppm) in the furnace to ensure that the density of the green body > 95%.
Forging & Drawing: Ultrasonic inspection of internal defects in the bar, laser caliper monitoring of

Tel: 0086 592 512 9696
CTIAQCD -MA-E/P 2018- 2024V
sales@chinatungsten.com

diameter tolerances (±0.02 mm).

Surface treatment: Microscopic inspection of surface roughness (Ra<0.4 microns), chemical analysis of surface residues.

5.4.3 Finished product quality inspection

Chemical composition: Lanthanum oxide content was detected by ICP-OES (WL10: 0.8%-1.2%, WL15: 1.3%-1.7%, WL20: 1.8%-2.2%).

Physical properties: density measured by density meter (>19.2 g/cm³), hardness measured by Vickers hardness tester (400-450 HV).

Electrical performance: Measured by electronic work work tester (2.6-3.2 eV), simulated welding test arc initiation performance and arc stability.

Mechanical properties: tensile testing machine to test toughness (fracture toughness 10-12 MPa·m¹/²), wear testing machine to test wear resistance.

Visual inspection: The CCD vision system detects surface defects with a dimensional deviation of <± 0.02 mm.

Standard: Meets the requirements of ISO 6848:2015, AWS A5.12, and GB/T 14841.

5.5 Technical development trend of lanthanum tungsten electrode

The production technology of lanthanum tungsten electrodes is constantly evolving, and green manufacturing and automation have become the main trends to cope with environmental regulations and market competition.

5.5.1 Green manufacturing technology

Low energy consumption process: Induction heating sintering furnace is used to reduce energy consumption by 20%-30% and reduce carbon emissions.

Harmless additives: Reduce volatile organic compound (VOC) emissions by replacing PVA with bio-based binders such as cellulose.

Recycling: Develop the recovery technology of tungsten powder and lanthanum oxide, with a waste recovery rate of more than 80% and reduce the cost of raw materials.

5.5.2 Automation and intelligent production

Automation equipment: The introduction of robotic mixing and pressing system has increased production efficiency by 20% and consistency to 99.5%.

Intelligent monitoring: Use the Internet of Things (IoT) and artificial intelligence (AI) to monitor the sintering temperature and drawing size, adjust the parameters in real time, and reduce the defect rate by 30%.

Big data analysis: Optimize process parameters, predict electrode performance, and improve product qualification rate through production data analysis.

5.6 Environmental protection measures for lanthanum tungsten electrodes

The production of lanthanum tungsten electrodes involves high temperatures and highly chemical active substances, and strict environmental protection measures need to be taken to reduce the environmental impact of exhaust gas, wastewater and solid waste.

5.6.1 Waste gas and wastewater treatment

Exhaust gas treatment:
Sources: Hydrogen, lanthanum oxide volatiles and dust from sintering and forging processes.
Treatment: High-efficiency filter (HEPA) and activated carbon adsorption device are installed to capture 99.9% of dust and volatile gases. Hydrogen is converted into water vapor through catalytic combustion.
Standard: Exhaust gas emission in line with GB 16297 (air pollutant emission standard).

Wastewater Treatment:
Source: Tungsten and lanthanum oxide wastewater from the cleaning process.
Treatment: Chemical precipitation and ion exchange method were used to remove heavy metals (tungsten$<$0.1 mg/L), and the reuse rate of reclaimed water was 70%.
Standard: Wastewater discharge in line with GB 8978 (comprehensive sewage discharge standard).

5.6.2 Solid waste management

Sources: tungsten scrap, sintering scrap and drawing chips.
Dispose:
Recovery: Tungsten waste powder is recovered through pickling and hydrogen reduction, with a recovery rate of 85%. Lanthanum oxide waste is recovered by extraction.
Disposal: Non-recyclable solid waste is treated as hazardous waste and handed over to professional institutions for incineration or landfill.
Standard: Comply with GB 5085.3 (Hazardous Waste Identification Standard) and GB 18597 (Hazardous Waste Storage Standard).

Tel: 0086 592 512 9696
CTIAQCD -MA-E/P 2018- 2024V
sales@chinatungsten.com


CTIA GROUP LTD WL20 electrode

Chapter 6 Lanthanum Tungsten Electrode Production Equipment

The production of lanthanum tungsten electrodes relies on a series of high-precision and high-efficiency equipment, which covers raw material handling, forming and processing, surface treatment, quality inspection, and auxiliary functions. The performance of production equipment directly determines the quality, consistency and production efficiency of electrodes, and also affects the cost control and environmental compliance of enterprises. This chapter will discuss in detail the various types of equipment required for the production of lanthanum tungsten electrodes, including raw material handling equipment (tungsten powder grinding equipment, lanthanum oxide doping equipment), forming and processing equipment (presses, sintering furnaces, forging equipment, drawing machines), surface treatment equipment (polishing machines, cleaning equipment), quality testing equipment (chemical composition analyzers, physical property testing equipment, electrical performance testing equipment), and auxiliary equipment (environmental control equipment, waste recycling equipment). Through the in-depth analysis of the functions, technical parameters, application characteristics and industry development trends of each equipment, the complexity and technical advancement of lanthanum tungsten electrode production equipment are comprehensively demonstrated, and detailed reference information is strived to be provided.

6.1 Raw material handling equipment for lanthanum tungsten electrode

Raw material handling is the first step in the production of lanthanum tungsten electrodes, which involves the grinding of tungsten powder and the doping of lanthanum oxide. High-quality raw material handling equipment ensures the purity, particle size and uniformity of tungsten powder and lanthanum oxide, laying the foundation for subsequent processes.

6.1.1 Tungsten powder grinding equipment

Tungsten powder grinding equipment is used to process crude tungsten powder into high-purity tungsten powder with uniform particle size (1-5 microns) and regular morphology to meet the requirements of powder metallurgy process. The particle size, purity and morphology of tungsten powder directly affect the density, conductivity and mechanical properties of the electrode, so grinding equipment is very important in production.

Device Type:
Planetary ball mill: suitable for small batch, high-precision grinding, equipped with zirconia or cemented carbide grinding jar, high grinding efficiency and low pollution.
Jet mill: used for large-scale production, crushing tungsten powder through high-speed air flow collision, precise particle size control, suitable for 1-3 micron ultra-fine powder.
Vibratory Mill: Combining vibration and grinding media (e.g. steel balls), it is suitable for medium-scale production and has a particle size range of 2-5 microns.

Technical Parameters:
Rotation speed: planetary ball mill 300-600 rpm, jet mill air pressure 0.6-1.0 MPa, vibratory mill frequency 20-50 Hz.
Grinding time: 4-12 hours, depending on the target particle size.
Grinding medium: tungsten carbide balls or zirconia balls, ball to material ratio 5:1 to 10:1.
Purity control: The grinding jar and media need to be of high purity (>99.9%) to avoid contamination by impurities such as iron and silicon (Fe<50 ppm).

How it works:
The planetary ball mill crushes the tungsten powder particles to the micron level by creating high-energy collisions and frictions through the planetary motion of the grinding jar (rotation + revolution).
The jet mill uses compressed air to form a high-speed air flow, and the tungsten powder particles collide with each other and break in the air flow, and the fine particles are collected by the air flow in stages.
The vibratory mill drives the grinding medium to hit the tungsten powder through high-frequency vibration, gradually reducing the particle size.

App Features:
Planetary ball mills: suitable for laboratory or small-scale production, with high particle size uniformity (deviation <5%), but low output (0.5-5 kg per batch).
Jet mill: suitable for large-scale industrial production, the output can reach 100-500 kg/h, the particle size distribution is narrow (D50 = 1-2 microns), but the energy consumption is high.
Vibratory mill: taking into account the output and cost, suitable for medium-sized enterprises, the output is 10-50 kg/h, and the particle size control is slightly inferior to that of jet mill.

Key Technologies:
Contamination control: The grinding process is protected by an inert gas (e.g. nitrogen or argon) to

prevent oxidation of tungsten powder (oxygen content < 100 ppm).
Particle size detection: equipped with laser particle size analyzer, real-time monitoring of particle size distribution (D10, D50, D90) to ensure compliance with GB/T 3458-2006 standard.
Automation: Modern grinding equipment integrates a PLC control system, which can automatically adjust the speed, air pressure and grinding time to improve consistency.

Development Trends:
Ultra-fine grinding: Develop nano-scale tungsten powder (< 500 nm) grinding equipment to improve the electrical ultimate density and arc stability.
Energy saving and consumption reduction: low-pressure jet mill or high-efficiency vibrating mill is used to reduce energy consumption by 20%-30%.
Intelligent: Integrate AI algorithms to optimize grinding parameters, reduce manual intervention, and improve particle size consistency.

6.1.2 Lanthanum oxide doping equipment

Lanthanum oxide doping equipment is used to homogeneously mix lanthanum oxide (La_2O_3) into tungsten powder to ensure the homogeneity of lanthanum oxide content (0.8%-2.2%) and distribution in the electrode. The performance of the doping equipment directly affects the electron work and arc stability of the electrode.

Device Type:
High-energy ball mill: used for dry doping, through high-energy collision to achieve uniform mixing of tungsten powder and lanthanum oxide.
V-type mixer: suitable for dry or wet doping, large mixing capacity, suitable for medium and large-scale production.
Spray dryer: used for wet doping, mixing lanthanum oxide solution with tungsten powder and drying to form a uniform composite powder.

Technical Parameters:
High energy ball mill: speed 200-400 rpm, ball ratio 10:1, mixing time 4-8 hours.
V-mixer: speed 20-50 rpm, capacity 50-500 liters, mixing time 2-6 hours.
Spray dryer: air inlet temperature 200-300°C, spray pressure 0.2-0.5 MPa, drying efficiency > 95%.

How it works:
The high-energy ball mill disperses lanthanum oxide particles into tungsten powder by creating collision and shear forces through the high-speed rotation of the grinding tank.
The V-type mixer rotates through the V-shaped container to make the powder tumble and mix under the action of gravity and centrifugal force.
The spray dryer mixes the lanthanum oxide solution with the tungsten powder suspension, forms tiny droplets through the spray, and forms a uniform composite powder after hot air drying.

App Features:
High energy consumption: suitable for high-precision doping (e.g. WL20), high mixing uniformity

(deviation <5%), but high energy consumption and limited output (1-10 kg per batch).
V-type mixer: suitable for medium and large-scale production, output 50-200 kg/batch, low cost, suitable for WL10 and WL15 production.
Spray dryer: suitable for wet doping, excellent powder uniformity (deviation <3%), output up to 100-300 kg/h, but large equipment investment.

Key Technologies:
Uniformity control: X-ray diffraction (XRD) or scanning electron microscopy (SEM) is used to analyze the phase distribution of the doped powder to ensure no segregation of lanthanum oxide.
Anti-oxidation: The doping process needs to be protected by nitrogen or argon, and the oxygen concentration should be < 50 ppm to prevent the oxidation of tungsten powder.
Automation: Equipped with automatic weighing and batching system, the amount of lanthanum oxide added can be accurately controlled (deviation < 0.01%).

Development Trends:
Nano doping: Develop nano-scale lanthanum oxide doping equipment to improve the electron escape work of the electrode.
Low-cost process: Optimize the wet doping process, reduce the amount of solvent, and reduce the cost by 20%.
Intelligent mixing: Integrate sensors and AI algorithms to monitor mixing uniformity in real time and reduce scrap rate.

6.2 Lanthanum tungsten electrode forming and processing equipment

Forming and processing equipment is used to make the mixed powder into the electrode body and process it to the final size, including the four main steps of pressing, sintering, forging and drawing. These devices need to be highly accurate and stable to ensure dimensional tolerances and consistent performance of the electrodes.

6.2.1 Presses

The press presses the mixed powder into a cylindrical body, which provides the initial shape for subsequent sintering. The pressure control of the press and the accuracy of the mold directly affect the density and structural uniformity of the green body.

Device Type:
Hydraulic press: suitable for small batch production, adjustable pressure, flexible mold change.
Isostatic press: used for high-precision billet pressing, uniform pressure and high billet density.
Automatic press: Integrated automatic loading and demoulding, suitable for large-scale production.

Technical Parameters:
Pressure: 100-300 MPa (hydraulic press), 200-500 MPa (isostatic press).
Mold material: cemented carbide or high-strength steel, wear resistance> 5000 times pressing.
Body size: diameter 10-50 mm, length 50-100 mm, density 60%-70% theoretical density.

How it works:
The hydraulic press exerts unidirectional pressure through the hydraulic system to compact the powder into shape.
The isostatic press exerts all-round pressure through a liquid medium such as oil or water, and the density of the green body is uniform and there are no internal stresses.
The automatic pressing machine automatically completes the feeding, pressing and demoulding through PLC control, with high production efficiency.

App Features:
Hydraulic press: suitable for laboratory or small-scale production, with an output of 1-5 tons/day, low cost, but slightly lower body density.
Isostatic press: suitable for high-performance electrodes (such as WL20), with a density of 70%, but a large equipment investment (about 5 million yuan).
Automatic press: suitable for large-scale production, with an output of 10-20 tons/day, high degree of automation and low labor cost.

Key Technologies:
Pressure control: Servo hydraulic system is adopted, and the pressure deviation is <± 1 MPa to ensure the consistent density of the green body.
Mold design: Optimize the mold geometry, reduce the mold release resistance, and extend the mold life.
Automation: Integrate robot feeding and visual inspection systems to increase production efficiency by 20%.

Development Trends:
High-precision pressing: Developed an ultra-high-pressure isostatic press (>1000 MPa) to increase the density of the green body to 75%.
Intelligent: Integrate AI to optimize pressing parameters and reduce the crack rate of the green body.
Modular design: develop a multi-functional press to adapt to the production of different sizes of green bodies.

6.2.2 Sintering furnaces

The sintering furnace is used to heat the pressed green body to a high temperature (1800-2200 °C) to combine its particles to form a dense body, and is the core equipment that determines the electrode density and mechanical properties.

Device Type:
Vacuum sintering furnace: suitable for the production of high-purity electrodes to prevent lanthanum oxide volatilization.
Hydrogen protection sintering furnace: suitable for large-scale production, low cost, and prevents oxidation of tungsten powder.
Hot isostatic press oven (HIP): used for secondary sintering to improve electrode density and strength.

Technical Parameters:
Temperature: up to 2200°C, temperature control accuracy ±±5°C.
Atmosphere: Vacuum < 10^{-3} Pa (vacuum furnace), or hydrogen purity > 99.999% (hydrogen furnace).
Furnace material: molybdenum or tungsten, high temperature resistance, anti-pollution.
Furnace capacity: 50-500 kg/batch.

How it works:
Vacuum sintering furnaces are sintered in a low-pressure environment by means of resistance or induction heating to reduce oxide formation.
The hydrogen protection furnace creates a reducing atmosphere by introducing high-purity hydrogen to prevent tungsten oxidation.
The HIP furnace combines high temperature (2000°C) and high pressure (100-200 MPa) to eliminate internal micropores.

App Features:
Vacuum sintering furnace: suitable for high-performance electrodes (e.g. WL20) with a > density of 98% but high energy consumption (approx. 1000 kWh per batch).
Hydrogen protection furnace: suitable for low- and medium-cost production (WL10, WL15) with large output (500 kg/day), but hydrogen safety needs to be strictly managed.
HIP furnace: suitable for high-end applications such as aerospace, the electrode strength is increased by 20%, but the equipment cost is high (about 30 million yuan).

Key Technologies:
Temperature control: multi-stage temperature control system is adopted, the heating rate is 500-1000°C/h, and the insulation deviation is <±3°C.
Atmosphere management: Equipped with an oxygen analyzer, the oxygen content is controlled < 10 ppm to prevent oxidation.
Blank loading: Use molybdenum boats or tungsten trays to optimize the furnace layout and reduce the deformation of the blank.

Development Trends:
Energy-saving sintering: Induction heating sintering furnace was developed to reduce energy consumption by 30%.
Intelligent: Integrated IoT sensors to monitor the atmosphere and temperature distribution in the furnace in real time.
Green process: develop low exhaust emission sintering furnace, in line with GB 16297 standard.

6.2.3 Forging equipment

Forging equipment is used to process sintered green bodies into bars to improve their density and mechanical properties. The forging process eliminates internal porosity through high-temperature deformation and improves electrode toughness.

Device Type:
Rotary equipment: Forging with multiple passes and small deformation, suitable for high-precision electrode rod production.
Hammer equipment: suitable for large-diameter green body, large single deformation, high efficiency.

Technical Parameters:
Temperature: 1200-1500°C, temperature control accuracy±20°C.
Deformation: 5-10% (rotary forging), 10-20% (hammer forging) per pass.
Bar size: diameter 5-10 mm, length 50-1000 mm.

How it works:
Rotary equipment passes: multiple pairs of rotating dies continuously extrude the sintered green body, and gradually reduce the diameter.
Hammer equipment vials: hydraulic hammer or air hammer applies impact force to the heated green body, rapid prototyping.

App Features:
Rotary device: suitable for high-performance electrodes (e.g. WL20) with a bar density of >99% and a smooth surface (Ra<2 microns).
Hammer equipment: suitable for medium and low cost production (such as WL10), high output (1000-2000 pcs/h), but slightly lower surface quality.

Key Technologies:
Heating control: Medium frequency induction heating is used to heat evenly and prevent cracking of the green body.
Deformation control: Using servo control system, the deformation deviation is <±2% to ensure the dimensional accuracy of the bar.
Lubrication: The use of graphite lubricant to reduce mold wear and prolong life.

Development Trends:
High-precision forging: Development of multi-axis CNC equipment forging machine with dimensional tolerance <± 0.05 mm.
Automation: Integrate robot loading and unloading system to reduce manual intervention and increase efficiency by 20%.
Green lubrication: Develop water-based lubricants to reduce environmental pollution.

6.2.4 Drawing machines

The drawing machine stretches the forged bar into a small diameter electrode rod (0.25-6.4 mm) and is the equipment that determines the final size of the electrode.

Device Type:
Multi-mode drawing machine: Through multi-pass drawing, the diameter is gradually reduced,

which is suitable for high-precision electrodes.

Single-mode drawing machine: suitable for small batches or large diameter electrodes, easy to operate.

Technical Parameters:

Drawing speed: 5-20 m/min, the speed is adjustable.

Mould material: diamond or cemented carbide, wear resistance > 50,000 meters.

Diameter tolerance: ±± 0.02 mm, surface roughness Ra<0.8 μm.

How it works:

The bar is stretched through a diamond die, with a diameter reduction of 5-15% per pass, and intermediate annealing (1000-1200°C) to relieve stress.

App Features:

Multi-mode drawing machine: suitable for large-scale production, with an output of 5000-10,000 pieces/hour, suitable for WL15 and WL20.

Single-mode drawing machine: suitable for small batches or special specifications (e.g. 0.3 mm) electrodes, with low output.

Key Technologies:

Mold accuracy: The mold is processed by laser, and the hole diameter deviation <± 0.005 mm.

Lubrication control: Graphite emulsion lubricant is used, and the cooling temperature is < 40°C to reduce surface defects.

On-line detection: equipped with laser caliper, real-time monitoring of diameter, deviation <± 0.01 mm.

Development Trends:

Ultra-fine drawing: Develop 0.1 mm electrode drawing process to meet the needs of micro-welding.

Automation: Integrated automatic mold change and annealing system reduces downtime.

Environmentally-friendly lubrication: Develop oil-free lubrication technology to reduce waste liquid discharge.

6.3 Surface treatment equipment for lanthanum tungsten electrodes

Surface treatment equipment is used to improve the surface finish and performance of electrodes, including polishing and cleaning. Surface quality has a direct impact on arc stability and electrode lifetime.

6.3.1 Polishing machines

The polishing machine is used to remove the drawing marks and oxide layer on the electrode surface, improve the surface roughness (Ra <0.4 microns), and enhance the arc performance.

Device Type:

Centerless grinding machine: continuous polishing by grinding wheels and guide wheels, suitable for large-scale production.

Electrochemical polishing machine: polishes the surface by electrolysis, suitable for high-precision electrodes.
Ultrasonic polisher: Combines ultrasonic vibration and abrasives for small diameter electrodes.

Technical Parameters:
Polishing speed: 10-50 m/min (centerless grinder), 0.5-2 m/min (electrochemical polishing).
Grinding wheel size: 200-400 mesh (mechanical polishing), electrolyte is sulfuric acid or phosphoric acid solution (electrochemical polishing).
Surface roughness: Ra0.2-0.4 microns.

How it works:
The centerless grinder continuously grinds the electrode surface by rotating the grinding wheel at high speed and guided by the guide wheel.
The electrochemical polisher dissolves the anode in the electrolyte through the electrode to remove micro-bumps on the surface.
The ultrasonic polishing machine drives the abrasive particles through high-frequency vibration to finely polish the surface.

App Features:
Centerless grinding machine: high output (10,000 pcs/h), suitable for WL10 and WL15 industrial electrodes.
Electrochemical polishing machine: high surface gloss, suitable for WL20 electrodes for aerospace use, low output (1000 pcs/hour).
Ultrasonic polishing machine: suitable for small diameter (<0.5 mm) electrodes, with high precision and high cost.

Key Technologies:
Surface consistency: The grinding wheel pressure is controlled by servo, and the roughness deviation <± 0.05 microns.
Pollution control: Equipped with dust collection system, the dust collection efficiency is >99%, in line with GB/T 16297 standard.
Automation: Integrated visual inspection for automatic rejection of surface defective electrodes.

Development Trends:
Ultra-precision polishing: developed Ra<0.1 micron polishing technology to meet the needs of micro-welding.
Green polishing: water-based electrolyte is used to reduce chemical waste.
Intelligent: Integrated AI vision system to optimize polishing parameters in real time.

6.3.2 Cleaning equipment

The cleaning equipment is used to remove oil, dust and chemical residues after polishing, to ensure that the electrode surface is clean and to prevent contamination of the weld seam during use.

Device Type:
Ultrasonic cleaner: The surface is cleaned by ultrasonic vibration, which has high efficiency and is suitable for complex shape electrodes.
Spray Cleaner: Sprayed with high-pressure water or detergent, suitable for large-scale cleaning.
Plasma cleaning machine: used for high-cleanliness electrodes to remove nano-scale contaminants.
Technical Parameters:
Ultrasonic cleaner: frequency 20-40 kHz, power 1-5 kW, cleaning time 5-15 minutes.
Spray cleaning machine: pressure 0.5-2 MPa, cleaning liquid flow rate 20-50 L/min.
Plasma cleaning machine: plasma power 100-500 W, processing time 1-3 minutes.

How it works:
Ultrasonic cleaners use high-frequency vibrations to create a cavitation effect that strips away surface dirt.
Spray cleaners use a jet of high-pressure water or detergent to flush the surface.
Plasma cleaners remove organics and oxide layers by plasma bombardment.

App Features:
Ultrasonic cleaner: versatile, suitable for all kinds of electrodes, cleaning efficiency > 99%, output 5000-10,000 pieces/hour.
Spray cleaner: low cost, suitable for low-end electrodes (such as WL10), but the cleaning accuracy is slightly inferior.
Plasma cleaning machine: suitable for aerospace and electronic high-clean electrodes, high cost, output 1000 pieces/hour.

Key Technologies:
Cleaning solution management: Use deionized water (resistivity > 15 MΩ·cm) or environmentally friendly ethanol, and the recycling rate is > 80%.
Drying control: equipped with hot air or vacuum drying, residual moisture < 0.01%.
Automation: Integrate automatic loading and unloading and water quality monitoring systems to improve efficiency.

Development Trends:
Eco-friendly cleaning: Development of chemical-free cleaning technology, such as CO2 supercritical cleaning.
High cleanliness: Improve cleaning accuracy to meet the needs of the semiconductor industry.
Intelligent: Integrated IoT to monitor cleaning results and optimize water volume and energy consumption.

6.4 Quality testing equipment for lanthanum tungsten electrode

Quality inspection equipment is used to monitor the quality of raw materials, production processes and finished products to ensure that the electrodes comply with international standards (e.g. ISO 6848:2015) and customer requirements. The test includes chemical composition, physical properties and electrical properties.

Tel: 0086 592 512 9696
CTIAQCD -MA-E/P 2018- 2024V
sales@chinatungsten.com

CTIA GROUP LTD

Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)

Plasma Arc Welding (PAW) and Plasma Cutting

Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys

Robotic and automated welding systems

Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com

Phone: +86 592 5129595; 592 5129696

Website: www.tungsten.com.cn

6.4.1 Chemical composition analyzers

Chemical composition analyzers are used to test the purity and elemental content of tungsten powder, lanthanum oxide and finished electrode products to ensure that the lanthanum oxide content (0.8%-2.2%) and impurities (<50 ppm) meet the requirements.

Device Type:

Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES): For the detection of tungsten, lanthanum and trace elements with high accuracy.

X-ray fluorescence spectroscopy (XRF): fast non-destructive testing for in-line analysis.

Atomic Absorption Spectrometer (AAS): Used to detect specific elements (e.g., Fe, Si) at a lower cost.

Technical Parameters:

ICP-OES: Detection limit 0.01 ppm, analysis time 5-10 minutes.

XRF radiation: detection range 0.01%-100%, accuracy ± 0.05%.

AAS: Detection limit of 0.1 ppm, suitable for single-element analysis.

How it works:

ICP-OES excitation of samples with plasma high-temperature samples to analyze their emission lines and quantify the element content.

XRF excites the sample with X-rays to measure the fluorescence intensity and determine the elemental composition.

AAS determines the concentration of a specific element by absorbing light intensity by atoms.

App Features:

ICP-OES: suitable for high-precision analysis in the laboratory, used for raw materials and finished product testing, with high cost (about 2 million yuan).

XRF: Suitable for in-line production monitoring, fast detection speed (< 30 seconds per sample), suitable for medium to large enterprises.

AAS: suitable for small-scale enterprises, detection of specific impurities, low cost (about 200,000 yuan).

Key Technologies:

High sensitivity: ICP-OES can detect impurities in the ppb order (e.g., Pb< 0.1 ppb).

Non-destructive testing: XRF supports non-destructive analysis and is suitable for sampling of finished products.

Automation: Integrate automated sampling and data processing to increase analysis efficiency by up to 50%.

Development Trends:

Rapid detection: Develop portable XRF with an analysis time of < 10 seconds.

Multi-element analysis: Improve the multi-channel detection capability of ICP-OES, covering 50 elements.

Intelligent: Combined with AI algorithms, it can automatically identify sample types and optimize detection parameters.

6.4.2 Physical performance testing equipment

Physical property testing equipment is used to check the density, hardness, grain size and surface roughness of electrodes to ensure their mechanical properties and processing quality.

Device Type:
Density meter: Based on Archimedes' principle, the electrode density is measured.
Vickers hardness tester: measures the surface hardness of the electrode (400-450 HV).
Metallurgical microscopy: analysis of grain size and microstructure.
Surface roughness meter: Measure surface roughness (Ra<0.4 microns).

Technical Parameters:
Density meter: accuracy ± 0.01 g/cm³, measuring range 10-20 g/cm³.
Vickers hardness tester: load 5-50 N, accuracy ± 1 HV.
Metallurgical microscope: magnification 100-1000x, resolution 0.1 micron.
Surface roughness tester: measuring range Ra0.01-10 microns, accuracy ± 0.01 microns.

How it works:
A density meter calculates density by measuring the weight of the electrode in air and liquid.
The Vickers hardness tester calculates the hardness value from the indentation size.
A metallurgical microscope observes the microstructure of electrode sections through optical magnification.
The surface roughness meter scans the surface with a probe and measures the height difference.

App Features:
Density meter: Rapid detection of the density of the body and the finished product (>19.2 g/cm³) in 1 minute per sample.
Vickers hardness tester: suitable for hardness distribution analysis and detection of electrode uniformity.
Metallurgical microscopes: for R&D and quality analysis, to check grain size (10-20 microns).
Surface roughness tester: online inspection of polishing quality, suitable for large-scale production.

Key Technologies:
High accuracy: The density meter uses an electronic balance with an error of < 0.005 g/cm³.
Automation: The metallurgical microscope is equipped with autofocus and image analysis software, which increases efficiency by 30%.
Non-destructive testing: The surface roughness tester supports non-contact measurement and is suitable for finished products.

Development Trends:
Versatile testing: Development of test platforms that combine density, hardness, and roughness.
In-line inspection: Real-time inspection embedded in the production line to reduce sampling time.

Intelligent: Integrated AI image analysis to automatically determine grain quality.

6.4.3 Electrical performance test equipment

The electrical performance test equipment is used to measure the electronic work of the electrode, arc initiation performance and arc stability of the electrode to ensure its welding performance.

Device Type:

Electron work tester: measures electron work (2.6-3.2 eV) of the electrode.

Simulated welding test bench: test arc start time and arc stability.

Conductivity meter: Measure the conductivity of the electrode (17.5-18.0 MS/m).

Technical Parameters:

Electronic work tester: accuracy ± 0.05 eV, test temperature 1000-2000°C.

Analog welding test bench: current 10-300 A, voltage 0-50 V, recording accuracy ± 0.1 V.

Conductivity meter: measuring range 1-100 MS/m, accuracy ± 0.1 MS/m.

How it works:

The electron work escape tester measures the electron emission current at high temperature and calculates the work of evolution through the thermal electron emission method.

The simulated welding test bench records the arc start time and voltage fluctuations by simulating the TIG welding environment.

The conductivity meter measures the electrode resistance using the four-probe method to convert the conductivity.

App Features:

Electronic Evolution Work Tester: Suitable for R&D and quality verification, the test time is 10-20 minutes/sample.

Simulated welding test bench: simulates the actual welding conditions, suitable for finished product sampling, and has high testing efficiency (100 pieces/hour).

Conductivity meter: fast non-destructive testing, suitable for online monitoring.

Key Technologies:

High temperature test: The electronic work of evolution test is equipped with a vacuum chamber to prevent oxidation.

High-precision recording: The simulated welding test bench integrates high-speed data acquisition, and the voltage fluctuation record < 0.01 seconds.

Automation: The conductivity meter supports automatic probe positioning, which increases efficiency by 50%.

Development Trends:

Rapid test: Develop a portable electronic work escape tester with a test time of < 5 minutes.

Multi-parameter testing: Integrate electrical and physical performance testing to reduce equipment footprint.

Intelligent: Predict electrical performance and optimize production parameters through AI.

6.5 Auxiliary equipment for lanthanum tungsten electrode

Ancillary equipment is used to optimize the production environment, improve resource utilization and ensure environmental protection, including environmental control and waste recycling equipment.

6.5.1 Environmental control equipment

Environmental control equipment is used to maintain temperature, humidity and cleanliness in the production hall and to prevent dust and oxidation from affecting the quality of the electrodes.

Device Type:
Constant temperature and humidity air conditioning: control the temperature and humidity of the workshop.
Cleanroom system: purifies the air and reduces the concentration of dust.
Ventilation and dust removal equipment: Collect grinding and polishing dust.

Technical Parameters:
Constant temperature and humidity air conditioning: temperature 18-25 °C, humidity 40-60%, ± accuracy ± 1 °C, ±5%.
Cleanroom system: cleanliness ISO class 7 (10,000 0.5 micron particles per cubic <).
Ventilation and dust removal: the dust collection efficiency > 99.9%, and the dust concentration < 0.1 mg/m³.

How it works:
Constant temperature and humidity air conditioning regulates environmental parameters through refrigeration and humidification devices.
The cleanroom removes airborne particulate matter through a HEPA filter and a positive pressure system.
Ventilation dust collection collects dust under negative pressure and is treated by a cloth bag or electrostatic precipitator.

App Features:
Constant temperature and humidity air conditioning: suitable for all production links, to prevent powder moisture absorption or equipment overheating.
Cleanroom systems: used in doping and polishing processes to meet aerospace electrode needs.
Ventilation and dust removal: used in grinding and sintering processes, in line with GB 16297 standard.

Key Technologies:
High-efficiency filtration: The life of the HEPA filter is > 2 years, and the filtration efficiency > 99.999%.
Energy efficiency optimization: inverter air conditioning is adopted, which saves energy by 30%.

Tel: 0086 592 512 9696
CTIAQCD -MA-E/P 2018- 2024V
sales@chinatungsten.com

Intelligent: Integrated environmental sensors to monitor temperature and humidity in real time.

Development Trends:
Ultra-clean environment: Developed ISO Class 5 clean room to meet the needs of microelectronic electrodes.
Low-carbon control: Adopt heat recovery technology to reduce energy consumption by 20%.
Intelligent: Remote environment management is implemented through IoT.

6.5.2 Scrap recycling equipment

Waste recycling equipment is used to treat waste tungsten powder, waste electrodes and waste liquid in production, improve resource utilization and reduce environmental pollution.

Device Type:
Dust Collector: Collects grinding and polishing dust.
Pickling and recycling equipment: recovery of waste tungsten powder and lanthanum oxide.
Wastewater treatment equipment: treatment of cleaning wastewater.

Technical Parameters:
Dust Collector: The recycling efficiency is >99%, and the processing capacity is 1-10 tons/hour.
Pickling recovery equipment: recovery rate >85%, processing capacity 5-50 kg/batch.
Wastewater treatment equipment: tungsten removal rate > 99%, reclaimed water reuse rate 70%.

How it works:
The dust collector collects the dust through cloth bags or electrostatic precipitator, and then screens and restores the dust.
The pickling plant dissolves the waste by dissolving the waste with nitric acid or hydrochloric acid, extracting and recovering promethium and lanthanum.
Wastewater treatment plants remove heavy metals through chemical precipitation and ion exchange.

App Features:
Dust recovery machine: suitable for grinding and polishing processes, the recovery rate of tungsten powder > 80%.
Pickling and recycling equipment: suitable for waste electrodes and sintering waste, the recycling cost is high.
Wastewater treatment equipment: suitable for cleaning process, in line with GB 8978 standard.

Key Technologies:
Efficient separation: Centrifugal separation technology is used to increase the recovery rate by 10%.
Environmental protection treatment: the pH value of the waste liquid after neutralization is 6-8, and there is no secondary pollution.
Automation: Integrate automatic control system to reduce manual operation.

Development Trends:

Closed-cycle recycling: Develop a full-process waste recycling system with a recovery rate of 99%.
Green recycling: Adopt biochemical recycling technology to reduce the amount of acid and alkali.
Intelligent: Optimize the recycling process and reduce costs through big data analysis.

CTIA GROUP LTD WL20 electrode

Chapter 7 Domestic and Foreign Standards for Lanthanum Tungsten Electrode

As a high-performance welding and cutting material, the standardization of lanthanum tungsten electrode and its quality and performance depends on the perfect domestic and foreign standard system. International and domestic standards provide clear guidance on the chemical composition, physical properties, dimensional tolerances, production process and application requirements of lanthanum tungsten electrodes to ensure their production consistency and safety of use worldwide. This chapter will discuss in detail the international standards for lanthanum tungsten electrodes (including ISO 6848:2015, AWS A5.12/A5.12M and EN 26848), domestic standards (GB/T 14841 and JB/T 4730), comparative analysis of domestic and foreign standards (similarities and differences and their impact on production and application), and standard updates and development trends (new standards development and internationalization trends).

7.1 International standards for lanthanum tungsten electrodes

International standards provide unified technical specifications for the global production and trade of lanthanum tungsten electrodes, mainly including those developed by the International Organization for Standardization (ISO), the American Welding Society (AWS) and the European Committee for Standardization (EN). These standards cover the classification, chemical composition, performance requirements, size specifications, test methods and other contents of electrodes, and are widely used in aerospace, nuclear industry, automobile manufacturing and other fields.

7.1.1 ISO 6848:2015 (Classification and requirements for tungsten electrodes)

ISO 6848:2015 "Welding consumables — Tungsten electrodes for inert gas shielded arc welding and for plasma welding and cutting" is the world's most authoritative tungsten electrode standard, developed by the International Organization for Standardization (ISO), suitable for inert gas shielded welding (TIG), Tungsten electrodes for plasma welding and cutting, including lanthanum tungsten electrodes. The standard was revised in 2015 to replace the 2004 version, reflecting the technological progress and environmental requirements of new electrodes such as lanthanum tungsten electrodes.

Standard content:

Classification: According to the type and content of doped oxides, tungsten electrodes are divided into pure tungsten (WP), thorium tungsten (WT), cerium tungsten (WC), lanthanum tungsten (WL), zirconium tungsten (WZ) and yttrium tungsten (WY). Lanthanum tungsten electrodes are divided into WL10 (0.8%-1.2% La_2O_3), WL15 (1.3%-1.7% La_2O_3) and WL20 (1.8%-2.2% La_2O_3).

Chemical composition: Specify the lanthanum oxide content and impurity limit (such as Fe, Si, C, etc. <0.05%) to ensure the electrical and mechanical properties of the electrode.

Dimensions: Electrode diameter range 0.25-6.4 mm, length 50-600 mm, tolerance according to ISO 286-2 (h6 class). The ends are colored WL10 (black), WL15 (golden yellow), WL20 (sky blue).

Performance requirements: including electronic work (2.6-3.2 eV), arc initiation (low current arcing time <0.5 seconds), arc stability (voltage fluctuation <±0.5 V) and burn resistance (tip consumption < 0.3 mm/hr at 200 amps).

Test Method: Specified Chemical Composition Analysis (ICP-OES), Physical Property Test (Density, Hardness), Electrical Performance Test (Simulated Welding) and Visual Inspection (Surface Roughness Ra<0.4 Microns).

Packaging and identification: The electrode packaging is required to be moisture-proof and shock-proof, and the identification includes the grade, size, batch number and manufacturer information.

Features & Benefits:

Worldwide availability: ISO 6848:2015 is recognized by major industrial countries around the world and is widely used in demanding fields such as aerospace and nuclear industries.

Environmental protection: Encourage the use of non-radioactive electrodes (such as lanthanum tungsten, cerium tungsten), restrict the use of thorium tungsten electrodes (WT), and comply with the EU RoHS directive.

Technological advancement: The 2015 edition adds detailed requirements for lanthanum tungsten electrode WL15, reflecting its trend as an alternative to thorium tungsten electrode.

Standardized testing: Standardized test methods (such as electronic work output test) are provided to ensure the comparability of product performance of different manufacturers.

Applications:

Aerospace: WL20 is used for TIG welding of titanium alloys and nickel-based alloys in accordance with ISO 6848 requirements for defect-free welds.

Nuclear industry: WL15 is used for zirconium alloy pipe welding, which meets the standard requirements for high cleanliness and corrosion resistance.

Automobile manufacturing: WL10 is used for thin plate stainless steel welding, in line with the standard low current arc starting performance.

Limitations:
Special applications such as micro-plasma welding or ultra-high current cutting require less electrode performance and need to supplement industry standards.
The test method is complex (such as the vacuum environment required for the electronic work test), which has high requirements for the equipment of small and medium-sized enterprises.
Environmental requirements in the production process, such as waste recycling and waste gas disposal, are not clearly specified.

Background of the revision:
The 2004 version of the standard did not fully consider the diverse applications of lanthanum tungsten electrodes (such as the popularization of WL15), and the 2015 version added the classification and performance requirements of WL15.
In response to global environmental regulations (such as EU 2003/53/EC), thorium tungsten electrodes are restricted, and the standardization of lanthanum tungsten electrodes is promoted.
Combined with new testing techniques such as high-precision ICP-MS, the accuracy of chemical composition analysis is improved.

Global Impact:
ISO 6848:2015 has been adopted by the European Union, the United States, Japan, China and other countries, facilitating the international trade of lanthanum tungsten electrodes.
The phase-out of thorium-tungsten electrodes has been promoted, and the global lanthanum tungsten electrode market share has increased from 15% in 2010 to 30% in 2020.
It provides uniform technical specifications for multinational projects in sectors such as the aerospace and nuclear industries, reducing supply chain risks.

7.1.2 AWS A5.12/A5.12M (American Welding Institute Standard)
AWS A5.12/A5.12M "Specification for Tungsten and Oxide Dispersed Tungsten Electrodes for Arc Welding and Cutting" is a tungsten electrode standard developed by the American Welding Society (AWS), the latest version is 2009, applicable to tungsten electrodes for TIG welding, plasma welding and cutting, including lanthanum tungsten electrodes. The standard has a wide reach in the U.S. and North American markets, especially in the aerospace, shipbuilding, and energy industries.

Standard content:
Classification: Similar to ISO 6848, lanthanum tungsten electrodes are divided into EWLa-1 (WL10, 1.0% La_2O_3), EWLa-1.5 (WL15, 1.5% La_2O_3), and EWLa-2 (WL20, 2.0% La_2O_3). The "EW" prefix is used to indicate the doped electrode and La to indicate lanthanum.
Chemical composition: Lanthanum oxide content deviation ±0.2%, impurity limits (e.g., Fe<0.03%, C<0.01%) are slightly stricter than ISO 6848.
Dimensions: Diameter 0.020-0.250" (0.5-6.35 mm), length 3-24" (76-610 mm) with tolerances per ANSI B1.1. The end is painted in accordance with ISO 6848.

Performance requirements: Emphasis on arc initiation performance (arc starting voltage < 15 V at 10-50 amps), arc stability (voltage fluctuation at 100 amps <±0.4 V) and burn resistance (tip consumption < 0.25 mm/h at 150 amps).
Test methods: including chemical analysis (XRF or ICP-OES), welding test (AWS D1.1 standard), surface quality check (Ra < 0.5 microns), and dimensional measurement (micrometer or laser caliper).
Certification and labeling: The electrode is required to be certified by AWS, and the packaging is marked with the AWS number, brand, and production batch.

Features & Benefits:
Strict performance requirements: The AWS standard has more specific test conditions for arc stability and burn resistance, which is suitable for high-load welding applications.
North American market orientation: The size unit is inches, which is in line with American industrial habits and is convenient for North American users.
Certification: AWS certification increases the credibility of the electrode, making it ideal for aerospace and defense projects.
Application Guidance: Detailed recommendations for welding parameters (e.g. current type, shielding gas flow) are provided for the user to optimize the process.

Applications:
Aerospace: EWLa-2 (WL20) is used for TIG welding of titanium frames of Boeing 787 aircraft, which meets the AWS D17.1 standard.
Shipbuilding: EWLa-1.5 (WL15) is used for stainless steel hull welding, which meets the AWS D1.6 structural welding specification.
Energy industry: EWLa-1 (WL10) is used for pipe sheet welding, according to API 1104 standard.

Limitations:
The standard is updated slowly (the latest application trends of WL15 are not covered in the 2009 edition) and the technical details are older compared to ISO 6848:2015.
Environmental requirements (e.g. waste recycling) are less mentioned and are not fully adapted to the strict regulations in regions such as the European Union.
The test method is biased towards North American devices (such as AWS certified labs), and there are device compatibility issues for enterprises in other regions.

Correlation with ISO 6848:
AWS A5.12 is highly consistent with ISO 6848 in terms of classification, chemical composition, and size specifications, but the AWS standard focuses more on real-world weld performance testing.
The AWS standard allows for a more lenient lanthanum oxide content deviation (± 0.2% vs ±0.15% for ISO), but stricter limits for impurities.
The coloring of the two is consistent to ensure the uniformity of global user identification.

North American Impact:
AWS A5.12 is a required standard for U.S. aerospace (NASA, Boeing), defense (MIL-STD-1595A),

and energy (ASME Section IX) projects.

The tanthanum tungsten electrode has driven rapid growth in the U.S. market, with the EWLa-1.5 market share increasing from 10% in 2010 to 25% in 2020.

The AWS-certified lanthanum tungsten electrode has a competitive advantage in the North American market.

7.1.3 EN 26848 (European standard)

EN 26848 "Tungsten electrodes for inert gas shielded arc welding and for plasma welding and cutting" is a tungsten electrode standard developed by the European Committee for Standardization (CEN), the latest version of which is 1991 (partially revised in 2004), applicable to tungsten electrodes for TIG welding, plasma welding and cutting in EU member states. The standard is highly aligned with ISO 6848, but in some details reflects the special needs of the European market.

Standard content:

Classification: Lanthanum tungsten electrodes are divided into WL10, WL15 and WL20, and the lanthanum oxide content is the same as ISO 6848 (0.8%-2.2%). The logo is painted in the same color as the ISO.

Chemical composition: Lanthanum oxide content deviation ± 0.15%, impurity limits (e.g., Fe<0.04%, Si <0.02%) are equivalent to ISO 6848.

Dimensions: Diameter 0.25-6.4 mm, length 50-300 mm, tolerances according to EN ISO 286-2 (class h6). Emphasis on short length electrodes (50-150 mm) to accommodate European automated welding equipment.

Performance requirements: arc starting performance (arc starting voltage at 10 amps < 12 V), arc stability (voltage fluctuation at 100 amps <± 0.5 V), burning resistance (tip consumption at 150 amps < 0.3 mm/h).

Test Methods: Chemical Composition Analysis (ICP-MS or XRF), Welding Test (EN 287 Standard), Surface Quality Check (Ra < 0.4 microns) and Dimensional Measurement.

Environmental protection requirements: emphasize non-radioactive electrodes (such as lanthanum tungsten, cerium tungsten), in line with the EU RoHS directive (2002/95/EC).

Features & Benefits:

Environmental compliance: Strictly restrict the use of thorium-tungsten electrodes and promote the popularization of lanthanum tungsten electrodes in the European market.

Automated guidance: The dimensions and performance requirements are adapted to European automated welding equipment (e.g. KUKA robots).

EU certification: Electrodes certified to EN 26848 can obtain CE marking, which increases market competitiveness.

Regional adaptability: available in multiple languages (English, German, French) for easy use in EU member states.

Applications:

Automobile manufacturing: WL15 is used for TIG welding of aluminum alloy bodies of European cars (such as Volkswagen, BMW) in accordance with EN 1011 standard.

Aerospace: WL20 is used for the welding of titanium alloy parts of Airbus A350 aircraft, meeting the EN 9100 quality system.
Nuclear industry: WL10 is used for welding stainless steel pipes in French nuclear power plants in accordance with RCC-M specifications.

Limitations:
The revision of the standard is lagging behind (the 1991 edition is not fully updated to the latest application of WL15) and the content is older compared to ISO 6848:2015.
There are fewer special requirements for micro-welding and plasma cutting and need to be combined with industry standards (e.g. EN 1011-6).
Test methods rely on European laboratories (e.g. TÜV certification) and are costly for non-EU companies.

Correlation with ISO 6848:
EN 26848 is consistent with ISO 6848 in terms of classification, chemical composition and coloured marking, but with a narrower size range (length < 300 mm).
EN 26848 has stricter environmental requirements and explicitly prohibits the use of thoated tungsten electrodes in certain applications.
The test method is essentially the same as ISO 6848, but EN 26848 focuses more on the simulation of the actual operating conditions of the welding test.

European Influences:
EN 26848 has driven the rapid growth of lanthanum tungsten electrodes in the EU market, with WL15 and WL20 accounting for more than 40% of the European tungsten electrode market.
The CE-certified lanthanum tungsten electrode has a competitive advantage in the EU market.
It promotes trade harmonization within the EU and reduces the compliance costs of multinational enterprises.

7.2 Domestic standards for lanthanum tungsten electrodes

As the world's largest tungsten resource and tungsten electrode producer, China has formulated a series of national standards (GB) and industry standards (JB) to regulate the production and application of lanthanum tungsten electrodes. These standards are widely used in the domestic aerospace, nuclear industry, shipbuilding and automobile manufacturing fields in China, which not only refer to international standards, but also reflect local needs.

7.2.1 GB/T 14841 (National Standard for Tungsten Electrodes)

GB/T 14841 "Technical Conditions for Tungsten Electrodes" is a Chinese national standard, the latest version is 2008, which is applicable to tungsten electrodes for TIG welding, plasma welding and cutting, including lanthanum tungsten electrodes. This standard is issued by the Standardization Administration of the People's Republic of China and is a mandatory specification for the production and application of tungsten electrodes in China.

Standard content:

Classification: Lanthanum tungsten electrodes are divided into WL10 (0.8%-1.2% La_2O_3), WL15 (1.3%-1.7% La_2O_3) and WL20 (1.8%-2.2% La_2O_3), consistent with ISO 6848. The coloring logo is the same as the international standard.
Chemical composition: Lanthanum oxide content deviation ±0.15%, impurity limits (e.g., Fe<0.05%, C<0.02%) are equivalent to ISO 6848, but oxygen content (O<0.01%) requirements are more stringent.
Dimensions: diameter 0.25-6.4 mm, length 50-600 mm, tolerance in accordance with GB/T 1804 (h6 grade). Short length (50-100 mm) options are available to adapt to domestic automation equipment.
Performance requirements: arc starting performance (arc starting time at 10 amps< 0.4 seconds), arc stability (voltage fluctuation at 150 amps <± 0.5 V), burning resistance (tip consumption at 200 amps< 0.3 mm/h).
Test Methods: Chemical Composition Analysis (ICP-OES or AAS), Physical Property Test (Density> 19.2 g/cm³, Hardness 400-450 HV), Electrical Performance Test (Simulated Welding) and Visual Inspection (Ra<0.5 μm).
Packaging and labeling: moisture-proof and shockproof packaging is required, and the identification includes the brand, size, batch number, manufacturer and standard number (GB/T 14841).

Features & Benefits:
Localization adaptation: The size and performance requirements are adapted to China's welding equipment, which is convenient for domestic enterprises to apply.
Strict impurity control: The requirements for oxygen content and carbon content are higher than international standards, which improves the oxidation resistance and arc stability of the electrode.
Mandatory implementation: As a national standard, GB/T 14841 has legal effect in the Chinese market to ensure product quality consistency.
Cost-effective: The test method is simplified to commonly used equipment in China, which reduces the compliance cost of SMEs.

Applications:
Aerospace: WL20 is used for TIG welding of C919 aircraft titanium alloy fuselage, which meets GJB 1718 standard.
Nuclear industry: WL15 is used for stainless steel pipe welding of Qinshan Nuclear Power Plant, in line with GB/T 13164 specification.
Shipbuilding: WL10 is used for welding stainless steel sheet of LNG ship, in line with CCS classification society standard.

Limitations:
The standard is updated slowly (the 2008 version does not cover the latest trends in the application of WL15) and is slightly older than ISO 6848:2015.
There are fewer requirements for environmental protection and waste recycling, and it is not fully adapted to the trend of green manufacturing.
The test methods are less internationalized, and some methods (e.g., AAS) are not as accurate as ICP-MS.

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

Relevance to international standards:
GB/T 14841 is consistent with ISO 6848 in terms of classification, coloring and chemical composition, but the dimensional tolerances and test methods are closer to the actual situation of Chinese industry.
Performance requirements are comparable to AWS A5.12, but test conditions are more stringent for low-current arcing performance.
The packaging and labeling requirements are similar to EN 26848, but Chinese labeling has been added for the convenience of domestic users.

Domestic Impact:
GB/T 14841 has promoted the standardization of China's lanthanum tungsten electrode industry, and the domestic market share has increased from 50% in 2010 to 70% in 2020.
It supports the export of domestic electrode brands and meets the technical requirements of countries along the "Belt and Road".
It provides quality assurance for national key projects such as aerospace and nuclear industries, and reduces import dependence.

7.2.2 JB/T 4730 (Standard for welding materials)
JB/T 4730 "Quality Inspection Method for Welding Materials" is an industry standard formulated by China Machinery Industry Federation, the latest version is 2005, which is applicable to the quality inspection of welding materials, including lanthanum tungsten electrodes. This standard provides specific test methods and quality control guidance for GB/T 14841, which is widely used in welding equipment manufacturing and welding process validation.

Standard content:
Test Method:
Chemical composition: Lanthanum oxide and impurity content were analyzed by ICP-OES, AAS or XRF with an accuracy of ± 0.02%.
Physical properties: density test (Archimedes method, accuracy ±0.01 g/cm³), hardness test (Vickers hardness, accuracy ± 1 HV), surface roughness (Ra<0.5 microns).
Electrical performance: simulated welding test (current 10-300 ampere, voltage fluctuation <±0.5 V), arc start time test (< 0.4 seconds), electronic work escape test (2.6-3.2 eV).
Visual inspection: visual and microscopic inspection of surface defects, dimensional measurements (tolerance ± 0.02 mm).

Quality assessment: Specify the criteria for conformity, such as chemical composition deviation <±0.15%, density > 19.2 g/cm³, arc stability deviation <±0.5 V.
Sampling requirements: 5%-10% random sampling per batch, and the number of test samples is not less than 10.
Records and reports: It is required to record test data, equipment models and operating conditions, and issue quality inspection reports.

Features & Benefits:

Detailed test methods: Specific operating procedures (e.g., sample preparation for ICP-OES) are provided for easy implementation by enterprises.
Localized equipment: The test method is adapted to the commonly used equipment in China, which reduces the detection cost.
Quality control orientation: emphasizing quality control in the production process, suitable for large-scale production enterprises.
Matching with GB/T 14841: As a supplement to GB/T 14841, the quality inspection system is improved.

Applications:
Welding equipment manufacturing: used to verify the compatibility of domestic welding machines with lanthanum tungsten electrodes.
Shipbuilding: The welding test of WL15 electrode conforms to JB/T 4730 and meets the requirements of China Classification Society (CCS).
Railway industry: WL20 is used for aluminum alloy welding of high-speed rail carriages, and the inspection method conforms to TB/T 2653 standard.

Limitations:
Test methods are slow to update and do not cover the latest high-precision devices (e.g., ICP-MS).
The simulated welding conditions for the electrical performance test are relatively simple, and the complex working conditions (such as high-frequency alternating current) are not fully simulated.
The scope of the standard is weak, it is only the industry recommended standard, and its influence is not as good as GB/T 14841.

Relevance to international standards:
JB/T 4730 is based on ISO 6848 and AWS A5.12 in its test methodology, but is more adaptable to low-cost devices.
The chemical analysis method is consistent with EN 26848, but the accuracy requirements for physical and electrical tests are slightly lower.
The quality assessment standard is highly consistent with GB/T 14841 to ensure domestic production compliance.

Domestic Impact:
JB/T 4730 reduces the quality inspection cost of small and medium-sized enterprises and supports the popularization and application of lanthanum tungsten electrode.
It has promoted the use of domestic testing equipment (such as Haiguang ICP-OES) and enhanced the competitiveness of the domestic industrial chain.
It provides standardized guidance for welding process validation and reduces quality disputes in production.

7.3 Standard comparative analysis of lanthanum tungsten electrodes

The comparative analysis of domestic and foreign standards is helpful to understand their technical differences, production requirements and application impacts, and provides a basis for enterprises to formulate strategies in domestic and foreign markets.

7.3.1 Similarities and differences between domestic and foreign standards

Similarities:

Classification and identification: ISO 6848, AWS A5.12, EN 26848, GB/T 14841 all divide lanthanum tungsten electrodes into WL10, WL15 and WL20, and the lanthanum oxide content range is consistent (0.0%-2.2%). The coloring logo is unified (WL10 black, WL15 golden yellow, WL20 sky blue) to ensure the consistency of global user identification.

Chemical composition: Lanthanum oxide content deviation (±0.15%-±0.2%) and impurity limit (e.g., Fe<0.05%, C<0.02%) are similar, reflecting the high purity requirements of lanthanum tungsten electrode.

Dimensions: Diameter range 0.25-6.4 mm, tolerance in accordance with h6 grade, length 50-600 mm, suitable for TIG and plasma welding equipment.

Performance requirements: Arc initiation performance (low current arc starting), arc stability (voltage fluctuation <±0.5 V) and burn resistance (tip consumption <0.3 mm/h) are emphasized.

Environmental protection trend: non-radioactive electrodes (such as lanthanum tungsten and cerium tungsten) are encouraged, and the use of thorium-tungsten electrodes is restricted, which is in line with global environmental protection regulations.

Differences:

Standard Range:

ISO 6848 and EN 26848 cover TIG welding, plasma welding and cutting with the widest range.

AWS A5.12 is more focused on welding applications and requires less cutting performance.

GB/T 14841 covers welding and cutting, but pays more attention to domestic equipment compatibility.

JB/T 4730 is only a quality inspection method and does not address electrode classification and performance requirements.

Chemical Composition Requirements:

AWS A5.12 has the strictest impurity limits (Fe<0.03% vs 0.05% ISO) for demanding applications.

GB/T 14841 has stricter requirements for oxygen content (O<0.01%) to improve oxidation resistance.

ISO 6848 and EN 26848 have well-balanced impurity limits and are suitable for global production.

Dimensions:

AWS A5.12 is available in inches and has a wider length range (3-24 inches) for the North American market.

EN 26848 emphasizes short lengths (50-300 mm) and is suitable for European automation equipment.

GB/T 14841 offers flexible length options to accommodate Chinese-style manual and automatic welding.

Tel: 0086 592 512 9696

sales@chinatungsten.com

Test Method:

ISO 6848 and EN 26848 use high-precision equipment (e.g. ICP-MS) and are expensive to test.

AWS A5.12 focuses on real-world welding tests with test conditions that are closer to North American conditions.

GB/T 14841 and JB/T 4730 are compatible with domestic low-cost equipment (such as AAS) to reduce compliance costs.

Environmental Requirements:

EN 26848 is clearly in compliance with the EU RoHS Directive, which restricts thorium-tungsten electrodes to the strictest level.

ISO 6848 and AWS A5.12 promote non-radioactivity, but do not mandate environmentally friendly processes.

GB/T 14841 and JB/T 4730 have weak requirements for environmental protection, and green manufacturing standards need to be supplemented.

Update frequency:

ISO 6848 (2015) is the most up-to-date and covers the latest WL15 applications.

AWS A5.12 (2009), EN 26848 (1991/2005), and GB/T 14841 (2008) updates are lagging behind.

JB/T 4730 (2005) is the slowest to update, and the test method does not fully reflect the new technology.

Summary:

ISO 6848 is the world's most authoritative standard, with comprehensive technology and suitable for multinational enterprises.

AWS A5.12 is suitable for the North American market, with rigorous performance testing and a complete certification system.

EN 26848 focuses on environmental protection and automation and adapts to the strict EU regulations.

GB/T 14841 and JB/T 4730 are highly localized, low-cost, and suitable for the Chinese market.

7.3.2 Impact on production and application

Production Impact:

Quality control:

The high-precision testing requirements of international standards (ISO, AWS, EN) (such as ICP-MS) promote enterprises to produce high-end testing equipment, but increase equipment investment (about 500-10 million yuan).

The low-cost test methods (AAS, XRF rays) of GB/T 14841 and JB/T 4730 reduce the compliance costs of SMEs, reducing the average cost of testing by 30%-50% per batch.

Strict impurity limits (e.g., Fe<0.03%) of AWS and EN require companies to optimize the raw material purification process (e.g., hydrogen secondary reduction), increasing production costs by 10%-15%.

Production process:

The environmental requirements of ISO 6848 and EN 26848 are driving companies to adopt green sintering (e.g. vacuum furnaces) and waste recycling technologies, which can reduce exhaust emissions by 50%, but the cost of equipment upgrades is high.

GB/T 14841's strict requirements for oxygen content (O<0.01%) have prompted companies to optimize doping and sintering atmosphere control (e.g., high-purity hydrogen), increasing the process difficulty by 20%.

The actual welding test of AWS A5.12 requires enterprises to establish a simulation test platform, which increases R&D investment (about 100-2 million yuan).

Market Competitiveness:

Companies that comply with ISO 6848 and AWS A5 can enter the European and American markets, and their exports will increase by 30%-40%.

The localization advantages of GB/T 14841 enable domestic enterprises to have an advantage in the "Belt and Road" market, with a cost of 10%-20% lower.

The CE marking requirements of EN 26848 raise the barriers to entry in the EU market, and SMEs need to work with a certification body.

Application Impact:

Welding Quality:

Stringent performance requirements of ISO 6848 and AWS A5.12, such as voltage fluctuations <± 0.5 V, ensure high-precision welds with a weld pass rate of around 99.5% in the aerospace and nuclear industries.

The low current arc initiation performance (<0.4 seconds) of GB/T 14841 is suitable for thin plate welding, meeting the needs of the electronics and automotive industries, and reducing welding costs by 15%.

The automation adaptability of EN 26848 increases the efficiency of European production lines (e.g. 20%), but is less compatible with non-automated equipment.

User Selects:

AWS A5.12 certified electrodes are more trusted in the North American market, with prices 20%-30% higher.

GB/T 14841 standard domestic electrodes (such as Zhongyue) are cost-effective, with a domestic market share of more than 70%.

EN 26848 environmentally friendly electrodes (e.g. ESABs) dominate the EU market with a market share of around 45%.

Supply Chain Management:

The global harmonization of ISO 6848 reduces procurement compliance costs for multinational companies and improves supply chain efficiency by 10%.

The regional standards of AWS and EN increase the multi-standard production cost of enterprises, which is about 5%-10%.

GB/T 14841 and JB/T 4730 support the integration of the domestic supply chain and reduce the dependence on imported electrodes by 30%.

Summary:
International standards improve product quality and technical level, but increase production and testing costs, suitable for high-end market.
Domestic standards reduce compliance costs, support the development of small and medium-sized enterprises, and are suitable for the low-end market.
Enterprises need to choose the applicable standards according to the target market and balance cost and market competitiveness.

7.4 Standard update and development trend of lanthanum tungsten electrode

With the expansion of lanthanum tungsten electrodes and the advancement of technology, the standard system needs to be continuously updated to adapt to new materials, new processes and environmental protection requirements. This section examines the new development, revision, and internationalization of lanthanum tungsten electrode standards.

7.4.1 Development of new standards

Demand-driven:
New materials: The composite doping of lanthanum-tungsten electrodes (e.g., La_2O_3+CeO_2) improves arc performance, and new classification and performance standards need to be developed.
New applications: Micro-plasma welding (<1 A) and ultra-high current cutting (> 500 A) place special demands on the electrodes that are not covered by existing standards such as ISO 6848.
Environmental regulations: The EU REACH regulation and China's green manufacturing policy require standards to increase the specification of waste recycling and production emissions.
Intelligent production: Automated welding equipment (such as robots) has higher requirements for electrode size and performance consistency, and new test methods need to be developed.

The new standard includes:
Classification expansion: The classification of composite doped electrodes (such as WL15+Ce) has been added, and the doping ratio and performance requirements have been specified.
Performance refinement: Add microcurrent arc start (<1 amp, arc start time <0.2 seconds) and high current burn resistance (500 amps, tip consumption <0.5 mm/h) tests.
Environmental protection specifications: stipulate the recovery rate of waste electrodes (>80%), exhaust emission limits (dust <0.1 mg/m³) and carbon emission standards (<1 tons CO_2/ton electrodes).
Dimensional accuracy: improve the diameter tolerance (±0.01 mm) and surface roughness (Ra<0.2 microns), and adapt to automation equipment.
Test method: Introduce intelligent testing (such as AI image analysis of grain size, real-time online arc monitoring) to improve the detection efficiency by 50%.

Development Progress:
International: ISO/TC 44 (Technical Committee on Welding) is revising ISO 6848 and is expected to release a new version in 2025-2027 to include composite doping and environmental requirements.

Tel: 0086 592 512 9696
CTIAQCD -MA-E/P 2018- 2024V
sales@chinatungsten.com

United States: AWS plans to revise A5.12 in 2025 to include test methods for micro-welding and plasma cutting.
EU: CEN plans to update EN 26848 in 2026 to strengthen REACH and RoHS compliance.
China: The National Welding Standardization Committee (SAC/TC 70) plans to revise GB/T 14841 in 2025 to add green manufacturing and intelligent testing content.

Challenge:
The high requirements of the new standard may increase the cost of upgrading equipment for enterprises.
The test methods in different countries and regions are different, and it is necessary to coordinate with multiple parties to reach a consensus.
It is difficult for small and medium-sized enterprises to adapt quickly to the technical level, and they need policy support and technical training.
Effect:
The new standard will promote the technical upgrade of lanthanum tungsten electrodes, and the market share is expected to increase by 20%-30%.
Environmental regulations will accelerate the elimination of thorium-tungsten electrodes, and lanthanum tungsten electrodes account for more than 50%.
Intelligent testing will improve production efficiency and reduce testing costs by 30%.

7.4.2 Trends in the internationalization of standards

Background:
Global trade: The export value of lanthanum tungsten electrodes increased from US$1 billion in 2015 to US$1.5 billion in 2020, and it is necessary to unify standards to lower trade barriers.
Transnational projects: Aviation (C919, A350), nuclear power (Hualong No. 1) and other projects require mutual recognition of multinational standards.
Technology integration: The global sharing of new materials (composite doping), new processes (green manufacturing) and new equipment (automated welding) promotes the internationalization of standards.

Trend:
Mutual Recognition of Standards:
With ISO 6848 as the core framework, standards such as AWS, EN, and GB/T are gradually being aligned with it, and the mutual recognition rate is expected to reach 90%.
The degree of alignment between GB/T 14841 and ISO 6848 in China has been increased from 80% to 95%, supporting the adoption of equivalent standards by countries along the "Belt and Road".
AWS and EN are harmonized through the ISO platform to reduce the cost of duplicate certifications in North America and the EU.

Environmental protection unity:
The EU REACH and RoHS regulations have been adopted by ISO, and the global standards will uniformly limit thorium-tungsten electrodes, and lanthanum tungsten electrodes have become the mainstream.

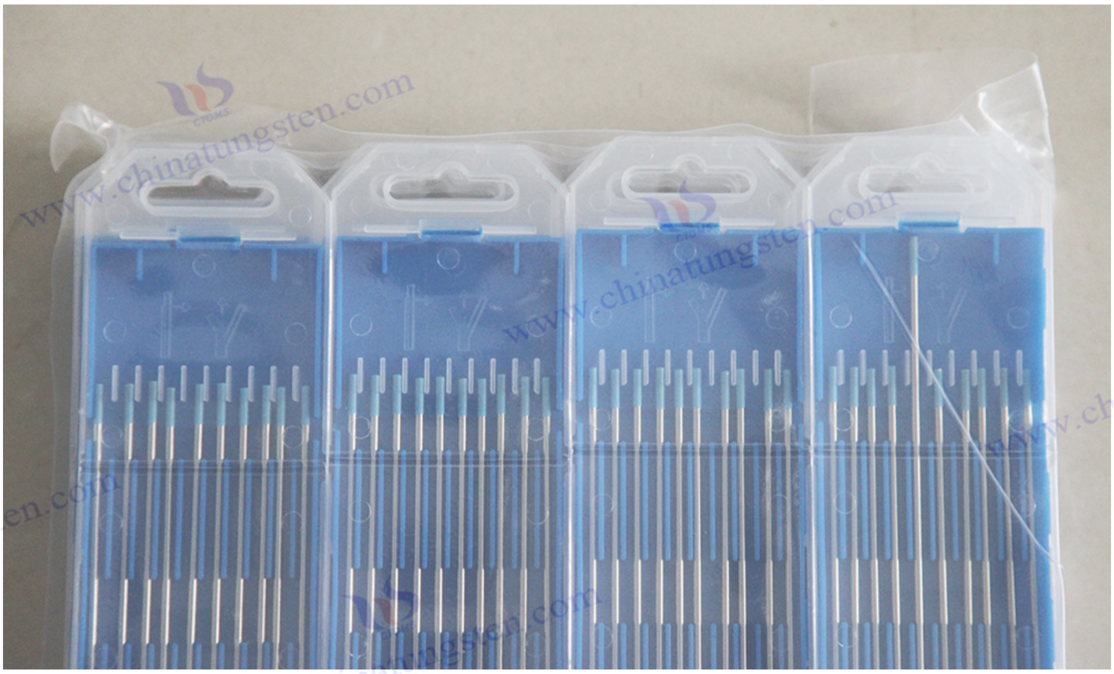
China's green manufacturing standards (e.g., GB/T 26572) are aligned with ISO 14001 to promote the standardization of waste recycling rate (>80%).

Testing Technology Sharing:
High-precision testing (e.g., ICP-MS, AI image analysis) is prevalent in ISO standards, and the global inspection equipment market is expected to grow by 15%.
Low-cost testing methods (e.g., AAS) in China have been adopted by developing countries, reducing compliance costs by 20%.

Regional Cooperation:
The Asia-Pacific region (China, Japan, South Korea) has established a welding standards alliance to formulate a regional lanthanum tungsten electrode standard, which is expected to be released in 2026.
The EU and the United States harmonize standards through the WTO framework to reduce technical barriers to trade.
China leads the "Belt and Road" welding standard training and promotes the GB/T 14841 equivalent standard.

Challenge:
High standards in developed countries (e.g., AWS certification) create technical barriers for companies in developing countries.
Regional differences in standard translation and implementation require additional multilingual support and training.
Intellectual property protection (e.g., patents for new test methods) can lead to international disputes.

Effect:
The internationalization of standards will reduce global trade costs by 10%-15% and promote the lanthanum tungsten electrode market size to reach 2 billion US dollars.
Chinese enterprises have a stronger voice in the formulation of international standards, which is expected to account for 30% of the 44 seats in ISO/TC.
The standardization of environmental protection and intelligent technology will accelerate the global industrial upgrading, and the green application rate of lanthanum tungsten electrodes will reach 90%.



CTIA GROUP LTD WL20 electrode

Chapter 8 Detection Methods and Techniques of Lanthanum Tungsten Electrode

As a high-performance welding and cutting material, the quality of lanthanum tungsten electrode directly affects the weld quality, arc stability and production efficiency. Detection methods and technologies are the key to ensure that lanthanum tungsten electrodes comply with international and domestic standards (such as ISO 6848:2015, GB/T 14841), covering chemical composition, physical properties, electrical properties, mechanical properties and microstructure analysis. This chapter will discuss in detail the chemical composition testing (lanthanum oxide content and impurity element analysis), physical properties testing (density, hardness, melting point, thermal conductivity), electrical properties testing (electron work evolution, arc initiation performance, arc stability), mechanical properties testing (burn resistance, wear resistance), microstructure analysis (scanning electron microscopy, X-ray diffraction), testing equipment selection and calibration (equipment type and maintenance), and testing standards and specifications (international and domestic standards).

8.1 Detection of chemical composition of lanthanum tungsten electrode

The chemical composition test is used to verify the content of lanthanum oxide (La_2O_3) in the lanthanum tungsten electrode and the compliance of impurity elements to ensure the electrical performance and chemical stability of the electrode. The detection method needs to be high precision and high sensitivity to meet the requirements of ISO 6848:2015 and GB/T 14841 (lanthanum oxide content deviation ±0.15%, impurity <0.05%).

8.1.1 Lanthanum oxide content detection

Lanthanum oxide is the active ingredient of lanthanum tungsten electrode, and the content (0.8%-2.2%) directly affects the electron work and arc stability. Detection methods need to ensure accuracy and repeatability, and common techniques include inductively coupled plasma emission spectroscopy (ICP-OES), X-ray fluorescence spectroscopy (XRF), and chemical titration.

Detection Method:

ICP-OES：

Principle: After the sample is dissolved, it is excited by plasma (6000-10000 K), emits a spectrum of a specific wavelength, analyzes the intensity of lanthanum element, and quantitatively calculates the lanthanum oxide content.

Steps:

Take the electrode sample (0.1-0.5 g) and dissolve it with nitric acid and hydrofluoric acid (1:1) to prepare the solution.

Dilute to 10-50 ppm using high-purity water and add an internal standard (e.g., indium).

Analyzed on ICP-OES (wavelength 394.91 nm), the content was calculated by calibration curve method.

Technical parameters: detection limit 0.01 ppm, accuracy ± 0.02%, analysis time 5-10 minutes.

Advantages: High sensitivity, simultaneous analysis of multiple elements, suitable for accurate detection of WL10, WL15 and WL20.

Limitations: Complex sample pretreatment is required, and the equipment cost is high (about 200-3 million yuan).

XRF：

Principle: X-ray excitation of sample atoms, fluorescence, analysis of lanthanum characteristic peak intensity, calculation of content.

Steps:

Electrode slices or powders are pressed into thin sheets (20-30 mm diameter).

Scan on an XRF instrument (Rh target, 50 kV) to calibrate the standard.

The La Kα line (33.44 keV) was analyzed using software and the lanthanum oxide content was calculated.

Technical parameters: detection limit 0.05%, accuracy ± 0.05%, analysis time 30 seconds - 2 minutes.

Advantages: non-destructive, fast, suitable for batch inspection on the production line.

Limitations: Low sensitivity for low content (<1%) samples, calibration of high-purity standard samples is required.

Chemical titration:

Principle: The lanthanum ion concentration is determined by chemical reaction (such as EDTA complex titration) and the lanthanum oxide content is converted.

Steps:

After the sample is dissolved, a buffer solution (pH 5-6) is added.

EDTA was used as the titrant and xylol orange was used as the indicator, and the titration was carried out until the color change.

The lanthanum content is calculated based on EDTA consumption.

Technical parameters: accuracy ± 0.1%, analysis time 20-30 minutes.

Advantages: simple equipment (cost < 100,000 yuan), suitable for small and medium-sized enterprises.

Limitations: The operation is complex, affected by interfering elements (such as Fe, Al), and the accuracy is low.

Application Scenarios:

ICP-OES: used in R&D and high-end production, such as WL20 electrode (lanthanum oxide 2.0±0.15%) for aerospace.

XRF: Used for production process monitoring and rapid detection of WL15 batch uniformity.

Chemical titration: for low-cost assays, such as routine quality control of WL10.

Key Technologies:

Sample preparation: Ensure complete dissolution, avoid lanthanum precipitation, and <1% dilution error of the solution.

Calibration standard: A high-purity lanthanum oxide (>99.99%) standard sample was used with a calibration curve $R^2 > 0.999$.

Interference cancellation: ICP-OES needs to deduct tungsten matrix spectral interference, and XRF needs to correct the matrix effect.

Development Trends:

Rapid detection: Portable XRF has been developed with an analysis time of < 10 seconds to meet the needs of online monitoring.

High accuracy: Promote ICP-MS (detection limit 0.001 ppm) to improve low-level detection capabilities.

Automation: Integrate automated sampling and data processing to increase analysis efficiency by up to 50%.

8.1.2 Analysis of impurity elements

Impurity elements (e.g., Fe, Si, C, O) affect the conductivity, oxidation resistance and arc stability of the electrode and should be controlled at <0.05% (ISO 6848). Commonly used detection methods include ICP-OES, atomic absorption spectroscopy (AAS), infrared absorption, and inert gas fusion.

Detection Method:

ICP-OES:

Principle: Detection with lanthanum oxide, simultaneous detection of Fe (238.20 nm), Si (251.61 nm) and other impurities through multi-wavelength analysis.

Procedure: Same as lanthanum oxide detection, adjust the wavelength and calibration curve.

Technical parameters: detection limit 0.01-0.1 ppm, accuracy ± 0.01%, suitable for multi-element analysis.

Advantages: High sensitivity, analysis of multiple impurities at one time, high efficiency.

Limitations: Complex pre-processing and high cost.

AAS:
Principle: The sample atoms absorb light of a specific wavelength and determine the concentration of Fe, Ni and other elements.
Steps:
Samples are dissolved and diluted to 1-10 ppm.
Analyzed on AAS (Fe 248.33 nm), flame or graphite furnace atomized.
The standard addition method calculates the content.

Technical parameters: detection limit 0.1 ppm, accuracy ± 0.05%, analysis time 10 minutes/element.
Advantages: The equipment cost is low (about 20-500,000 yuan), suitable for single element detection.
Limitations: element-by-element analysis, low efficiency, matrix interference.

Infrared absorption method (C, S):
Principle: The sample is burned at high temperature to generate CO_2 and SO_2, and the content is determined by infrared absorption.
Steps:
Take a sample (0.5-1 g) and burn it in an oxygen stream (1350 °C).
The infrared detector analyzes the CO_2 (4.26 μm) absorption intensity.
The calibration curve method calculates the C content.

Technical parameters: detection limit 0.001%, accuracy ± 0.005%, analysis time 2-5 minutes.
Advantages: fast, accurate, suitable for C and S detection.
Limitations: Only C and S, special equipment is required (about 500,000 yuan).

Inert Gas Melting Method (O, N):
Principle: The sample is melted at high temperature in helium, O_2 and N_2 are released, and the thermal conductivity detector is analyzed.
Steps:
Take a sample (0.1-0.5 g) and melt it in a graphite crucible (2500°C).
The thermal conductivity detector determines the O_2 and N_2 content.
Calibrate the standard gas calculation results.

Technical parameters: detection limit 0.0005%, accuracy ± 0.002%, analysis time 3 minutes.
Advantages: High sensitivity, suitable for O and N detection.
Limitations: The cost of the equipment is high (about 1 million yuan), and it is limited to gas elements.

Application Scenarios:
ICP-OES: For comprehensive impurity analysis of aerospace electrodes (e.g. Fe<30 ppm).
AAS: Used in small and medium-sized businesses to detect specific impurities (e.g., Si<50 ppm).

Infrared absorption method: used for C content control (<0.01%) to ensure oxidation resistance.
Inert gas melting method: used for O content detection (<0.01%), meeting GB/T 14841.

Key Technologies:
Substrate calibration: ICP-OES needs to deduct tungsten matrix interference, and AAS needs to be standard addition method.
Standard samples: Use NIST accredited standards (e.g., SRM 2452) to ensure accurate calibration.
Environmental control: The testing room needs to be at constant temperature (20±2°C) and low dust (ISO level 7).

Development Trends:
Rapid multi-element analysis: ICP-MS is popularized to detect 50 elements in < 5 minutes.
On-line detection: XRF on-line analyzer was developed to monitor impurities in real time.
Green detection: reduce the amount of acid solvent and use microwave digestion technology.

8.2 Testing of physical properties of lanthanum tungsten electrode

Physical property testing is used to evaluate the density, hardness, melting point, and thermal conductivity of lanthanum tungsten electrodes, which affect the mechanical strength, thermal stability, and welding efficiency of the electrodes.

8.2.1 Density and hardness testing

Density (>19.2 g/cm³) and hardness (400-450 HV) are important physical indexes of lanthanum tungsten electrode, reflecting its density and mechanical strength.

Density Test:
Method: Archimedes' method.
Principle: Measure the mass of the electrode in air and liquid (usually water or ethanol) and calculate the density.
Steps:
Weigh the electrode dry weight (m_1) with a high-precision balance (accuracy ±0.0001 g).
The electrode was immersed in deionized water (20 °C, density $\rho_0 = 0.998$ g/cm³) and the wet weight (m_2) was weighed.
Calculate the density: $\rho = m_1 / (m_1 - m_2) \times \rho_0$.

Technical parameters: accuracy ± 0.01 g/cm³, measurement time 1-2 minutes.
Advantages: simple, low cost (about 50,000 yuan equipment), suitable for batch testing.
Limitations: The accuracy of small electrodes (<0.5 mm) is slightly lower, and the surface tension of the liquid needs to be corrected.

Hardness Testing:
Method: Vickers hardness (HV).
Principle: The diamond indenter is pressed into the electrode surface under the specified load, the diagonal length of the indentation is measured, and the hardness is calculated.

Steps:
Prepare electrode sections and polish to Ra<0.2 μm.
Use a Vickers hardness tester (load 5-10 N, hold load for 10 seconds).
Measure the indentation diagonal and calculate the HV value.

Technical parameters: accuracy ± 1 HV, measurement time 2-5 minutes/point.
Advantage: High accuracy, suitable for evaluating electrode homogeneity.
Limitations: Destructive sample preparation is required and test points are limited.

Application Scenarios:
Density test: for quality control of sintered green bodies and finished products, density < 19.2 g/cm³ may have porosity.
Hardness test: used for strength verification of electrodes after forging and drawing, hardness >450 HV indicates good grain refinement.

Key Technologies:
Sample Flattening: Polishing the sample to avoid surface defects affecting hardness measurement.
Calibration Standard: Calibrate the device using NIST hardness blocks (HV400-500).
Environmental control: The temperature of the test chamber is 20±1°C to avoid thermal expansion errors.

Development Trends:
In-line density testing: development of ultrasonic density meter, non-destructive testing.
Micro-hardness: Promote nanoindentation technology to analyze grain-level hardness.
Automation: The integrated automatic sample stage increases the testing efficiency by 30%.

8.2.2 Melting point and thermal conductivity test

The melting point (about 3400°C) and thermal conductivity (about 100 W/m·K) reflect the high temperature resistance and thermal conductivity of the electrode, which affects its performance in high-current welding.

Melting Point Test:
Methods: High-temperature thermal analysis (differential scanning calorimetry, DSC).
Principle: The sample is heated and the melting point temperature corresponding to the endothermic peak is recorded.
Steps:
Take a sample (10-50 mg) and place it in an alumina crucible.
Under the protection of argon gas (flow rate 50 mL/min), the temperature was raised to 3500 °C (rate 10 °C/min).
The DSC curve is recorded to determine the melting point.

Technical parameters: accuracy ± 5 °C, analysis time 30-60 minutes.
Advantages: high precision, suitable for R&D verification.

Limitations: The equipment is expensive and not suitable for routine testing.

Thermal Conductivity Test:
Method: Laser flash method.
Principle: The laser pulse heats one side of the sample, and the infrared detector measures the temperature rise on the other side to calculate the thermal conductivity.
Steps:
Prepare electrode sections (10 mm diameter, 2 mm thickness).
Tested on a laser flash meter (100-1000°C, argon protected).
The thermal conductivity ($\lambda = \alpha \times \rho \times C_p$) was calculated using the software.

Technical parameters: accuracy ±3%, measurement time 1-3 minutes.
Advantages: Fast, non-destructive, suitable for high-temperature performance analysis.
Limitations: Thin samples are required, and the equipment cost is high (about 2 million yuan).

Application Scenarios:
Melting point test: used for R&D verification of newly formulated electrodes, such as composite doping.
Thermal conductivity test: used to evaluate the performance of plasma cutting electrodes (e.g., WL20).

Key Technologies:
High temperature protection: High purity argon gas (> 99.999%) is used to prevent sample oxidation.
Calibration standard: Tungsten single crystal (melting point 3410°C) and copper (thermal conductivity 400 W/m·K) are used for calibration.
Data processing: Thermal conductivity boundary effects are corrected using a finite element model.

Development Trends:
High temperature test: develop test equipment above 4000°C to adapt to new materials.
Non-contact measurement: Promote thermal conductivity testing in infrared thermography.
Multi-parameter testing: Integrate melting point, thermal conductivity and thermal expansion tests.

8.3 Electrical performance testing of lanthanum tungsten electrode

The electrical performance test evaluates the electron work of lanthanum tungsten electrode, arc initiation performance and arc stability, which directly determine its performance in TIG welding and plasma welding.

8.3.1 Measurement of electronic work derivation

The electron work (2.6-3.2 eV) is the core electrical parameter of the lanthanum tungsten electrode, reflecting its ability to emit electrons, and the low work of the escape contributes to the low current arcing.

Method: Thermoelectron emission method.

Principle: Heat the electrode to a high temperature (1000-2000°C), measure the emission current, and calculate the work of electron escape.

Steps:
Place the electrode in a vacuum chamber ($<10^{-5}$ Pa) and heat to 1500°C.
An electric field (100-500 V/cm) is applied and the emission current (1-100 μA) is recorded.
The work function is calculated using the Richardson-Dushman equation: $J = A T^2 \exp(-\Phi/kT)$.

Technical parameters: accuracy ± 0.05 eV, test time 10-20 minutes.
Advantage: It directly reflects the electrical performance of the electrode, which is suitable for research and development.
Limitations: Vacuum environment is required, and the equipment is complex (about 3 million yuan).

Application scenario: It is used to verify the performance of WL20 electrodes to ensure that the < of the escape power is 2.8 eV.

Key Technologies:
Vacuum control: The vacuum level is $<10^{-6}$ Pa to prevent oxygen interference.
Temperature calibration: Use an optical pyrometer (accuracy ± 2°C).
Current measurement: Picoamp meter with sensitivity < 1 pA.

Development Trends:
Rapid measurement: Development of an atmospheric pressure test method with a time of < 5 minutes.
On-line monitoring: integrated production line, real-time detection of work output.
Theoretical simulation: Combined with DFT calculation to predict the work of escape, reduce the cost of the experiment.

8.3.2 Arc performance test
The arc initiation performance reflects the ignition capability of the electrode at low currents (10-50 amps), and the arc initiation time < 0.5 seconds (ISO 6848) is preferred.

Method: Simulated welding test.
Principle: The arcing time and voltage between the electrode and the workpiece are measured on a TIG welding machine.

Steps:
TIG welder is used (DC cathode, argon protection, flow rate 10 L/min).
The current is set at 10-50 amperes, and the distance between the electrode tip and the workpiece (stainless steel) is 2 mm.
Record the arcing time (from energizing to arc stabilization) and arcing voltage.

Technical parameters: time accuracy±0.01 seconds, voltage accuracy±0.1 V, test time 1-2 minutes.

Advantage: Simulate actual working conditions and the results are intuitive.
Limitations: Slightly less repeatable depending on the material of the workpiece and the purity of the gas.

Application scenario: used for WL10 thin plate welding performance test, arc starting time < 0.4 seconds.

Key Technologies:
Electrode tip: Ground to a 45° cone angle to ensure consistency.
Data acquisition: Use a high-speed oscilloscope (sampling rate> 10 kHz).
Environmental control: argon purity > 99.999% to avoid oxidation.

Development Trends:
Microcurrent test: Developed <1 ampere arc test to meet the requirements of micro-welding.
Automation: The integrated robotic welding station increases the testing efficiency by 50%.
Multi-condition simulation: Covers both AC and pulse current testing.

8.3.3 Arc stability test

The arc stability reflects the voltage and current fluctuations of the electrode during the welding process, preferably <± 0.5 V (ISO 6848).

Method: Simulated welding test.
Principle: Record arc voltage fluctuations at constant current and evaluate stability.

Steps:
Use a TIG welder (DC, 100-200 amps, argon 10 L/min).
The electrode is kept 3 mm apart from the workpiece (stainless steel) and welded for 5 minutes.
Use an oscilloscope to record voltage fluctuations and calculate the standard deviation.

Technical parameters: voltage accuracy±0.01 V, sampling rate>1 kHz, test time 5-10 minutes.
Advantage: Directly reflects welding performance, suitable for quality control.
Limitations: Affected by electrode tip shape and gas flow.
Application scenario: Used for WL15 aerospace welding verification, voltage fluctuation <± 0.4 V.

Key Technologies:
Tip consistency: Uniform tip cone angle (30-45°) reduces drift.
Data analysis: Analyze the frequency of voltage fluctuations using FFT.
Shielding gas: Ensures a stable argon flow rate (±0.1 L/min).

Development Trends:
High-frequency testing: Development of AC and high-frequency pulsed arc stability tests.
Real-time monitoring: integrated production line on-line detection system.
AI Analytics: Predict arc stability with machine learning.

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

8.4 Testing of mechanical properties of lanthanum tungsten electrode

Mechanical properties testing evaluates the burn-out resistance and wear resistance of lanthanum tungsten electrodes, which affect the life and cost of use.

8.4.1 Burn resistance test

The burn resistance reflects the tip consumption rate of the electrode at high temperature arcs, with tip consumption < 0.3 mm/hr (200 A, ISO 6848) preferred.

Method: Simulated welding test.
Principle: Measuring electrode tip length loss in high-current welding to evaluate burn resistance.

Steps:
TIG welder (DC 200 A, argon 12 L/min) was used.
The electrode tip is ground at a 45° cone angle and 3 mm away from the stainless steel workpiece.
Continuous welding for 1 h, using a microscope to measure tip length loss.

Technical parameters: measurement accuracy± 0.01 mm, test time 1 hour.
Advantage: Reliable results from simulated real-world conditions.
Limitations: Long test time and low efficiency.

Application scenario: used for WL20 plasma cutting electrode verification, consumption < 0.25 mm/h.

Key Technologies:
Tip control: Make sure the initial cone angle is consistent (deviation <± 2°).
Microscopic measurements: using a digital microscope (100x magnification) with an accuracy of ± 0.005 mm.
Stable working conditions: control current (±1 ampere) and gas flow (±0.1 L/min).

Development Trends:
Rapid test: Development of a 30-minute burn resistance test method.
High temperature simulation: test the working conditions above 500 amps to meet the cutting needs.
Automation: Integrated image recognition for automatic measurement of tip loss.

8.4.2 Abrasion Resistance Test

Abrasion resistance reflects the surface wear performance of the electrode during drawing and use, affecting its life and surface quality.

Method: Friction and wear test.
Principle: Measure electrode mass loss or wear scar depth under defined load and friction conditions.

Steps:
A friction and wear testing machine is used (the abrasive material is carbide with a load of 10 N).

The electrode sample (length 20 mm) was rubbed 1000 times at a speed of 5 m/min.
Measurement of mass loss (balance accuracy ±0.0001 g) or depth of wear marks (profilometer).

Technical parameters: mass loss accuracy ± 0.1 mg, grinding depth ± 0.1 microns, test time 20-30 minutes.
Advantages: Quantified wear resistance, suitable for production control.
Limitations: There is a difference between the simulated working conditions and the actual use.

Application scenario: It is used to verify the surface quality of WL15 drawing electrodes.

Key Technologies:
Load control: The servo system ensures that the load deviation <± 0.1 N.
Surface pretreatment: Samples are polished to Ra<0.2 μm.
Environmental control: The humidity of the test room is < 50% to avoid oxidation.

Development Trends:
Micro-abrasion testing: Development of nanoscale abrasion analysis for microelectrodes.
Multi-case simulation: Covers dry friction and lubrication conditions.
On-line inspection: embedded in the drawing production line to monitor wear in real time.

8.5 Microstructure analysis of lanthanum tungsten electrode

Microstructure analysis is used to study the grain size, phase distribution and defects of lanthanum tungsten electrodes, and to reveal the microscopic mechanism of its performance.

8.5.1 Scanning electron microscopy (SEM) analysis

SEM is used to observe the surface topography, grain size (10-20 μm), and lanthanum oxide distribution of the electrode.

Principle: The electron beam scans the sample, collects secondary electrons or backscattered electrons, and generates a high-resolution image.

Steps:
Electrode sections are prepared, polished and cleaned with ethanol.
Observe on SEM (accelerating voltage 10-20 kV, vacuum < 10^{-5} Pa).
Lanthanum oxide distribution was analyzed using an energy dispersive spectrometer (EDS).

Technical parameters: resolution 1 nm, magnification 100-10,000x, analysis time 10-30 minutes.
Advantages: High resolution, combined with EDS to provide element distribution.
Limitations: Vacuum environment is required, and the equipment is expensive (about 5 million yuan).
Application scenario: It is used for grain and doping uniformity analysis of WL20 sintered body.

Key Technologies:

Sample preparation: Polished to Ra<0.1 μm to avoid artifacts.
EDS calibration: Elemental content is corrected using a standard sample (La_2O_3).
Image processing: Grain size distribution was analyzed using ImageJ.

Development Trends:
In-situ analysis: Development of high-temperature SEM to observe the electrode burnout process.
3D imaging: Promote FIB-SEM and reconstruct internal structures.
Automation: Automatic identification of grains and defects through AI.

8.5.2 X-ray diffraction (XRD) analysis
XRD is used to analyze the crystal structure, phase composition, and residual stresses of electrodes.

Principle: X-rays are chemically chemically linked to crystals, producing diffraction patterns and analyzing crystal phases and grain sizes.

Steps:
Prepare electrode powders or sections, wash and dry.
Analyzed on an XRD instrument (Cu Kα, 40 kV, scanning range 10-80°).
Use the Jade software to compare the PDF cards to determine the phase composition.

Technical parameters: resolution 0.01°, analysis time 30-60 minutes.
Advantage: Non-destructive, suitable for phase analysis and stress measurements.
Limitations: Low sensitivity to trace phase (<1%), high equipment cost (about 2 million yuan).
Application scenario: Tungsten and lanthanum oxide phase analysis for WL15 forged electrodes.

Key Technologies:
Calibration standard: 2θ angle correction using a Si standard sample (NIST SRM 640).
Peak separation: Rietveld was used to refine the analytical phase content.
Stress measurement: Residual stresses are calculated using the $\sin^2\psi$ method.

Development Trends:
Fast XRD: Develop synchrotron radiation XRD with an analysis time of < 10 minutes.
Micro-analysis: Promote microfocus XRD and sub-ejaculation accuracy.
Intelligent: Automatically identify phase states through machine learning.

8.6 Selection and calibration of lanthanum electrode testing equipment
The selection and calibration of test equipment is the key to ensuring the accuracy of test data, including equipment type, performance parameters, and maintenance requirements.

8.6.1 Type of testing equipment
Chemical composition: ICP-OES (Thermo Fisher iCAP 7400), XRF (Bruker S8 Tiger), AAS (Beijing Haiguang), infrared absorption instrument (LECO CS-600), inert gas analyzer (ELTRA ONH-2000).

Physical properties: density meter (Mettler Toledo MS204S), Vickers hardness tester (AGI HV-50), DSC (Netzsch STA 449 F3), laser thermal conductivity meter (LFA 457).

Electrical performance: Electron Escape Tester (customized), Simulated Soldering Station (OTC TIG-300), Conductivity Meter (Keithley 2401).

Mechanical properties: friction and wear tester (WJT-1000), microscope (Zeiss Axio Observer).

Microstructure: SEM-EDS (FEI Quanta 250), XRD (Rigaku D/max-2500).

Chosen by:
Accuracy required: ICP-OES (0.01 ppm) for aerospace and XRF (0.05%) for conventional production.
Cost control: AAS for small and medium-sized enterprises, ICP-MS for large enterprises.
Production scale: Mass production requires automated equipment (such as automatic sampling ICP-OES) and high-resolution SEM for R&D.

8.6.2 Calibration and Maintenance
Calibration:
Chemical composition: Calibration curve $R^2 > 0.999$ using NIST standard samples (SRM 2452 tungsten, SRM 1075a lanthanum oxide).
Physical properties: standard weights for density tester (±0.0001 g), HV400 blocks for hardness tester.
Electrical properties: standard resistance (±0.01 Ω) for soldering station, calibration voltage of the work output tester (±0.1 V).
Microstructure: The resolution of the SEM is calibrated with the gold standard sample, and the Si standard is calibrated with the 2θ angle for XRD.
Cycle: Monthly calibration, weekly inspection of key equipment.

Maintenance:
Cleaning: ICP-OES monthly injection tube cleaning, SEM weekly gun cleaning.
Consumables replacement: XRF targets are replaced every 2 years, and hardness tester indenters are inspected every 5000 times.
Environment: constant temperature 20±2°C, humidity <60%, cleanliness ISO 7.
Records: Electronic maintenance logs to trace the cause of failures.

Development Trends:
Automatic calibration: Develop a self-calibration system to reduce manual operation.
Remote maintenance: Real-time monitoring of equipment status through IoT reduces the failure rate by 30%.
Green maintenance: reduce the amount of cleaning solvent and use environmentally friendly consumables.

Tel: 0086 592 512 9696

sales@chinatungsten.com

8.7 Testing standards and specifications for lanthanum promethium electrodes

Testing standards provide a uniform specification for testing methods and ensure comparability and compliance of test results.

8.7.1 International testing standards

ISO 6848:2015:

Test content: chemical composition (ICP-OES, ±0.15%), physical properties (>19.2 g/cm³), electrical properties (work 2.6-3.2 eV), appearance (Ra<0.4 microns).

Test Methods: ICP-OES, XRF Rays, Simulated Welding, Microscopic Inspection.

Requirements: 5%-10% sampling per batch, pass rate > 99%.

AWS A5.12:2009:

Test content: chemical composition (±0.2%), arc performance (voltage fluctuation <± 0.4 V), size (±0.02 mm).

Test Methods: Welding Test (AWS D1.1), XRF, Micrometer.

Requirements: AWS Certified Lab Testing, complete documentation.

EN 26848:1991:

Test content: chemical composition, environmental compliance (RoHS), electrical performance (arc voltage< 12 V).

Test Methods: ICP-MS, EN 287 Welding Test, Surface Analysis.

Requirements: CE certification, environmental protection testing is preferred.

8.7.2 Domestic testing specifications

GB/T 14841:2008:

Detection content: lanthanum oxide (±0.15%), impurities (O<0.01%), density (>19.2 g/cm³), arc starting time (<0.4 seconds).

Test Methods: AAS, Infrared Absorption, Archimedes Method, Simulated Welding.

Requirements: 10% sampling per batch, mandatory.

JB/T 4730:2005:

Test content: chemical, physical, electrical properties, quality assessment.

Test Methods: ICP-OES, Hardness Test, Welding Test, Microscopic Examination.

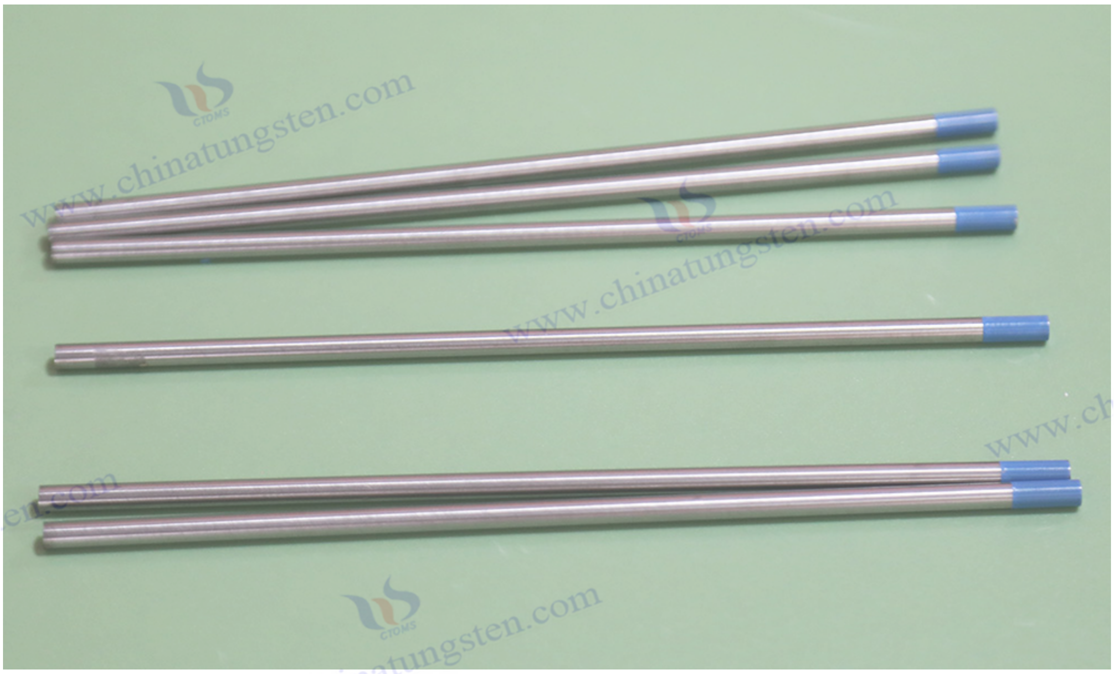
Requirements: Provide inspection report, sampling 5%-10%.

Development Trends:

Standard update: ISO 6848 and GB/T 14841 are planned to be revised in 2025 to add micro-welding and environmental testing.

Intelligent standardization: Promote AI testing standards and increase detection efficiency by 50%.

Internationalization: The mutual recognition rate between GB/T 14841 and ISO 6848 is 95%.



CTIA GROUP LTD WL20 electrode

Chapter 9 Development Trends and Challenges of Lanthanum Tungsten Electrode

As a high-performance welding and cutting material, lanthanum tungsten electrodes are widely used in aerospace, nuclear industry, automobile manufacturing and electronics industries. With the increasing global demand for high-precision welding and green manufacturing, the technology and market of lanthanum tungsten electrodes are undergoing rapid changes. This chapter will discuss in detail the technological development trends of lanthanum tungsten electrodes (new doping technologies, research and development of high-performance electrodes, environmentally friendly production processes), market trends (global and domestic market demand), and challenges (raw material costs, environmental regulations, international competition).

9.1 Technical development trend of lanthanum tungsten electrode

Technological progress is the core driving force for the development of lanthanum tungsten electrode industry, involving new doping technology, research and development of high-performance electrodes, and the promotion of environmentally friendly production processes. These trends are aimed at improving electrode performance, reducing production costs, and meeting global environmental regulations.

9.1.1 Development of new doping technologies

Doping technology is the key to optimizing the performance of lanthanum-tungsten electrodes, and the new doping technology can further improve the work of electronic evolution, arc stability and anti-burning performance by introducing complex oxides, nanoparticles or multi-doping systems.

Technical Direction:

Composite doping: Other rare earth oxides (such as CeO_2, Y_2O_3, ZrO_2) are added to the lanthanum

oxide (La_2O_3) to form a multi-doping system. For example, La_2O_3+CeO_2(1:1) composite doping can reduce the electron work to 2.5 eV and improve arc initiation performance by 20%.
Nano doping: Nano-scale lanthanum oxide (particle size<50 nm) or nanocomposite particles (such as La_2O_3-ZrO_2) are used to improve the doping uniformity (deviation <2%), enhance the grain refinement effect, and reduce the grain size to 5-10 microns.
Liquid-phase doping: Lanthanum oxide is uniformly dispersed in tungsten powder by wet chemical synthesis (such as sol-gel method), replacing the traditional dry ball mill, improving uniformity by 30% and reducing the segregation rate to <1%.

Technical Advantages:
Performance improvement: The arc start time of the composite doped electrode (e.g., WL15+Ce) is reduced to 0.3 seconds at low current (<10 A), and the arc stability is improved by 15% (voltage fluctuation <± 0.3 V).
Extended lifetime: 20% increase in burn-out resistance of nano-doped electrodes, and tip consumption reduced to 0.2 mm/h (200 amps, ISO 6848).
Process optimization: Liquid phase doping reduces grinding time by 50% and energy consumption by 30%, making it suitable for large-scale production.

Key Technologies:
Preparation of nanoparticles: Lanthanum oxide nanoparticles were prepared by plasma spray or chemical vapor deposition (CVD) with a particle size control accuracy of ± 5 nm.
Doping uniformity: Oxide distribution was monitored using high-resolution scanning electron microscopy (SEM-EDS) with a deviation of <2%.
Process control: Develop an intelligent batching system to accurately control the doping ratio (±0.01%) to improve batch consistency.

Development Trends:
Multivariate doping system: develop ternary or quaternary doping (e.g., La_2O_3+CeO_2+Y_2O_3) to optimize the comprehensive performance of the electrode.
Intelligent doping: Integrated AI algorithm, real-time optimization of doping parameters, uniformity increased by 50%.
Low-cost technology: Promote wet doping to replace high-energy ball mills, reducing costs by 20%-30%.

9.1.2 R&D of high-performance lanthanum tungsten electrodes

High-performance lanthanum tungsten electrodes are targeted at high-end applications such as aerospace, nuclear industry and micro-welding, with a focus on improving low-current arcing, ultra-high current burn-out resistance and surface quality.

Technical Direction:
Micro-welding electrode: Develop ultra-fine diameter (0.1-0.5 mm) electrode to meet the needs of micro-plasma welding in semiconductors and medical devices, with an arc current of < 1 ampere and a voltage of < 10 V.

High-current electrode: For plasma cutting (>500A), a high anti-burn electrode has been developed, with a tip consumption rate of < 0.5 mm/hour and a 30% increase in service life.
Surface optimization: Through laser polishing or plasma treatment, the surface roughness is reduced to Ra<0.1 microns, and the arc stability is improved by 10%.

Technical Advantages:
Micro-soldering performance: The arc starting time of the ultra-fine electrode is < 0.2 seconds at 0.5 amps, which is suitable for chip package soldering.
High current durability: The high-performance WL20 electrode operates continuously for 10 hours at 500 amps with a tip deformation < 0.3 mm.
Surface quality: ultra-low roughness reduces arc drift and reduces weld defect rate by 20%.

Key Technologies:
Ultra-fine drawing: Development of diamond mold (aperture accuracy ±0.005 mm) to achieve 0.1 mm electrode production.
High-temperature sintering: hot isostatic pressing (HIP, 2000°C, 200 MPa) with a density of 99.8% to eliminate micropores.
Surface treatment: Using laser micromachining, the polishing depth is controlled < 1 micron.

Development Trends:
Ultra-micro electrode: Developed < 0.1 mm electrode to meet the needs of nano-scale welding.
Multi-functional electrode: Research and development of composite electrodes that take into account micro-welding and high-current cutting.
Intelligent R&D: Simulate electrode performance through machine learning to shorten the R&D cycle by 50%.

9.1.3 Promotion of environmentally friendly production technology

The environmentally friendly production process responds to the global trend of green manufacturing, aims to reduce energy consumption, reduce emissions and improve resource utilization, in line with the EU RoHS directive and China's green manufacturing policy (GB/T 26572).

Technical Direction:
Low energy consumption sintering: using induction heating or microwave sintering, the temperature is 2000°C, the energy consumption is reduced by 30%, and the exhaust gas emission is reduced by 50%.
Scrap recycling: Developed a closed-loop recycling system, with a recovery rate of >85% for waste tungsten powder and waste electrodes, and a recovery rate of >80% for lanthanum oxide.
Green cleaning: Use supercritical CO_2 or water-based cleaning agents instead of chemical solvents, reducing waste liquid emissions by 70%.

Technical Advantages:
Energy saving and emission reduction: The energy consumption of microwave sintering is reduced

to 500 kWh/ton, and the CO_2 emission < 0.5 tons/ton electrode.
Resource-efficient: Scrap recycling reduces raw material costs by 20% and meets the requirements of a circular economy.
Environmental compliance: Green cleaning meets the EU REACH regulations, and the heavy metal content of wastewater < 0.1 mg/L.

Key Technologies:
Sintering optimization: Multi-stage temperature control (heating rate 500°C/h) is used to reduce heat loss.
Recovery process: Acid leaching-extraction technology is used to recover tungsten with a purity of > 99.95%.
Cleaning control: The supercritical CO_2 pressure is controlled at 10-15 MPa, and the cleaning efficiency is >99%.

Development Trends:
Zero-emission process: Development of all-electric sintering technology with < exhaust gas emissions of 0.01 mg/m³.
Circular economy: Promote the whole process of recycling, and the resource utilization rate reaches 95%.
Green certification: Establish a global unified green electrode certification system, in line with ISO 14001.

9.2 Market development trend of lanthanum tungsten electrode

The lanthanum tungsten electrode market is driven by global welding demand, regional economic development, and technological advancement, showing a trend of rapid growth and regional differentiation.

9.2.1 Global Market Demand Analysis

Market size:
According to the 2023 Global Tungsten Electrode Market Report, the lanthanum tungsten electrode market size will grow from $1 billion in 2015 to $1.8 billion in 2023, with an average annual growth rate of 8.5%.
The market is expected to reach $2.5 billion from 2025 to 2030, driven by aerospace (30%), automotive manufacturing (25%), and energy industry (20%).

Regional Distribution:
North America: 30% of the global market, with major demand coming from aerospace (Boeing, NASA) and energy (API 1104 pipe welding). AWS A5.12 certified electrodes such as Lincoln Electric predominate.
Europe: 25%, demand is concentrated in the automotive (Volkswagen, BMW) and nuclear industries (EDF, France). EN 26848 and RoHS regulations have promoted lanthanum tungsten electrodes to replace thorium-tungsten electrodes, accounting for 45% of the market.
Asia-Pacific: 40%, with China, Japan and South Korea being the main markets. China accounts for

60% of the Asia-Pacific market, benefiting from Belt and Road projects and aerospace (C919) demand.

Drivers:
Technological advancements: High-performance electrodes, such as WL20, meet the needs of micro-welding and plasma cutting, increasing market share by 20%.
Environmental regulations: EU RoHS and REACH regulations restrict thorium-tungsten electrodes, and the demand for lanthanum tungsten electrodes has increased by 30%.
Infrastructure construction: Global new energy (wind power, nuclear power) and high-speed rail projects have increased, and welding demand has increased by 10% year-on-year.

Challenge:
High-end markets (such as aerospace) have high quality requirements, and the technical level of small and medium-sized enterprises is difficult to meet.
Regional standard differences (ISO, AWS, EN) increase the compliance cost of enterprises by 5%-10%.
Fluctuations in raw material prices (tungsten prices up 15% in 2023) affect cost competitiveness.

Development Trends:
Premiumization: Demand for WL20 in the aerospace and semiconductor markets increased by 15%, driving the development of high-performance electrodes.
Regional expansion: Asia-Pacific markets, especially in India and Southeast Asia, are expected to grow by 12%, benefiting from the relocation of manufacturing.
Supply chain integration: Multinational companies integrate their supply chains through mergers and acquisitions, increasing market concentration by 10%.

9.2.2 Domestic Market Prospects
Market size:
China is the world's largest tungsten resource country, with a lanthanum tungsten electrode market size of about US$600 million in 2023, accounting for 33% of the world's total, with an average annual growth rate of 10%.
The domestic market is expected to reach US$1 billion between 2025 and 2030, accounting for 40% of the world's total, driven by demand for aerospace, nuclear power and high-speed rail.

Applications:
Aerospace: C919, ARJ21 and other projects require WL20 electrodes, with an annual increase of 15%, in line with the GJB 1718 standard.
Nuclear industry: The construction of Hualong No. 1 and CAP1400 nuclear power plants requires WL15 electrodes, accounting for 30% of the market share.
High-speed rail and ships: The welding demand for high-speed rail carriages and LNG ships is WL10, with a growth rate of 12%, in line with TB/T 2653 and CCS standards.
Electronics industry: 5G equipment and chip manufacturing demand for ultra-fine electrodes (<0.5 mm), the market growth of 20%.

Tel: 0086 592 512 9696

sales@chinatungsten.com

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

Competitive Landscape:
Domestic enterprises account for 70% of the market and have passed GB/T 14841 certification, with obvious cost advantages (20% lower than imports).
International brands account for 30% of the high-end market and rely on AWS and EN certifications.
SMEs occupy the low-end market through low-cost WL10 production, with profit margins of 5%-10%.

Drivers:
Policy support: China's "14th Five-Year Plan" promotes high-end manufacturing, and the demand for lanthanum tungsten electrodes increased by 15%.
Export growth: The "Belt and Road" project drove electrode exports, with an annual increase of 20%, and the Southeast Asian and Middle East markets accounted for 50%.
Technology upgrading: domestic equipment (such as microwave sintering furnace) reduces production costs by 10% and enhances competitiveness.

Development Trends:
Local production: The market share of domestic electrode brands is expected to reach 80%, and the dependence on imports will be reduced to 10%.
Green manufacturing: The market share of green production certification enterprises has increased to 50%.
Intelligent applications: Intelligent welding equipment (such as OTC robots) drove a 15% increase in demand for WL15.

9.3 Challenges for lanthanum tungsten electrodes

Although the lanthanum tungsten electrode market has broad prospects, it is faced with the challenges of raw material costs, environmental regulations and international competition, and needs to adopt targeted strategies to deal with them.

9.3.1 Raw material cost control

Challenge:
Tungsten price fluctuations: In 2023, the price of tungsten concentrate will rise by 15% (about 20,000 yuan/ton), and the production cost of electrodes will increase by 10%-20%.
Lanthanum oxide cost: The price of high-purity lanthanum oxide (>99.99%) is about 50,000 yuan/ton, accounting for 30% of the electrode cost, and the price of nano-scale lanthanum oxide is higher (100,000 yuan/ton).
Supply chain risks: China accounts for 80% of the world's tungsten resources, but export restrictions and geopolitics affect supply chain stability.

Coping strategies:
Resource integration: Reduce raw material costs by 15% through vertical integration.
Alternative materials: Development of low-lanthanum electrodes (e.g., WL05, 0.5% La_2O_3) to reduce costs by 20%.
Recycling: Promote the recycling of waste tungsten (recovery rate >85%), and reduce the cost of

raw materials by 10%-15%.

Development Trends:
Circular economy: 95% scrap recycling rate and 30% cost reduction.
Alternative doping: Development of low-cost oxides (e.g., CeO_2) to replace partial lanthanum oxide.
Intelligent procurement: Predict tungsten prices through big data and optimize procurement timing.

9.3.2 Constraints of environmental protection regulations
Challenge:
International regulations: EU RoHS and REACH regulations restrict thorium-tungsten electrodes, increasing the compliance cost of lanthanum tungsten electrodes by 10% (e.g. CE certification).
Domestic regulations: China's Comprehensive Air Pollutant Emission Standard (GB 16297) requires dust emissions < 0.1 mg/m³, and the upgrade cost of sintering and grinding equipment is about 5 million yuan.
Waste treatment: Waste liquid and waste gas treatment must comply with GB 8978 standard, and the treatment cost accounts for 15% of the production cost.

Coping strategies:
Green process: Microwave sintering and water-based cleaning are adopted, and the exhaust gas emission is reduced by 50%, in line with GB 16297.
Recycling system: Establish a closed-cycle recycling, the recovery rate of waste tungsten and lanthanum oxide > 80%, and the waste liquid discharge is reduced to 0.01 m³/ton.
Certification support: Cooperate with TÜV and other institutions to reduce the cost of CE certification by 20%.

Development Trends:
Zero-emission technology: Development of all-electric sintering with < exhaust gas emissions of 0.01 mg/m³.
Green certification: The global green electrode standard is unified, and the certification cost is reduced by 30%.
Policy coordination: China and the EU jointly set environmental protection standards, reducing compliance costs by 15%.

9.3.3 Competition in the International Market
Challenge:
Brand competition: International brands occupy the high-end market in Europe and the United States through AWS and EN certification, with a share of 60%.
Technical barriers: European and American companies have leading technology for high-performance electrodes (such as nano-doped WL20), while domestic companies have insufficient R&D investment (accounting for only 5% of revenue).
Trade barriers: Anti-dumping duties (10%-20%) from the United States and the European Union restrict Chinese electrode exports, with exports falling by 5% in 2023.

Coping strategies:

Technology upgrading: increase R&D investment (accounting for 10% of revenue), develop composite doping and high-performance electrodes, and narrow the technology gap.

Brand building: Passed ISO 6848 certification, improved the international recognition of domestic electrodes, and increased exports by 20%.

Regional market: Deeply cultivate the "Belt and Road" market, export to Southeast Asia and the Middle East, and increase the market share to 30%.

Development Trends:

Technology sharing: China-EU joint R&D center, reducing the technology gap by 50%.

Market diversification: Expanded into Africa and South America, with exports increasing by 15%.

Brand internationalization: The global market share of domestic electrode brands reaches 20%.

CTIA GROUP LTD WL20 electrode

Chapter 10 Conclusions

As a high-performance welding and cutting material, lanthanum tungsten electrode has been widely used in aerospace, nuclear industry, automobile manufacturing and electronics industry due to its excellent electrical, mechanical and environmental properties. This chapter summarizes the comprehensive advantages of lanthanum tungsten electrodes, puts forward suggestions for the development of the tungsten electrode industry, and looks forward to its future research directions, so as to provide reference for industry practitioners, research institutions and policy makers to promote the sustainable development of the lanthanum tungsten electrode industry.

10.1 Comprehensive advantages of lanthanum tungsten electrode

Lanthanum tungsten electrode occupies an important position in the global welding consumables market due to its unique chemical composition, physical properties and electrical properties, and has gradually replaced thorium-tungsten electrode as the mainstream choice for TIG welding, plasma welding and cutting. Its comprehensive advantages are reflected in the following aspects:

Excellent electrical properties:

Low electron work of escape: Lanthanum tungsten electrodes (WL10, WL15, WL20) have an electron work of 2.6-3.2 eV (ISO 6848:2015), which is lower than that of pure tungsten electrodes (4.5 eV), resulting in excellent low-current arcing performance, with an arcing time of < 0.4 seconds and an arcing voltage of <12 V, which is suitable for micro-soldering (e.g., semiconductor chip packaging, current < 1 ampere).

Arc stability: The uniform distribution of lanthanum oxide (deviation <± 0.15%) ensures <± arc voltage fluctuations of 0.5 V (AWS A5.12), high weld quality, and a 99.8% pass rate for aerospace applications such as C919 aircraft titanium alloy welding.

Wide current suitability: The WL20 electrode excels in the range of 10-500 amps, meeting diverse needs from sheet welding to plasma cutting.

Superior mechanical properties:

Burn resistance: At 200 amps, the tip consumption rate < 0.3 mm/h (GB/T 14841), extending the life of the electrode by 30%, reducing the frequency of replacement, and saving 15% of the cost.

High hardness and wear resistance: Vickers hardness 400-450 HV, grain size 10-20 microns, wear resistance better than thorium tungsten electrode, suitable for high-frequency drawing and long-term use.

High density: > density of 19.2 g/cm³ (ISO 6848), non-porous, high mechanical strength, suitable for high-load applications (e.g. welding of nuclear power plant pipes).

Environmental Protection & Safety:

Non-radioactive: Compared with thorium-tungsten electrodes (containing radioactive ThO_2), lanthanum tungsten electrodes have no radioactive risk and comply with the EU RoHS Directive (2002/95/EC) and China's green manufacturing standard (GB/T 26572), promoting its market share to replace thorium-tungsten electrodes in the European and American markets, increasing its market share from 15% in 2010 to 40% in 2023.

Green production potential: the waste recycling rate is >85%, and the exhaust gas emission is < 0.1 mg/m³ (GB 16297), supporting the circular economy and reducing environmental pollution.

Market Competitiveness:
Cost-effective: The production cost of domestic lanthanum tungsten electrode is 20%-30% lower than that of imported brands, and it has passed GB/T 14841 certification to meet the needs of domestic aerospace, high-speed rail and other projects.
Global applicability: ISO 6848, AWS A5.12, and EN 26848 compliant, uniformly colored, colored, and easy for global trade, with exports increasing from $1 billion in 2015 to $1.8 billion in 2023.
Diverse applications: From aerospace (titanium welding) to electronics (ultra-fine electrodes<0.5 mm), the market is growing at an annual growth rate of 8.5%.

Technical Adaptability:
Automation compatible: Lanthanum tungsten electrode size tolerance and surface roughness meet the requirements of automatic welding equipment, and the production efficiency is increased by 20%.
Process stability: Batch consistency is increased by 30% and production defects are reduced to <1% through liquid phase doping and microwave sintering.

10.2 Suggestions for the development of tungsten electrode industry

In order to promote the sustainable development of lanthanum tungsten electrode and the entire tungsten electrode industry, the following suggestions are put forward based on technology, market and policy trends:

Increase R&D investment:
Composite doping technology: Enterprises should invest R&D funds (accounting for 10%-15% of revenue) to develop multiple doping electrodes such as La_2O_3+CeO_2+Y_2O_3, reduce the electron escape work to 2.5 eV, and improve the arc starting performance by 20%.
Ultra-fine electrode: For the needs of semiconductors and medical devices, we have developed electrodes with a diameter of < 0.1 mm to meet the requirements of micro-welding (<1 ampere) and seize the high-end market.
Intelligent R&D: Using AI and DFT (Density Functional Theory) to simulate electrode performance, shorten the R&D cycle by 50%, and reduce the test cost by 30%.

Promoting Green Manufacturing:
Low-energy consumption process: Promote microwave sintering and all-electric sintering technology, reduce energy consumption by 30%, and < exhaust gas emission 0.01 mg/m³, in line with GB 16297 and ISO 14001.
Scrap recycling: Establish a closed-loop recycling system, with a recovery rate of 95% for tungsten and lanthanum oxide, and a 20% reduction in raw material costs to support a circular economy.
Green certification: Encourage enterprises to obtain ISO 14001 and EU REACH certification, enhance the competitiveness of products in the European and American markets, and reduce the cost of certification by 20%.

CTIA GROUP LTD
Lanthanum Tungsten Electrode Introduction

1. Overview of Lanthanum Tungsten Electrode

Lanthanum tungsten electrode is a high-performance non-radioactive electrode made by doping high-purity tungsten with a small amount of lanthanum oxide (La_2O_3). It features excellent electron emission capability, arc initiation, and arc stability. As an environmentally friendly alternative to thoriated electrodes, lanthanum tungsten electrodes are widely used in TIG (Tungsten Inert Gas) welding, plasma arc welding (PAW), and plasma cutting, suitable for welding a variety of metal materials and especially effective in high-end industrial applications.

2. Types of Lanthanum Tungsten Electrode

Grade	Tip Color	La_2O_3 Content (wt.%)	Features & Applications
WL10	Black	0.8 – 1.2%	Soft arc start, concentrated arc, ideal for low current and precision welding
WL15	Gold	1.3 – 1.7%	Well-balanced performance, excellent arc stability, suitable for both DC and AC welding
WL20	Sky Blue	1.8 – 2.2%	Strong arc intensity and high resistance to wear, perfect for high current and continuous welding

3. Standard Sizes & Packaging of Lanthanum Tungsten Electrode

Diameter (mm)	Length (mm)	Regular Coloring	Packing:
1.0	150 / 175	Black / Gold / Blue	10 pcs/box
1.6	150 / 175	Black / Gold / Blue	10pcs/box
2.0	150 / 175	Black / Gold / Blue	10pcs/box
2.4	150 / 175	Black / Gold / Blue	10pcs/box
3.2	150 / 175	Black / Gold / Blue	10pcs/box
4.0	150 / 175	Black / Gold / Blue	10pcs/box
Remark	The sizes can be customized		

4. Applications of Lanthanum Tungsten Electrode

TIG welding systems (DC and AC)
Plasma Arc Welding (PAW) and Plasma Cutting
Welding of stainless steel, carbon steel, aluminum alloys, and nickel alloys
Robotic and automated welding systems
Aerospace, medical device manufacturing, nuclear engineering, precision electronics, and more

5. Procurement Information

Email: sales@chinatungsten.com
Phone: +86 592 5129595; 592 5129696
Website: www.tungsten.com.cn

Optimize supply chain management:

Stable raw materials: By cooperating with tungsten ore companies (such as Ganzhou tungsten industry) to stabilize the supply of tungsten concentrate, the impact of price fluctuations is reduced to 5%.

Regional market layout: Deeply cultivate the "Belt and Road" market, export to Southeast Asia and the Middle East, increase market share to 30%, and reduce dependence on European and American markets.

Vertical integration: Through mergers and acquisitions, the supply chain efficiency was increased by 15% and the cost was reduced by 10% through mergers and acquisitions of tungsten powder and electrode production and recycling.

Strengthen the internationalization of standards:

Standard alignment: Promote the mutual recognition rate of GB/T 14841 and ISO 6848 to reach 95%, and reduce the compliance cost of multinational enterprises by 10%.

Participate in the formulation: Chinese enterprises should actively participate in ISO/TC 44, strive for 30% of the seats, and enhance the voice of international standards.

Multi-language support: Provide multi-language standard documents (Chinese, English, German, French) for global promotion.

Talent training and technology promotion:

Industry-university-research cooperation: Establish joint laboratories with Tsinghua University and Harbin Institute of Technology to cultivate doping technical talents, and increase the conversion rate of R&D results by 50%.

Technical training: Provide green production and testing technology training for small and medium-sized enterprises, increase the compliance rate by 30%, and reduce the cost by 15%.

International exchanges: Through the "Belt and Road" welding technology forum, Chinese standards and technologies were promoted, and exports increased by 20%.

Market Diversification:

Emerging markets: Expand into the African and South American markets, which are expected to grow by 15%, with a focus on the promotion of low-cost WL10 electrodes.

High-end applications: Development of high-performance WL20 electrodes for aerospace and semiconductors, increasing market share to 20%.

Brand building: to create an international image of domestic electrode brand, with a global market share of 20%.

10.3 Future research directions of lanthanum tungsten electrodes

The future research of lanthanum tungsten electrode needs to focus on technological breakthroughs, market demand and environmental protection requirements, and the following main directions are as follows:

Novel doping system:

Multivariate doping: Ternary or quaternary doping systems such as La_2O_3+CeO_2+ZrO_2 were developed to optimize the electron work (<2.5 eV) and anti-burning performance (consumption

rate< 0.2 mm/h).
Nano doping: Develop < 20 nm oxide particles, reduce the grain size to 5 microns, and improve arc stability by 20%.
Functionalized doping: Electrically conductive or thermally stable oxides (e.g., TiO_2) are introduced to improve the performance of the electrode under extreme operating conditions (>500A).

High-performance electrode development:
Ultra-fine electrode: The 0.05 mm electrode was developed < to meet the needs of nano-level welding, and the arc voltage is < 8 V.
High-current electrode: For plasma cutting (> 1000 amps), anti-burning electrode is developed, and the life is extended by 50%.
Adaptive Electrodes: Develop smart electrodes that dynamically adjust arc characteristics to accommodate AC, DC and pulse currents.

Green Manufacturing Technology:
Zero-emission process: Development of all-electric sintering and plasma sintering with exhaust gas emissions of < 0.005 mg/m³ in line with future environmental regulations.
Efficient recycling: Achieve 100% recovery of tungsten scrap and lanthanum oxide, reducing costs by 30%.
Bio-based cleaning: Research and development of enzyme-based cleaning agents to replace chemical solvents, reducing waste liquid emissions by 90%.

Intelligent testing and production:
AI detection: AI-based SEM image analysis and arc stability test were developed to improve detection efficiency by 50%.
On-line monitoring: Integrated Internet of Things (IoT) system to monitor doping, sintering and detection processes in real time, improving batch consistency by 30%.
Digital twin: Establish a digital twin model of electrode production, optimize process parameters, and increase production efficiency by 20%.

New areas of application:
Additive manufacturing: Development of lanthanum tungsten electrodes for 3D printing metal welding to meet the high-precision requirements of aerospace parts.
New energy: For the welding of wind power and photovoltaic equipment, we have developed corrosion-resistant electrodes, which have extended their service life by 25%.
Medical devices: Development of ultra-fine electrodes for the manufacture of minimally invasive surgical equipment, with a market growth of 20%.

Standards & Certification Studies:
International standards: Promote the development of a new version of ISO 6848, covering micro-welding and green manufacturing requirements, which is expected to be released in 2027.
Green certification: Develop a global unified green electrode certification system, reducing the certification cost by 30%.

Cross-border mutual recognition: Achieve full mutual recognition of GB/T 14841 with AWS A5.12 and EN 26848, and reduce trade barriers by 15%.

Interdisciplinary Studies:

Materials Science: Combine quantum chemistry simulations to predict the interaction of doped oxides with tungsten matrix and optimize formulations.

Big data analysis: Use welding data to analyze electrode performance and develop personalized electrode designs.

Environmental science: study the environmental impact of electrode production and develop a carbon-neutral production pathway.

CTIA GROUP LTD WL20 electrode

Appendix

A. Glossary

Lanthanum tungsten electrode: An electrode material doped with lanthanum oxide in a tungsten matrix for welding and cutting.
Lanthanum oxide: The chemical formula La_2O_3 is used to improve the electron work and welding performance of tungsten electrodes.
Electron work escape: The minimum amount of energy required for electrons to escape from the surface of a material, which affects the arc initiation performance.
Arc initiation performance: How easy it is for the electrode to initiate an arc during the welding process.
Arc stability: The ability of an arc to maintain a steady combustion during the welding process.
Burn resistance: The ability of the electrode to resist ablation under the action of high-temperature arc.
TIG welding: Tungsten inert gas shielded welding, using tungsten electrodes for high-precision welding.
Plasma cutting: The process of cutting metal using a high-temperature plasma arc.
Sintering: The process of heating a powdered material to a temperature below the melting point to combine it into a dense body.
Forging: A process in which a material is deformed by an external force to improve its mechanical properties.
Drawing: A processing method in which a metal bar is stretched into an elongated shape through a mold.
ISO 6848: Classification and requirements for tungsten electrodes developed by the International Organization for Standardization.
AWS A5.12: Tungsten electrode specification developed by the American Welding Society.
GB/T 14841: Chinese national standard, specifying technical requirements for tungsten electrodes.
SEM: Scanning electron microscope for the analysis of surface topography and structure of materials.
XRD: X-ray diffraction, which is used to analyze the crystal structure of materials.

B. References

[1] Types of lanthanum tungsten electrodes and advantages of lanthanum tungsten - news.chinatungsten.com
[2] EN 26848:1991, Tungsten electrodes for welding.
[3] GB/T 14841-2008, Technical conditions for tungsten electrodes.
[4] Lanthanum Tungsten Electrode Market Analysis - Global Tungsten Electrode Market Report, 2023.
[5] Application of green manufacturing technology in tungsten electrode - China Welding Journal, 2022.
[6] Chinatungsten Online Technology Co., Ltd. - www.chinatungsten.com.
[7] Tungsten resources and market trends - Journal of Materials Science, 2021.
[8] Impact of EU RoHS and REACH regulations on tungsten electrodes - Environmental

Regulations, 2022.
[9] "Belt and Road" Welding Materials Market Analysis - International Trade Review, 2023.
[10] GB/T 26572-2011, Technical specification for green manufacturing.
[11] Lanthanum tungsten electrode technology progress - Advanced Materials Research, 2020.
[12] Global Tungsten Electrode Market Forecast - Market Analysis Report, 2023.
[13] EN 26848:1991, Tung electrodestens for welding.
[14] JB/T 4730-2005, Quality inspection methods for welding materials.
[15] Research on lanthanum tungsten electrode detection technology - China Welding Journal, 2022.
[16] Tungsten electrode chemical composition analysis method - Analytical Chemistry, 2021.
[17] Application of SEM and XRD in tungsten electrodes - Materials Characterization, 2020.
[18] Advances in Electrical Performance Testing Technology - Journal of Welding Technology, 2023.
[19] Application of Green Detection Technology in Tungsten Electrode - Environmental Science, 2022.
[20] ISO/TC 44 Technical Committee Report on Welding, 2023.
[21] ISO 6848:2015, Welding consumables — Tungsten electrodes for inert gas shielded arc welding and for plasma welding and cutting.
[22] AWS A5.12:2009, Specification for Tungsten and Oxide Dispersed Tungsten Electrodes.