



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Q&A on Tungsten Heavy Alloy (WHA) Rods

CTIA GROUP LTD

CONTENT

I. Basic Concepts of Tungsten Alloy Rods

Q1: What Is a Tungsten Alloy Rod?

Q2: What Is the Difference Between Tungsten Alloy Rods and Pure Tungsten Rods?

Q3: What Are the Main Grades of Tungsten Alloy Rods?

Q4: Why Are They Called High-Density Tungsten Alloys?

Q5: Is a Higher Tungsten Content Always Better for Tungsten Alloy Rods?

Q6: Are Tungsten Alloy Rods Radioactive?

Q8: What Are the Available Appearance Forms of Tungsten Alloy Rods?

II. Performance Parameters of Tungsten Alloy Rods

Q9: What Is the Density Range of Tungsten Alloy Rods?

Q10: What Is the Melting Point of Tungsten Alloy Rods?

Q11: What Is the Hardness of Tungsten Alloy Rods?

Q12: What Is the Tensile Strength of Tungsten Alloy Rods?

Q13: What Are the Electrical Conductivity and Thermal Conductivity of Tungsten Alloy Rods?

Q14: What Is the Coefficient of Thermal Expansion of Tungsten Alloy Rods?

Q15: Is Tungsten Alloy Rod Corrosion Resistant?

Q16: How Do Different Dopants Affect Performance?

III. Manufacturing Processes of Tungsten Alloy Rods

Q17: What Are the Main Manufacturing Processes for Tungsten Alloy Rods?

Q18: How Much Does the Sintering Process Affect the Quality of Tungsten Alloy Rods?

Q19: What Is Rotary Swaging? How Does It Improve the Performance of Tungsten Alloy Rods?

Q20: Can Tungsten Alloy Rods Be Heat Treated?

IV. Product Standards for Tungsten Alloy Rods

Q21: What International Standards Apply to Tungsten Alloy Rods?

Q22: What National Standards Apply to Tungsten Rods in China?

Q23: How Strict Are the Dimensional Tolerances for Tungsten Alloy Rods?

Q23A: What Are the Main Factors Affecting Dimensional Tolerance of Tungsten Alloy Rods?

Part V Inspection Methods for Tungsten Alloy Rods

Q24: How Is the Density of Tungsten Alloy Rods Measured?

Q25: How Is the Hardness of Tungsten Alloy Rods Tested?

Q26: How Are Internal Defects in Tungsten Alloy Rods Detected?

Q27: How Is the Chemical Composition of Tungsten Alloy Rods Analyzed?

Q28: How Is the Grain Size of Tungsten Alloy Rods Measured?

Q29: How Is the High-Temperature Performance of Tungsten Alloy Rods Evaluated?

PART VI Applications of Tungsten Alloy Rods

Q30: What Are the Main Applications of Tungsten Alloy Rods in the Military Industry?

Q31: What Are the Applications of Tungsten Alloy Rods in the Electronics Industry?



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

- Q32: What Is the Role of Tungsten Alloy Rods in High-Temperature Furnaces?
Q33: How Are Tungsten Alloy Rods Used in the Medical Industry?
Q34: What Role Do Tungsten Heavy Alloy Rods Play in Aerospace?
Q35: What Are the Advantages of Using Tungsten Heavy Alloy Rods for Welding Electrodes?
Q36: How Are Tungsten Alloy Rods Used in the Mold Industry?
Q37: Where Are Tungsten Alloy Rods Used in the Automotive Industry?

VII. Use and Safety of Tungsten Alloy Rods

- Q38: Are Tungsten Alloy Rods Toxic?
Q39: Are There Any Safety Precautions for Processing Tungsten Alloy Rods?
Q40: Are Tungsten Alloy Rods Prone to Fracture?
Q40A What Are the Main Sources of Fracture Risk in Tungsten Alloys?
Q40B How Can the Fracture Resistance of Tungsten Alloy Rods Be Improved?
Q41: How Should Tungsten Alloy Rods Be Stored?

VIII. Customization and Procurement of Tungsten Alloy Rods

- Q42: What Are the Available Dimensions and Specifications of Tungsten Alloy Rods?
Q43: What Surface Finishes Are Available for Tungsten Alloy Rods?
Q44: How Should the Type of Tungsten Alloy Rod Be Selected According to the Application?
Q45: Does CTIA GROUP Offer Custom Tungsten Alloy Rod Services?

IX. Common Misconceptions About Tungsten Alloy Rods

- Q46: Are Tungsten Alloy Rods the Same as Cemented Carbide Rods?
Q47: Is a Tungsten Alloy Rod the Same Kind of Weapon as Rods from God?
Q48: Can Tungsten Alloy Rods Be Used to Make Jewelry?
Q49: Is a Heavier Tungsten Alloy Rod Always Better?
Q50: Why Do Tungsten Alloy Rod Prices Vary So Much?

How to Customize and Purchase Tungsten Alloy Rods?

Tungsten Alloy Rod Customization and Procurement Requirements Checklist
Tungsten Alloy Rod Procurement Information – Quick Inquiry Form

CTIA GROUP LTD.

CONTACT INFORMATION

Address: 3F, No. 25-1 WH Rd, Software Park II, Xiamen, Fujian, China 361009

Tel: +86 592 512 9696 / +86 592 512 9595

Email: sales@chinatungsten.com

Web: www.ctia.group / www.ctia.com.cn



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



Q&A on Tungsten Heavy Alloy (WHA) Rods

CTIA GROUP LTD

I. Basic Concepts of Tungsten Alloy Rods

Q1: What Is a Tungsten Alloy Rod?

A tungsten alloy rod, also known as a tungsten heavy alloy rod, is a high-density engineering material primarily composed of refractory tungsten (W), with metals such as nickel (Ni), iron (Fe), copper (Cu), and cobalt (Co) used as binder phases. It is manufactured through powder metallurgy processes. Compared with conventional pure tungsten rods, tungsten alloy rods not only retain the characteristics of tungsten, including high density, high melting point, high elastic modulus, and excellent radiation resistance, but also significantly improve the material's ductility, toughness, machinability, and impact resistance. As a result, tungsten alloy rods have become important structural materials in aerospace, defense and military industries, medical equipment, petroleum, electronics, power generation, nuclear industry, and high-end equipment manufacturing.

In industrial applications, commonly used tungsten alloy rods generally contain 90%–97%



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

tungsten. According to the composition of the binder phase, they can be divided into several series, including W-Ni-Fe, W-Ni-Cu, and W-Ni-Co. Among them, the W-Ni-Fe system offers the best overall combination of properties and is currently the most widely used type. The W-Ni-Cu system is non-magnetic and offers good corrosion resistance, making it suitable for electronics, medical equipment, and magnetic-field environments. The W-Ni-Co system provides higher strength but is relatively more difficult to machine.

Tungsten alloy rods are manufactured using a powder metallurgy route, which mainly includes raw material preparation, powder mixing, compaction, liquid-phase sintering, heat treatment, forging or rotary swaging, straightening, turning, grinding, and inspection. During sintering, the nickel, iron, and other binder-phase materials first melt and form a liquid phase, which promotes the rearrangement and densification of the tungsten particles. The final material consists of a continuous binder-phase matrix with uniformly distributed tungsten particles. This typical two-phase microstructure enables the material to combine high density with good strength and ductility, which is one of the major advantages of tungsten alloys over pure tungsten.

The most distinctive characteristic of tungsten alloy rods is their extremely high density. Typical densities range from approximately 16.5 to 19.3 g/cm³, which is higher than that of most engineering metals and only lower than that of a few high-density precious metals such as gold and platinum. This is far higher than the density of steel, approximately 7.85 g/cm³, copper, approximately 8.96 g/cm³, and lead, approximately 11.34 g/cm³. The high density gives tungsten alloy rods excellent kinetic-energy storage capacity, inertia characteristics, and radiation shielding capability. Therefore, they are widely used in aerospace counterweights, gyroscope rotors, flywheels, high-speed rotating components, drilling weights, medical radiation protection, industrial radiation shielding, and nuclear-industry shielding components.

In addition to high density, tungsten alloy rods also possess high mechanical strength. Depending on the grade, tensile strength is generally in the range of 700–1200 MPa. After strengthening processes such as rotary swaging and heat treatment, some high-performance products can even exceed 1300 MPa. Their elastic modulus is approximately 320–380 GPa, significantly higher than that of ordinary steels. Consequently, they exhibit relatively low deformation under high loads and excellent dimensional stability.

Tungsten alloy rods also have good high-temperature performance. Although the binder phase limits their long-term service temperature, most products can still operate for extended periods at several hundred degrees Celsius or even higher temperatures, significantly outperforming ordinary heavy-metal materials. In addition, pure tungsten has a melting point as high as 3422 °C, giving tungsten alloys good structural and dimensional stability in high-temperature environments.

Machinability is another important advantage of tungsten alloy rods. Compared with the relatively high brittleness of pure tungsten materials, tungsten alloys can be processed using conventional CNC turning, milling, drilling, grinding, tapping, and other machining methods to manufacture complex components, significantly improving machining efficiency. For high-precision products, additional processes such as wire cutting, electrical discharge machining (EDM), polishing, and surface treatment can also be employed to meet the requirements of precision equipment manufacturing.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

In recent years, with the development of new energy, semiconductors, advanced medical equipment, commercial aerospace, and nuclear technology, higher requirements have been placed on tungsten alloy rods, including higher density, higher strength, better dimensional consistency, lower magnetic properties, higher purity, and improved fatigue life. As a result, modern tungsten alloy manufacturing is continuously developing toward fine-grain microstructure control, high densification, digitalized powder metallurgy, and precision near-net-shape forming, further expanding the application range of these materials in high-end manufacturing.

Overall, tungsten alloy rods are high-performance engineering materials that combine ultra-high density, high strength, good ductility, excellent wear resistance, and relatively good machinability. In applications requiring extremely high density, inertia, radiation shielding capability, and dimensional stability, tungsten alloy rods remain an important material option that is difficult to replace with other metals.

Q2: What Is the Difference Between Tungsten Alloy Rods and Pure Tungsten Rods?

Although both tungsten alloy rods and pure tungsten rods are primarily composed of tungsten, they differ significantly in chemical composition, microstructure, manufacturing process, mechanical properties, machinability, and application fields. There is no simple distinction in terms of which material is better; rather, each is suitable for different engineering requirements.

(1) In terms of chemical composition, pure tungsten rods are generally manufactured from high-purity tungsten powder, with a tungsten content typically no lower than 99.9%, and are essentially single-metal materials. Tungsten alloy rods, on the other hand, contain approximately 3%–10% nickel, iron, copper, or cobalt as binder-phase elements, with a typical tungsten content of 90%–97%. Although these binder-phase elements account for only a relatively small proportion of the material, they significantly change its microstructure and overall properties.

(2) In terms of manufacturing processes, pure tungsten rods are mainly produced by powder metallurgy sintering, followed by plastic processing methods such as forging, rolling, and drawing. Their microstructure is primarily composed of interconnected tungsten grains. Tungsten alloy rods, by contrast, are manufactured through liquid-phase sintering. During sintering, the liquid binder phase promotes the rearrangement and densification of tungsten particles, ultimately forming a two-phase structure in which tungsten particles are distributed throughout the binder-phase matrix. This microstructure enables tungsten alloys to combine high density with relatively good strength and ductility.

(3) In terms of density, the theoretical density of pure tungsten is approximately 19.25 g/cm³, while industrial pure tungsten products can typically reach 18.9–19.3 g/cm³. Tungsten alloy rods generally have densities of approximately 17.0–18.8 g/cm³ depending on tungsten content, while high-tungsten-content products can approach 19.0 g/cm³. Although pure tungsten has a slightly higher density, tungsten alloys are still considered typical ultra-high-density materials for most engineering applications.

(4) The difference in mechanical properties is even more significant. Pure tungsten has high hardness, a high elastic modulus, and excellent high-temperature performance, but its room-temperature ductility is relatively low and it is susceptible to brittle fracture,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

particularly under low-temperature or stress-concentration conditions. Tungsten alloys, due to the presence of the binder phase, have significantly improved ductility and impact toughness. Their elongation is typically around 10%–30%, considerably higher than that of pure tungsten, making them more suitable for dynamic loads and complex stress environments.

(5) In terms of machinability, pure tungsten is a typical difficult-to-machine material. Tool wear is rapid during cutting, and there is a relatively high risk of machining cracks and edge chipping. Tungsten alloys have better cutting performance and can be processed using conventional CNC equipment for turning, milling, drilling, tapping, and grinding, resulting in significantly higher machining efficiency. This is an important reason why tungsten alloys are preferred for many complex components.

(6) Pure tungsten has an advantage in high-temperature performance. Since it does not contain a low-melting-point binder phase, pure tungsten can operate at higher temperatures for extended periods and is an important material for heating elements in high-temperature furnaces, electron-emission cathodes, ion sources, vacuum electronic devices, and fusion-energy equipment. Tungsten alloys also have good heat resistance, but the binder phase limits their long-term service temperature. Therefore, they are more commonly used as high-density structural components rather than ultra-high-temperature heating elements.

(7) The two materials also have different application focuses. Pure tungsten rods are mainly used for high-temperature heating elements, electrodes, vacuum electronic devices, semiconductor thermal-field components, high-temperature furnace components, and fusion-energy equipment. Tungsten alloy rods are widely used for aerospace counterweights, missile counterweights, gyroscope rotors, medical radiation shielding, industrial radiation protection, oil-drilling tools, high-speed rotating components, and precision mechanical components.

(8) In addition, their cost structures are also different. Pure tungsten generally has relatively high processing costs because of its difficult machinability. Although tungsten alloys require additional alloying elements, their higher machining efficiency and better production yield can give them better overall economic performance in the manufacture of many complex components.

With the development of modern powder metallurgy and materials engineering, both pure tungsten and tungsten alloys are continuously being upgraded. Pure tungsten is developing toward ultra-high purity, ultrafine grains, and improved high-temperature stability, while tungsten alloys are continuously being optimized toward higher density, higher strength, improved microstructural uniformity, lower magnetic properties, and longer fatigue life. In the future, the two classes of materials will continue to coexist in their respective areas of advantage and jointly meet the growing technical requirements of aerospace, semiconductors, advanced medical equipment, nuclear industry, and advanced manufacturing.

3: What Are the Main Grades of Tungsten Alloy Rods?

Tungsten alloy rods are a class of high-performance tungsten-based materials formed by using tungsten (W) as the matrix and adding elements such as nickel, iron, copper, rhenium, thorium, cerium, and lanthanum. Depending on the alloy system, strengthening mechanism,



and application field, they can be divided into several series, including high-density tungsten alloys, tungsten-copper alloys, rare-earth tungsten alloys, and tungsten-rhenium alloys.

Among them, high-density tungsten alloys are mainly used for counterweights, radiation shielding, and inertial devices; tungsten-copper alloys combine electrical conductivity, thermal conductivity, and resistance to arc erosion; rare-earth tungsten and thoriated tungsten materials are mainly used as welding electrodes; while tungsten-rhenium alloys are widely used in high-temperature temperature measurement, aerospace, nuclear industry, and other fields. At present, the common grades of tungsten alloy rods in industrial production and international trade mainly include the following categories.

Alloy Series	Common Grades	Main Characteristics	Typical Applications
Tungsten-Nickel-Iron High-Density Alloy	90WNiFe, 93WNiFe, 95WNiFe, 97WNiFe	High density, high strength, good ductility	Counterweights, inertial devices, radiation shielding
Tungsten-Copper Alloy	WK40, WK50, WK60, WK70, WK80, WK90	Excellent thermal and electrical conductivity, high arc-erosion resistance	EDM electrodes, electrical contact materials, vacuum switches
Tungsten-Cerium Alloy	WCe0.8, WCe1.5, WCe2.0, WCe2.4	Excellent arc-starting performance, non-radioactive	TIG welding, automated welding
Tungsten-Lanthanum Alloy	WLa0.6, WLa1.0, WLa1.5, WLa1.7	High current-carrying capacity, long service life	Robotic welding, AC and DC welding
Tungsten-Rhenium Alloy	WRe1, WRe3, WRe5, WRe25, WRe26	High-temperature strength, excellent thermoelectric properties	Thermocouples, high-temperature structural components, aerospace components
Tungsten-Thorium Alloy	WTh0.7, WTh1.0, WTh2.0, WTh3.3	Easy arc starting, high burn-off resistance	TIG welding, gradually being replaced by non-radioactive electrodes

From the perspective of market applications, tungsten-nickel-iron high-density alloys represent the largest-demand category of tungsten alloy rods. Their tungsten content is typically 90%–97%, with nickel and iron making up most of the remainder. They combine a density close to that of pure tungsten with significantly better machinability than pure tungsten, and are therefore widely used in aerospace counterweights, missile balance weights, medical radiation shielding, oil-well logging weights, and high-speed rotating components. Among these grades, 90WNiFe has the best ductility and is suitable for applications requiring subsequent machining or exposure to relatively high impact loads. 95WNiFe and 97WNiFe have higher densities and are more suitable for precision counterweight systems where strict requirements are imposed on volume and weight.

Tungsten-copper alloys are typical pseudo-alloys. Tungsten and copper have almost no mutual solid solubility and are generally manufactured by powder metallurgy infiltration processes. As the copper content increases, the electrical and thermal conductivity of the material continuously increases, while its hardness and high-temperature resistance tend to decrease. For example, WK40 represents approximately 40% copper and 60% tungsten and is suitable for high-strength electrode applications. WK80, with its higher copper content, is more suitable for electronic components and electrical contact components requiring rapid heat dissipation. Engineers generally select different grades according to the required balance between electrical conductivity and arc-erosion resistance.

Rare-earth tungsten alloys are mainly used as non-consumable electrode materials for Gas Tungsten Arc Welding (GTAW/TIG) and Plasma Arc Welding (PAW). Tungsten-cerium electrodes feature low arc-starting voltage and good arc stability and are particularly suitable for low-current precision welding. Tungsten-lanthanum electrodes provide good performance in both AC and DC welding and are increasingly used on automated welding production lines. In recent years, as occupational health and environmental protection



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

requirements have continued to increase, non-radioactive tungsten-cerium, tungsten-lanthanum, and composite rare-earth tungsten electrodes have gradually replaced traditional thoriated tungsten electrodes and have become an important direction in the international market.

Tungsten-rhenium alloys are another category of high-value-added products. Rhenium can significantly improve the high-temperature ductility, thermal shock resistance, and recrystallization temperature of tungsten, allowing the material to maintain relatively good mechanical properties above 2000 °C. Low-rhenium alloys such as WRe3 and WRe5 are mainly used for high-temperature structural components, while WRe25 and WRe26 are widely used in high-temperature thermocouples and can measure ultra-high temperatures above 2000 °C over extended periods. They therefore play an important role in aero engines, nuclear fusion experimental devices, and high-temperature research equipment. In addition, tungsten-nickel-copper alloys, tungsten-silver alloys, tungsten-molybdenum alloys, and various functionalized tungsten alloy rods doped with lanthanum oxide, yttrium oxide, and other materials have been developed for specialized applications. These materials are playing increasingly important roles in electronic packaging, semiconductor equipment, vacuum technology, and special-purpose electrodes.

CTIA GROUP believes that the development of tungsten alloy rods has gradually shifted from simply pursuing high density and high strength toward higher purity, greater microstructural uniformity, higher dimensional accuracy, and application-specific specialization. In the future, with the development of semiconductor technology, fusion energy, aerospace, and advanced manufacturing, different tungsten alloy systems will become increasingly specialized and customized, forming more professional product series to meet the comprehensive requirements for high-temperature performance, electrical conductivity, wear resistance, and machinability under different operating conditions.

Q4: Why Are They Called High-Density Tungsten Alloys?

High-density tungsten alloys (HDTA) are named for their density, which is significantly higher than that of most engineering metals and is surpassed among commonly used metallic materials only by pure tungsten and a small number of precious metals. The density of high-density tungsten alloys can reach 16.5–18.75 g/cm³, compared with approximately 7.85 g/cm³ for ordinary carbon steel, approximately 7.9–8.0 g/cm³ for stainless steel, 11.34 g/cm³ for lead, and only 2.70 g/cm³ for aluminum. Therefore, for the same volume, high-density tungsten alloys can provide substantially greater mass. This is the fundamental reason why they are called high-specific-gravity or high-density tungsten alloys. The density comparison of different materials is shown below:

Material	Density (g/cm ³)	Compared with Ordinary Steel
Aluminum	2.70	Approx. 0.34×
Titanium Alloy	4.50	Approx. 0.57×
Ordinary Steel	7.85	1×
Stainless Steel	7.90–8.00	Approx. 1.02×
Copper	8.96	Approx. 1.14×
Lead	11.34	Approx. 1.45×
High-Density Tungsten Alloy	16.5–18.75	Approx. 2.1–2.4×
Pure Tungsten	19.25	Approx. 2.45×

In terms of composition, high-density tungsten alloys are not pure tungsten. They generally contain 90%–98% tungsten as the primary component, with a small amount of nickel, iron,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

or nickel and copper as the binder phase. They are typically produced through liquid-phase sintering to form a two-phase microstructure. The tungsten particles form the high-density skeleton, while the nickel-iron or nickel-copper matrix provides bonding and toughening. As a result, the material retains a density close to that of pure tungsten while overcoming the high room-temperature brittleness and poor machinability of pure tungsten. High-density tungsten alloys therefore combine high density, high strength, and good machinability.

Density is also an important basis for classifying high-density tungsten alloys. For example, the density of 90WNiFe is typically around 17.0 g/cm³, 93WNiFe around 17.6 g/cm³, 95WNiFe around 18.0 g/cm³, while 97WNiFe can reach more than 18.5 g/cm³. As the tungsten content increases, the material density continuously increases, but ductility and machinability tend to decrease. Therefore, practical material selection requires a comprehensive balance based on the required performance.

The reason high-density tungsten alloys are widely favored in aerospace, defense, military, medical equipment, and other industries is not simply their high density, but also their ability to maintain relatively high strength and toughness while providing high density. The tensile strength of typical products can generally reach 700–1000 MPa or higher, while elongation can reach approximately 10%–30%, significantly better than that of pure tungsten. This means that they can serve not only as static counterweights but also withstand relatively high impact loads and dynamic stresses. They are therefore widely used in aircraft counterweights, missile inertial weights, gyroscope rotors, high-speed rotating components, and drilling-weight components.

In the nuclear and medical industries, high-density tungsten alloys also take advantage of their high density to provide excellent radiation shielding. Tungsten has a high atomic number of 74 and a high electron density, giving it strong attenuation capabilities for X-rays and gamma rays. Therefore, for the same shielding effect, tungsten alloy shielding components can be thinner and more compact than lead shielding components, while also offering environmental advantages. At present, high-density tungsten alloys are widely used in CT equipment collimators, radiotherapy collimators, PET equipment shielding blocks, and industrial radiographic inspection shielding components as alternatives to traditional lead materials.

In addition, high-density tungsten alloys have a relatively low coefficient of thermal expansion, good corrosion resistance, and a high elastic modulus, enabling them to maintain good dimensional stability under high-temperature, high-vacuum, and long-term service conditions. This is also an important reason for their widespread application in spacecraft attitude-control systems, semiconductor equipment, and precision instruments.

CTIA GROUP believes that the term high-density tungsten alloy not only reflects the material's most prominent physical characteristic but also represents its core engineering value. In the future, as powder metallurgy, hot isostatic pressing, and microstructural control technologies continue to advance, high-density tungsten alloys will further develop toward higher strength, greater toughness, higher precision, and improved environmental performance while retaining their high-density advantage. They are expected to play an increasingly important role in aerospace, advanced medical equipment, advanced manufacturing, and new energy equipment.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Q5: Is a Higher Tungsten Content Always Better for Tungsten Alloy Rods?

Not necessarily. A higher tungsten content does not automatically mean better overall performance for tungsten alloy rods. Instead, the material needs to achieve a balance among density, strength, hardness, toughness, machinability, and cost according to the specific operating conditions. Common high-density tungsten alloys used in industry generally belong to the W-Ni-Fe or W-Ni-Cu systems, with tungsten contents typically ranging from 85% to 98%. Grades containing 90%, 92.5%, 95%, and 97% tungsten are among the most widely used. Different tungsten contents mean different proportions of tungsten particles and binder phases, and therefore different material properties.

First, in terms of density, material density continuously increases as the tungsten content rises. Pure tungsten has a density of approximately 19.25 g/cm³, while 90% tungsten alloy generally has a density of about 17.0–17.3 g/cm³, 95% tungsten alloy about 18.0 g/cm³, and 97% tungsten alloy can reach more than 18.5 g/cm³. Therefore, for products requiring the highest possible mass per unit volume, such as aerospace inertial counterweights, high-end gyroscope counterweights, oil-well logging weights, and kinetic-energy armor-piercing penetrators, materials with higher tungsten content offer significant advantages.

Second, in terms of mechanical properties, a higher tungsten content does not necessarily mean the best overall performance. As the tungsten proportion increases, the amount of nickel-iron or nickel-copper binder phase decreases, resulting in lower overall plasticity and toughness, while hardness, elastic modulus, and wear resistance tend to increase. In other words, high-tungsten materials are harder and heavier, but their ability to withstand impact loads and absorb deformation energy is reduced. Lower-tungsten materials have slightly lower density but offer better elongation, impact resistance, and machinability.

Machinability is also an important consideration when selecting tungsten content. High-tungsten materials have higher hardness and greater cutting resistance, resulting in faster tool wear and significantly greater difficulty in turning, milling, drilling, and other machining operations. By contrast, 90%–92.5% tungsten alloys contain more binder phase and are relatively easier to machine, making them more suitable for components with complex shapes and high dimensional accuracy requirements. Therefore, when a product requires extensive machining or involves complex-shaped components, the highest possible tungsten content is not necessarily the preferred choice.

In addition, different application fields have completely different performance priorities. For example, tungsten alloys used in medical CT equipment, X-ray equipment, and radiation therapy equipment require not only high density but also good machinability and dimensional stability. Therefore, tungsten contents of around 95% are generally more common. In balancing counterweights for high-speed rotating equipment, density and mass concentration are often prioritized, making tungsten contents above 97% advantageous.

Cost is also an important factor. As the tungsten content increases, the raw material cost generally rises, while machining difficulty and processing costs also increase accordingly. Therefore, provided that the design requirements are satisfied, engineering design generally selects the material with the lowest overall cost and the best overall performance rather than simply choosing the highest tungsten content. The following table can be used as a reference for the characteristics of materials with different tungsten contents.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Tungsten Content (wt.%)	Density Characteristics	Mechanical Characteristics	Machinability	Typical Applications
Around 90%	Relatively high density	Good toughness and relatively high plasticity	Relatively easy to machine	Industrial counterweights, medical counterweights, complex mechanical components
92.5%–95%	Balanced density and toughness	Excellent overall properties	Good	Aerospace counterweights, X-ray shielding, inertial counterweights
Around 97%	Highest density	High hardness & strength, reduced toughness	More difficult to machine	Armor-piercing penetrators, high-density inertial components, specialized military pro.

In addition to tungsten content, the selection between the nickel-iron system (W-Ni-Fe) and nickel-copper system (W-Ni-Cu) also affects material performance. The former generally offers higher strength and toughness and is suitable for load-bearing structural components. The latter is non-magnetic and has better corrosion resistance, making it more suitable for electronics, medical equipment, and precision instruments. Therefore, material selection in practical applications should consider both the chemical system and tungsten content rather than focusing on only one parameter.

CTIA GROUP believes that there is no absolute rule that a higher tungsten content is always better for high-density tungsten alloys. Different applications have different optimum compositions. Modern tungsten alloy design places greater emphasis on optimizing overall performance. Material selection should be systematically based on density requirements, mechanical properties, machining processes, service environment, and economic cost, so that material performance and product functionality can achieve the best possible match.

Q6: Are Tungsten Alloy Rods Radioactive?

Most tungsten alloy rods are not radioactive and do not pose radiation hazards to people or the environment. Whether a material is radioactive does not depend on the tungsten element itself, but on whether radioactive elements have been added to the material. Therefore, ordinary tungsten alloys, high-density tungsten alloys, and a small number of tungsten materials containing radioactive additives should be distinguished.

First, tungsten (W) itself is a naturally stable element and is not classified as a radioactive element. Pure tungsten, high-density tungsten alloys (W-Ni-Fe and W-Ni-Cu), tungsten-copper alloys, tungsten-silver alloys, and most tungsten products widely used in industry do not produce ionizing radiation. Their radiation levels are essentially comparable to those of ordinary metallic materials, and they can be safely used in aerospace, medical equipment, electronics, semiconductor equipment, and machinery manufacturing. The materials that require particular attention are thorium-containing materials.

Thorium (Th) is a naturally radioactive element. Therefore, thoriated tungsten materials, such as traditional thoriated tungsten electrodes (Thoriated Tungsten Electrode), contain approximately 1%–2% thorium oxide (ThO_2) and consequently exhibit a low level of natural radioactivity. During normal storage, transportation, and welding, the radiation dose is generally very low. However, during grinding, cutting, and other machining operations, fine dust containing thorium oxide may be generated. If such dust is inhaled over a prolonged period, occupational exposure risks may increase. For this reason, the international welding industry is increasingly moving toward non-radioactive alternatives.

Currently, widely promoted alternative materials include lanthanated tungsten electrodes (EWLa), ceriated tungsten electrodes (EWCe), yttriated tungsten electrodes (EWY), and



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

composite rare-earth tungsten electrodes. These products can meet the requirements of most welding applications in terms of arc-starting performance, arc stability, and service life, while avoiding radioactive material management issues. As a result, they have become mainstream products in regions such as Europe, North America, and Japan.

High-density tungsten alloy rods and thoriated tungsten electrodes are two completely different categories of materials. Tungsten alloy rods used for industrial counterweights, medical shielding, aerospace inertial counterweights, and other applications generally use nickel, iron, or copper as binder phases and do not contain thorium. Therefore, they do not present a radioactivity concern. In fact, because tungsten has a high density and high atomic number, it is widely used to manufacture X-ray and gamma-ray shielding materials. Its function in these applications is to shield radiation rather than generate radiation. The radioactivity characteristics of different tungsten materials can be referenced in the following table.

Material Type	Radioactive	Main Applications
Pure tungsten rod	No	High-temperature structural components, electrodes, semiconductors, vacuum equipment
W-Ni-Fe high-density tungsten alloy	No	Counterweights, aerospace, medical applications, military products
W-Ni-Cu high-density tungsten alloy	No	Non-magnetic counterweights, electronic equipment, medical devices
Lanthanated tungsten electrode (EWLa)	No	TIG welding, automated welding
Ceriated tungsten electrode (EWCe)	No	Precision welding, low-current welding
Yttriated tungsten electrode (EWY)	No	High-end welding applications
Thoriated tungsten electrode (EWTh)	Slight natural radioactivity	Some traditional welding processes; usage is gradually declining

For ordinary users, as long as the high-density tungsten alloy rods or pure tungsten products are manufactured by a reputable manufacturer, there is generally no need to be concerned about radiation. If the product is a thorium-containing tungsten material, it should be processed in accordance with occupational health requirements. In particular, during grinding, local exhaust ventilation, high-efficiency filtration and dust-removal equipment, and appropriate dust protection should be used to reduce the risk of dust inhalation.

CTIA GROUP believes that the global tungsten materials industry is currently moving from traditional thorium-containing systems toward non-radioactive rare-earth tungsten systems. High-density tungsten alloys, pure tungsten materials, and most industrial tungsten products do not present a radioactivity risk. For modern manufacturing industries that need to balance safety, environmental protection, and occupational health, non-radioactive tungsten materials have become the mainstream direction of industry development.

Q7: Do Tungsten Alloy Rods Comply with RoHS Environmental Standards?

Yes. The mainstream tungsten alloy rods currently available on the market, including pure tungsten rods, lanthanum-doped tungsten rods (La-W), cerium-doped tungsten rods (Ce-W), tungsten-nickel-iron heavy alloy rods (W-Ni-Fe), and some tungsten-nickel-copper alloy rods (W-Ni-Cu), can be manufactured in accordance with the EU RoHS (Restriction of Hazardous Substances) Directive and meet environmental protection requirements. For products exported to the European Union, North America, Japan, and other high-end manufacturing markets, RoHS compliance has become one of the basic requirements and an important purchasing criterion for industries such as electronics, electrical equipment, medical devices, semiconductors, and aerospace.

The RoHS Directive mainly restricts the content of hazardous substances including lead



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(Pb), cadmium (Cd), mercury (Hg), hexavalent chromium (Cr⁶⁺), polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE), as well as certain phthalates subsequently added to the list. Since tungsten and its commonly used alloying elements are not themselves RoHS-restricted substances, whether a tungsten material complies with RoHS depends primarily not on the tungsten material itself, but on whether restricted additives, coatings, lubricants, solders, and surface treatment materials are used throughout the production process, as well as whether a comprehensive quality control system has been established.

For tungsten alloy rods manufactured by powder metallurgy, mainstream production processes generally use high-purity tungsten powder and environmentally compliant sintering additives. Lanthanum-doped tungsten and cerium-doped tungsten electrode materials use lanthanum oxide (La₂O₃) and cerium oxide (CeO₂), respectively, as rare-earth additives. Neither of these oxides is a RoHS-restricted substance, and therefore they can meet environmental regulatory requirements. Nickel and iron in tungsten-nickel-iron heavy alloys are also not RoHS-restricted elements. As long as the impurity content of the raw materials is properly controlled, the products can pass RoHS testing.

It should be noted that not all tungsten materials inherently comply with all environmental regulations. For example, although traditional thoriated tungsten (Thoriated Tungsten) is not restricted under the RoHS Directive due to excessive heavy-metal content, thorium oxide is a naturally radioactive substance and is therefore subject to strict controls under occupational health and safety regulations and the regulations of certain countries and regions.

Consequently, its use has gradually declined in recent years, with lanthanum tungsten, cerium tungsten, yttrium tungsten, and composite rare-earth tungsten materials increasingly replacing it. From the perspective of green manufacturing, occupational health, and safety, non-radioactive tungsten materials have become an important direction in the international market.

For exported products, RoHS compliance alone is usually not sufficient. Many customers also require compliance with REACH regulations, conflict minerals reporting requirements (CMRT), Halogen Free requirements, PFAS restrictions, and ISO 14001 environmental management systems. Therefore, high-end tungsten alloy manufacturers generally establish comprehensive raw-material traceability systems and third-party testing systems to ensure that their products meet environmental requirements in different countries and industries.

The following table summarizes the environmental compliance characteristics of several common tungsten alloy rod materials:

Material Type	Composition	RoHS Compliance	Typical Applications
Pure tungsten rod	W ≥ 99.95%	Compliant	Semiconductors, vacuum equipment, high-temperature furnaces
Lanthanum-doped tungsten rod	W + La ₂ O ₃	Compliant	TIG welding, electrodes, automated welding
Cerium-doped tungsten rod	W + CeO ₂	Compliant	Precision welding, sheet-metal welding
Tungsten-nickel-iron alloy rod	W-Ni-Fe	Compliant	Counterweights, radiation shielding, inertial components
Tungsten-nickel-copper alloy rod	W-Ni-Cu	Compliant	Electrical discharge machining, electrical contacts, high-density components
Thoriated tungsten rod, W + ThO ₂	Generally capable of meeting RoHS testing requirements, but subject to radioactive material management requirements		Special industrial applications; use is gradually declining



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

From a testing perspective, RoHS compliance is generally verified by third-party laboratories using analytical methods such as XRF screening, ICP-OES, and ICP-MS, with a RoHS test report or Declaration of Conformity (DoC) issued accordingly. For long-term cooperation with major customers, manufacturers may also provide material composition analysis reports (Mill Test Certificates, MTC), batch traceability information, and environmental compliance documentation to meet supply-chain audit requirements.

CTIA GROUP believes that RoHS compliance has become a basic requirement for modern tungsten alloy rod products rather than a competitive advantage. What truly demonstrates product quality is the ability to achieve high purity, low impurity levels, high consistency, and long-term stability while complying with environmental regulations such as RoHS and REACH. In the future, as global environmental regulations continue to evolve and green manufacturing continues to advance, high-performance, non-radioactive, traceable tungsten alloy rods that comply with multiple international environmental standards will become mainstream products in the international market.

Q8: What Are the Available Appearance Forms of Tungsten Alloy Rods?

Tungsten alloy rods are among the most common product forms of tungsten and tungsten-based alloys. Depending on the manufacturing process, cross-sectional shape, dimensional specifications, surface condition, and final application, tungsten alloy rods can be produced in a variety of forms. Different appearance forms not only affect transportation, machining, and assembly methods, but are also directly related to subsequent machining efficiency, dimensional accuracy, and service performance. Therefore, when purchasing tungsten alloy rods, the appearance form is an important technical parameter in addition to the material grade.

In terms of cross-sectional shape, round rods are the most widely used type and account for a major portion of market demand. Round rods are suitable for turning, grinding, forging, drawing, and various machining processes, and can subsequently be manufactured into shafts, electrodes, connectors, thermal-field support components, and various specially shaped products. In addition to round rods, square rods, rectangular rods, hexagonal rods, and other special cross-sectional products can also be manufactured. Square rods are commonly used for die machining, fixture manufacturing, and special structural components, while hexagonal rods are mainly used in applications requiring direct machining of threads or fasteners.

According to the manufacturing process, tungsten alloy rods can be classified into sintered rods, forged rods, rolled rods, and precision-ground rods. Sintered rods generally retain their original condition after powder-metallurgy sintering and are usually available in larger dimensions, primarily serving as blanks for subsequent thermomechanical processing or machining. Forged rods undergo high-temperature forging, resulting in a denser microstructure and significantly improved mechanical properties. Rolled rods generally provide good dimensional consistency and structural uniformity.

Precision-ground rods are processed by centerless grinding or precision grinding and can achieve higher dimensional accuracy and surface quality, making them suitable for high-precision equipment manufacturing.

According to surface condition, tungsten alloy rods can generally be classified as follows:



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Surface Condition	Characteristics	Typical Applications
As-sintered / as-forged surface	Retains the original sintering or thermal-processing oxide layer; relatively rough surface	Blanks for subsequent forging and machining
Turned surface	Machined by turning; relatively accurate dimensions	General machined components
Ground surface	Processed by grinding; high dimensional accuracy	Precision shafts, electrodes, guide components
Polished surface	High surface smoothness; mirror-like finish can be achieved	Semiconductor, medical, optical equipment
Pickled surface	Oxide scale removed to improve surface cleanliness	Vacuum equipment, subsequent coating processes

Different products have different dimensional accuracy requirements. Ordinary industrial tungsten rods are generally controlled according to diameter tolerances, while high-precision tungsten rods for semiconductors, aerospace, and medical equipment may require h7, h6, or even higher precision grades, together with strict requirements for roundness, straightness, and concentricity.

In addition to standard rods, many manufacturers can also produce various customized shapes, including stepped rods, rods with center holes, specially shaped rods, polygonal rods, and near-net-shape rods with localized machined structures. These products can reduce subsequent machining allowances, improve material utilization, and lower machining costs, and are increasingly used in semiconductor thermal fields, high-temperature furnaces, electron-beam equipment, and fusion devices.

For different material systems, the basic appearance forms are similar, although their color and surface texture may differ slightly. Pure tungsten rods generally exhibit a silver-gray metallic luster, while TZM, MHC, and other molybdenum-based alloy rods tend to have a slightly darker appearance. Tungsten-nickel-iron heavy alloys, because they contain a binder phase, may also exhibit metallographic characteristics on fracture surfaces and machined surfaces that differ from those of pure tungsten. These differences are primarily related to the material microstructure and do not affect normal product use.

With the development of precision manufacturing, an increasing number of customers require not only dimensional compliance but also surfaces free from scratches, indentations, cracks, oxidation spots, and mechanical damage. For exported products, moisture-resistant packaging, vacuum packaging, or clean packaging is also often required to meet the requirements of long-distance transportation and high-cleanliness industries.

CTIA GROUP believes that the appearance form of a tungsten alloy rod not only reflects its processing condition but also demonstrates the level of manufacturing technology. Modern high-end tungsten rods have gradually evolved from conventional sintered blanks into precision rods featuring high dimensional accuracy, low surface roughness, and high dimensional consistency. Manufacturers can provide products with different cross-sectional shapes, surface conditions, and near-net-shape configurations according to customer requirements, providing more efficient and reliable material solutions for semiconductors, aerospace, medical devices, electronics, and high-end equipment manufacturing.



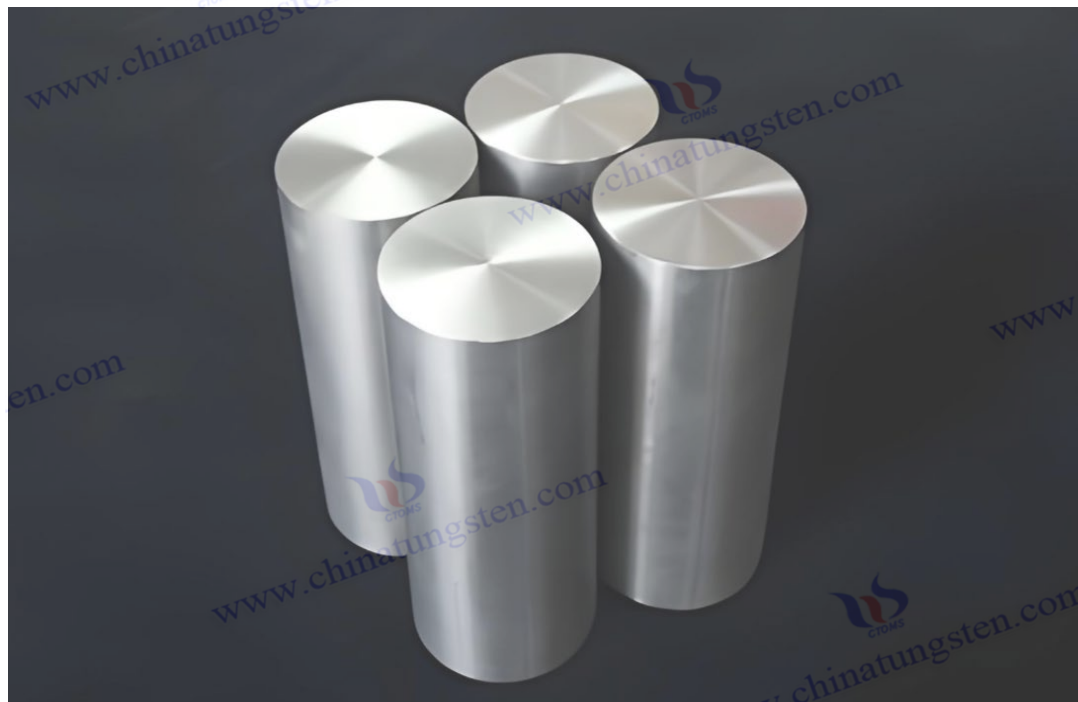
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com




www.chinatungsten.com


www.chinatungsten.com


www.chinatungsten.com


www.chinatungsten.com


www.chinatungsten.com



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



II. Performance Parameters of Tungsten Alloy Rods

Q9: What Is the Density Range of Tungsten Alloy Rods?

The density of tungsten alloy rods is one of the important indicators used to evaluate material quality, structural compactness, and performance. Tungsten itself has an extremely high atomic weight of 183.84 and a body-centered cubic crystal structure, with a theoretical density of approximately 19.25 g/cm³. This is one of the highest densities among commonly used engineering metals, surpassed only by a few precious metals such as gold and platinum. As a result, tungsten and tungsten alloys are widely used in high-specific-gravity counterweights, radiation shielding, high-temperature structural components, aerospace, nuclear industry, and semiconductor equipment.

The actual density of a tungsten alloy rod is not a fixed value. It varies depending on the material system, chemical composition, manufacturing process, and degree of densification. Tungsten rods can generally be divided into three major categories: pure tungsten rods,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

high-density tungsten alloy rods, and doped tungsten rods. Their typical density ranges are as follows:

Material Type	Typical Composition	Density (g/cm ³)	Description
Pure tungsten rod	W ≥ 99.95%	19.20–19.30	Close to the theoretical density of 19.25 g/cm ³
Doped tungsten rod	Doped with La ₂ O ₃ , CeO ₂ , Y ₂ O ₃ , etc.	19.00–19.20	Doping content is generally 0.1%–2%, resulting in a slight reduction in density
TZM molybdenum alloy rod	Mo-Ti-Zr-C	10.0–10.2	A molybdenum-based alloy rather than a tungsten alloy
High-density tungsten alloy rod	W-Ni-Fe, W-Ni-Cu, etc.	17.00–18.80	Varies considerably with tungsten content

It should be particularly noted that the term tungsten alloy rod commonly used in industry generally refers to high-density tungsten alloys such as W-Ni-Fe and W-Ni-Cu. TZM, however, is a molybdenum-based high-temperature alloy rather than a tungsten alloy, with a density of approximately 10.2 g/cm³, which is significantly different from that of tungsten materials. For high-density tungsten alloys, density is primarily determined by tungsten content. For example, the density of a 90W-7Ni-3Fe alloy is generally around 17.0 g/cm³, the 93W series is approximately 17.6 g/cm³, the 95W series can exceed 18.0 g/cm³, while products containing more than 97% tungsten can approach 18.5–18.8 g/cm³. As tungsten content increases, specific gravity increases, but material ductility generally decreases and machining becomes correspondingly more difficult. Therefore, different density grades are selected according to the performance requirements of different applications.

Manufacturing processes are also important factors affecting density. Modern tungsten alloy rods are mainly produced by powder metallurgy, involving processes such as powder mixing, compaction, liquid-phase sintering, hot forging, rotary swaging, and hot rolling. After sintering, the material can generally reach more than 98% of its theoretical density. Following hot isostatic pressing (HIP) or plastic deformation, residual internal porosity can be further reduced, resulting in a more uniform microstructure and improved mechanical properties and fatigue life.

In practical production, density reflects not only the weight of the material but also directly affects several important properties. First, it affects shielding capability. For X-ray and gamma-ray shielding materials, higher density generally means a greater number of atoms per unit volume and therefore higher shielding efficiency. Consequently, high-density tungsten alloys are widely preferred in medical, radiation protection, and nuclear industry applications.

Second, density affects inertial performance. In aerospace counterweights, missile balancing components, and gyroscope rotors, high density allows a greater mass to be obtained within the same volume, thereby increasing the moment of inertia and improving stability.

Third, density reflects structural quality. For pure tungsten rods, an actual density closer to the theoretical density generally indicates lower porosity and higher sintering quality. This also contributes to more stable subsequent machining performance, high-temperature performance, and creep resistance.

In industry, the Archimedes water displacement method is commonly used to measure density, combined with metallographic analysis, ultrasonic inspection, and other methods to comprehensively evaluate internal densification. For high-end tungsten materials used in semiconductor equipment, aerospace, and fusion energy equipment, the density is



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

generally required to reach more than 99% of the theoretical density to ensure good dimensional and microstructural stability during long-term high-temperature service.

Overall, pure tungsten rods have a density of approximately 19.25 g/cm³, while high-density tungsten alloy rods generally range from 17.0 to 18.8 g/cm³ depending on their chemical composition. Various rare-earth-doped tungsten rods generally have slightly lower densities than pure tungsten because of the addition of small amounts of oxides, but their densities typically remain above 19.0 g/cm³. This combination of high density, high-temperature performance, and machinability is one of the important reasons why tungsten materials continue to be used in advanced manufacturing applications.

Q10: What Is the Melting Point of Tungsten Alloy Rods?

The melting point is an important physical property for evaluating the high-temperature resistance of metals and is one of the fundamental reasons why tungsten materials can be widely used in ultrahigh-temperature environments. Pure tungsten has a melting point of approximately 3410–3422 °C, commonly taken as 3422 °C. It has the highest melting point among metallic elements and is one of the most temperature-resistant unalloyed engineering metals. In comparison, iron has a melting point of approximately 1538 °C, nickel approximately 1455 °C, titanium approximately 1668 °C, and molybdenum approximately 2623 °C. Tungsten therefore exceeds these common metals by hundreds or even more than a thousand degrees Celsius.

Because of its extremely high melting point, tungsten and tungsten alloys can operate in extreme environments that cannot be tolerated by conventional high-temperature alloys. They are therefore widely used in vacuum furnace heating elements, electron-beam equipment, semiconductor thermal-field components, fusion devices, rocket nozzles, high-temperature molds, and aerospace applications. The temperature characteristics of different tungsten materials can be summarized as follows:

Material	Melting Point or Operating Temperature	Characteristics
Pure tungsten (W)	3410–3422 °C	Highest melting point and excellent ultrahigh-temperature resistance
Lanthanum-doped tungsten, cerium-doped tungsten, and other rare-earth tungsten	Close to 3422 °C	Melting point remains essentially unchanged while high-temperature ductility is improved
W-Ni-Fe high-density tungsten alloy	Liquid-phase sintering temperature approximately 1520 °C; tungsten phase melting point remains 3422 °C	The binder phase limits the service temperature
W-Ni-Cu high-density tungsten alloy	Similar to W-Ni-Fe	More suitable for shielding and counterweight applications

It should be noted that although the tungsten particles in high-density tungsten alloys still have a melting point of 3422 °C, the addition of low-melting-point binder phases such as Ni, Fe, or Cu means that the overall alloy does not have a single melting point of 3422 °C. Instead, during liquid-phase sintering, the binder phase begins to form a liquid phase when its temperature reaches approximately 1450–1520 °C.

Accordingly, the long-term service temperature of these alloys is normally much lower than that of pure tungsten and is generally controlled within the range of approximately 600–1000 °C, depending on the specific alloy system.

At the same time, melting point should not be directly equated with actual service temperature. Although pure tungsten does not melt until approximately 3422 °C,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

phenomena such as recrystallization, grain coarsening, creep deformation, and oxidation can occur at high temperatures. Therefore, its long-term continuous operating temperature is considerably lower than its melting point.

For example, under vacuum or an inert atmosphere, tungsten can operate for extended periods at approximately 1600–2200 °C and can withstand temperatures above 2500 °C for short periods. In air, however, tungsten begins to undergo significant oxidation at approximately 400–500 °C, so its continuous operating temperature is substantially lower and a protective atmosphere or vacuum environment is required.

For doped tungsten materials such as lanthanum-doped tungsten (La-W), cerium-doped tungsten (Ce-W), and yttrium-doped tungsten (Y-W), the added oxide content is generally less than 2%. These oxides have little effect on the melting point of tungsten, but they can significantly increase the recrystallization temperature and resistance to grain coarsening, allowing the material to maintain better strength and dimensional stability at high temperatures. Therefore, in applications such as electron emission, electrodes, and high-temperature thermal-field components, doped tungsten materials often provide a longer service life than pure tungsten.

From the perspective of materials science, tungsten has such an extremely high melting point mainly because of its strong metallic bonding energy and dense crystal structure. The bonds between tungsten atoms are extremely strong and require a very high amount of energy to disrupt the crystal lattice. As a result, tungsten not only has an extremely high melting point, but also a high elastic modulus, excellent high-temperature strength, and low vapor pressure. These properties provide the foundation for its long-term stable operation in applications such as electron tube filaments, vacuum furnace heating elements, and plasma environments.

With the development of semiconductor technology, large-size single-crystal silicon growth, fusion energy, and aerospace technology, the focus of modern tungsten material research is no longer limited to maintaining its 3422 °C melting point. Greater emphasis is being placed on improving microstructural stability and creep resistance during long-term operation above 2000 °C. Through rare-earth doping, dispersion strengthening, grain-boundary engineering, and powder-metallurgy optimization, new-generation tungsten materials can maintain relatively high mechanical properties and low deformation rates even when operating close to their temperature limits, thereby continuously expanding their applications in extreme high-temperature equipment.

Q11: What Is the Hardness of Tungsten Alloy Rods?

The hardness of tungsten alloy rods mainly depends on the material system, chemical composition, powder metallurgy process, plastic working method, and final heat-treatment condition. Therefore, there is no single fixed hardness value.

In general, pure tungsten rods have a Vickers hardness of approximately 340–450 HV. Tungsten rods doped with rare-earth oxides, such as lanthanum tungsten rods ($\text{La}_2\text{O}_3\text{-W}$), cerium tungsten rods ($\text{CeO}_2\text{-W}$), and yttrium tungsten rods ($\text{Y}_2\text{O}_3\text{-W}$), generally have a hardness of approximately 400–500 HV because grain refinement occurs and the recrystallization temperature is increased. For high-density tungsten heavy alloys, such as W-Ni-Fe and W-Ni-Cu, the hardness is generally in the range of 300–400 HV due to their different strengthening mechanisms. After strengthening processes such as rotary swaging and cold working, the hardness of some products can reach approximately 40 HRC,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

equivalent to about 375–410 HV. Hardness not only reflects a material's resistance to localized plastic deformation, but also directly affects its wear resistance, compressive strength, and subsequent machinability. For high-temperature structural components, hardness is also closely related to microstructural stability.

Therefore, when evaluating the performance of tungsten alloy rods, hardness should normally be analyzed together with strength, ductility, thermal conductivity, and high-temperature properties rather than being compared solely on the basis of hardness values. The main factors affecting the hardness of tungsten alloy rods include the following aspects.

(1) The first is material composition. Pure tungsten obtains its relatively high hardness mainly from its high melting point and high elastic modulus. After a small amount of rare-earth oxide is added, grain growth can be effectively suppressed and dislocation movement can be hindered, thereby further increasing hardness. In tungsten heavy alloys, the matrix contains binder phases such as Ni, Fe, or Cu. These metallic phases improve the material's ductility, but they also make the overall hardness slightly lower than that of pure tungsten.

(2) The second factor is grain size. According to the Hall–Petch relationship, the finer the grains, the greater the number of grain boundaries and the stronger the obstruction to dislocation movement, so the material generally exhibits higher hardness. Fine-grained tungsten rods manufactured using ultrafine powders, optimized high-temperature sintering, and thermomechanical processing generally have significantly higher hardness than conventional coarse-grained products.

(3) The third factor is plastic working. After rotary swaging, hot forging, hot rolling, or cold drawing, the dislocation density inside the material increases, resulting in a significant work-hardening effect and further increasing hardness. For example, rotary-swaged tungsten rods not only have higher surface hardness, but also exhibit a denser microstructure and a higher degree of fiber texture. They are therefore widely used in electron-beam equipment, medical radiation shielding, and aerospace components.

(4) Heat-treatment conditions also affect hardness. Stress-relief annealing mainly releases residual stress and has relatively little effect on hardness. If the annealing temperature is too high and recrystallization or even grain growth occurs, hardness may decrease to some extent. Therefore, high-performance tungsten rods generally use optimized heat-treatment schedules to maintain high hardness while also achieving a suitable balance of ductility and toughness.

Hardness values can also vary depending on the testing method. Vickers hardness (HV) is the most commonly used method in industry because it is suitable for high-hardness materials and can accurately characterize the surface hardness of tungsten and tungsten alloys. Rockwell hardness (HRC) is mainly used for products that have undergone rotary swaging or special processing. In research and quality control, micro-Vickers hardness testing is also used to evaluate local microstructural changes.

The table below lists typical hardness ranges for different types of tungsten and tungsten alloy rods. Actual values may vary depending on the manufacturing process and product specifications.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Material Type	Typical Hardness
Pure tungsten rod	340–450 HV
Lanthanum tungsten rod ($\text{La}_2\text{O}_3\text{-W}$)	400–500 HV
Cerium tungsten rod ($\text{CeO}_2\text{-W}$)	390–480 HV
Yttrium tungsten rod ($\text{Y}_2\text{O}_3\text{-W}$)	400–500 HV
W-Ni-Fe tungsten heavy alloy rod	300–380 HV
W-Ni-Cu tungsten heavy alloy rod	280–360 HV
Rotary-swaged tungsten rod	Approximately 40 HRC (approximately 375–410 HV)

Overall, the hardness of tungsten alloy rods is significantly higher than that of ordinary carbon steel and stainless steel, and is comparable to or even higher than that of many tool steels. This gives tungsten alloy rods excellent wear resistance and high-temperature dimensional stability. However, higher hardness does not necessarily mean better overall performance. For high-end applications such as semiconductor equipment, vacuum electronic devices, and aerospace components, the optimal balance must be achieved among hardness, ductility, high-temperature strength, and thermal fatigue resistance. Therefore, high-end tungsten alloy manufacturers generally use a combination of powder purity control, grain refinement, rare-earth dispersion strengthening, and thermomechanical processing to optimize hardness together with overall material performance.

Q12: What Is the Tensile Strength of Tungsten Alloy Rods?

Tensile strength is an important mechanical property used to measure the ability of a tungsten alloy rod to withstand tensile loads, and it is also an important basis for evaluating structural reliability. Because tungsten has an extremely high melting point of 3422 °C and a relatively high elastic modulus, its tensile strength is significantly higher than that of many common engineering metals. Different types of tungsten rods can exhibit considerable differences in tensile strength because of variations in composition, microstructure, and processing technology. In general, the room-temperature tensile strength of pure tungsten rods is approximately 600–1000 MPa. After doping with rare-earth oxides such as lanthanum, cerium, or yttrium oxides, tensile strength can increase to approximately 1000–1200 MPa.

High-performance tungsten alloy rods strengthened through rotary swaging, hot forging, and cold working can reach approximately 1200–1400 MPa, while some ultrafine-grained products can achieve even higher strength. Tungsten is a typical body-centered cubic (BCC) refractory metal, and its strength varies with temperature differently from conventional steels. At room temperature, pure tungsten has relatively low ductility. As the temperature rises above its ductile-to-brittle transition temperature, its ductility improves significantly, while it can still maintain relatively high strength at elevated temperatures. This is one of the main reasons why tungsten and tungsten alloys are widely used in high-temperature furnaces, aerospace propulsion systems, fusion devices, and semiconductor thermal-field systems. The main factors affecting tensile strength include the following aspects.

(1) The first is material purity and chemical composition. High-purity tungsten contains fewer impurity elements, which can reduce the formation of brittle phases and improve microstructural uniformity. In doped tungsten materials, small amounts of La_2O_3 , CeO_2 , or Y_2O_3 can not only increase the recrystallization temperature, but also improve tensile



strength through dispersion strengthening and grain refinement while enhancing high-temperature microstructural stability.

(2) The second factor is grain size. Fine-grained materials have more grain boundaries, which can effectively hinder dislocation movement. Therefore, their strength is generally higher than that of coarse-grained materials. Modern powder metallurgy technologies use ultrafine tungsten powders, optimized sintering schedules, and thermomechanical processing to maintain small grain sizes, thereby significantly improving both room-temperature and high-temperature strength.

(3) The third factor is work hardening. Plastic working processes such as rotary swaging, hot rolling, and cold drawing cause the grains to develop a fibrous structure along the processing direction while increasing dislocation density, resulting in a significant work-hardening effect. Therefore, rotary-swaged tungsten rods generally have higher tensile strength and better fatigue performance than conventional sintered rods.

(4) Sintered density is also highly important. If significant residual porosity remains inside the material, these pores can act as crack initiation sites during tensile loading, thereby reducing the actual tensile strength. Therefore, high-quality tungsten rods generally use processes such as vacuum sintering and hot isostatic pressing (HIP) to increase material density and bring the actual tensile strength closer to the theoretical level.

In addition to room-temperature properties, high-temperature tensile performance is also an important indicator for evaluating tungsten alloys. The strength of conventional structural steels decreases rapidly above 600 °C, whereas tungsten and tungsten alloys can still maintain relatively high load-bearing capacity above 1000 °C. This is an important reason why they are used as high-temperature structural materials. For doped tungsten and high-performance tungsten alloys, the retention of high-temperature strength is generally better than that of pure tungsten, and their long-term service stability is also superior. The table below lists typical room-temperature tensile strength ranges for different types of tungsten and tungsten alloy rods.

Material Type	Room-Temperature Tensile Strength (MPa)
Pure tungsten rod	600–1000
Lanthanum tungsten rod	1000–1200
Cerium tungsten rod	950–1150
Yttrium tungsten rod	1000–1200
Rotary-swaged tungsten rod	1200–1400
W-Ni-Fe tungsten heavy alloy rod	900–1200
W-Ni-Cu tungsten heavy alloy rod	800–1100

Higher tensile strength generally means that ductility may decrease to some extent. Therefore, actual engineering design should consider yield strength, elongation, reduction of area, fracture toughness, and high-temperature creep properties in combination. For example, semiconductor thermal-field components place greater emphasis on long-term high-temperature dimensional stability, whereas aerospace structural components place greater emphasis on achieving an appropriate balance between strength and toughness.

In conclusion, the development of modern high-performance tungsten alloy rods has shifted from simply pursuing higher tensile strength toward the comprehensive



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

optimization of strength, ductility, high-temperature performance, and microstructural stability. Through the combined use of high-purity powder preparation, grain refinement, rare-earth dispersion strengthening, thermomechanical processing, and advanced sintering technologies, modern tungsten alloy rods can operate reliably for extended periods under extreme high-temperature, high-vacuum, and high-load conditions, making them indispensable engineering materials for advanced equipment manufacturing.

Q13: What Are the Electrical Conductivity and Thermal Conductivity of Tungsten Alloy Rods?

Tungsten alloy rods combine excellent electrical conductivity and thermal conductivity, making them important engineering materials widely used in electronics, electrical vacuum equipment, semiconductor manufacturing, aerospace, nuclear industry, and high-temperature equipment. Although their electrical and thermal conductivity are lower than those of conventional conductive metals such as copper and silver, tungsten alloys offer unique overall advantages in high-temperature, high-vacuum, and high-heat-flux environments because tungsten has an extremely high melting point of 3422 °C, excellent high-temperature strength, low vapor pressure, and good dimensional stability. Pure tungsten rods typically have an electrical conductivity of approximately 30% IACS (International Annealed Copper Standard), corresponding to an electrical resistivity of approximately $5.5 \times 10^{-8} \Omega \cdot m$. At room temperature, their electrical conductivity is approximately one-third that of pure copper. However, as temperature increases, tungsten exhibits significantly better electrical stability than many conventional metals and is less susceptible to rapid degradation in electrical conductivity caused by high-temperature softening or oxidation. Therefore, tungsten alloy rods remain important conductive materials for electron-beam equipment, resistance welding electrodes, high-temperature electrodes, and vacuum electrical contact components.

In terms of thermal conductivity, pure tungsten generally has a thermal conductivity of approximately 165–180 W/(m·K) at room temperature, with approximately 170 W/(m·K) commonly used for engineering calculations. Although this value is lower than that of copper, approximately 390–400 W/(m·K), and silver, approximately 420 W/(m·K), it is much higher than that of most heat-resistant alloys and stainless steels. For example, common austenitic stainless steels typically have thermal conductivity of only about 15–20 W/(m·K), while nickel-based superalloys are generally around 10–30 W/(m·K). Tungsten can therefore rapidly conduct localized heat, reduce thermal-stress concentration, and improve component stability in high-temperature environments.

In actual industrial applications, not all tungsten alloy rods are made of pure tungsten. Small amounts of potassium, rhenium, lanthanum, cerium, thorium, yttrium, or other rare-earth elements may be added to improve high-temperature performance, recrystallization resistance, and machinability. For example, doped potassium tungsten rods, also known as non-sag tungsten, form stable potassium bubble structures that provide higher resistance to high-temperature creep. Their thermal conductivity is generally slightly lower than that of pure tungsten, approximately 155–165 W/(m·K), while their electrical conductivity changes only slightly and may even be slightly higher in some cases because of a more uniform microstructure. Tungsten-rhenium alloys exhibit significantly improved ductility and high-temperature elongation due to the addition of rhenium, although their electrical and thermal conductivity is generally slightly lower than that of pure tungsten. Rare-earth-doped tungsten is more commonly used to improve electron emission characteristics and machinability, while maintaining relatively high thermal



conductivity.

The thermal conductivity of tungsten gradually decreases as temperature increases, which is a common characteristic of metallic materials. For example, its thermal conductivity is approximately 170 W/(m·K) near room temperature and may decrease to around 100 W/(m·K) when the operating temperature exceeds 1000 °C. Even so, it remains significantly higher than that of most heat-resistant structural materials. Therefore, tungsten can still effectively dissipate heat and maintain temperature uniformity in high-temperature vacuum furnaces, single-crystal silicon growth furnaces, fusion devices, and aerospace thermal structures.

The electrical and thermal conductivity of tungsten alloy rods is also closely related to material purity, grain size, sintered density, and manufacturing processes. High-purity, high-density materials with fine-grained structures generally exhibit lower electrical resistivity and higher thermal conductivity. If the material contains relatively high levels of impurities such as oxygen, carbon, and nitrogen, or has significant porosity and grain-boundary defects, the transport of electrons and phonons will be hindered, thereby reducing electrical and thermal conductivity. Therefore, high-end semiconductor, electronics, and research equipment commonly use high-purity tungsten or high-purity TZM materials to obtain more stable thermophysical properties.

Typical Electrical and Thermal Conductivity of Different Materials

Material	Electrical Conductivity (IACS)	Thermal Conductivity W/(m·K)	Main Characteristics
Silver	Approximately 105	Approximately 420	Highest electrical and thermal conductivity
Copper	100	390–400	Excellent electrical and thermal conductor
Aluminum	Approximately 61	Approximately 235	Lightweight with good thermal conductivity
Pure tungsten	Approximately 30	165–180	Excellent high-temperature stability
Doped tungsten	Approximately 28–32	155–165	Higher creep resistance
TZM alloy	Approximately 25–30	125–145	Excellent overall high-temperature performance
304 stainless steel	Approximately 2–3	15–20	Low thermal conductivity

The greatest advantage of tungsten alloy rods is not their absolute electrical or thermal conductivity, but their ability to maintain stable electrical and thermal performance together with excellent mechanical properties under extremely high temperatures, high vacuum, and long-term thermal cycling. This is an important reason why tungsten and its alloys are widely used in semiconductor thermal fields, electron-beam equipment, vacuum metallurgy, high-temperature furnaces, resistance welding electrodes, and nuclear fusion equipment.

Q14: What Is the Coefficient of Thermal Expansion of Tungsten Alloy Rods?

The coefficient of thermal expansion (CTE) is an important parameter for evaluating the dimensional stability of a material. It represents the relative change in unit length when the material temperature increases by 1 K or 1 °C. For high-temperature equipment, precision instruments, semiconductor manufacturing equipment, and aerospace thermal structures, the coefficient of thermal expansion directly affects component fit accuracy, thermal-stress levels, and long-term service reliability. Tungsten is a typical low-thermal-expansion metal. Its linear coefficient of thermal expansion from room temperature to 100 °C is generally approximately $4.3\text{--}4.7 \times 10^{-6}/\text{K}$, with approximately $4.5 \times 10^{-6}/\text{K}$ commonly used for engineering design. This value is much lower than those of common engineering materials



such as steel, copper, and aluminum. For example, ordinary carbon steel has a coefficient of approximately $12 \times 10^{-6}/K$, stainless steel approximately $16 \times 10^{-6}/K$, copper approximately $17 \times 10^{-6}/K$, and aluminum approximately $23 \times 10^{-6}/K$. Therefore, tungsten undergoes very little dimensional change as temperature varies.

Low thermal expansion is one of the important material advantages of tungsten. Taking a 1000 mm-long tungsten rod as an example, when the temperature increases by 100 °C, its theoretical elongation is only approximately 0.45 mm. Under the same conditions, a copper rod of the same length would elongate by approximately 1.7 mm, while an aluminum rod would elongate by approximately 2.3 mm. For equipment requiring dimensional stability at the micrometer level, this difference is highly significant.

After the addition of small amounts of strengthening elements, the coefficient of thermal expansion of tungsten alloy rods generally changes only slightly. For example, the coefficient of thermal expansion of TZM (Ti-Zr-Mo alloy) is generally approximately $5.0-5.5 \times 10^{-6}/K$. Due to the addition of rhenium, tungsten-rhenium alloys have a slightly higher coefficient of thermal expansion, but it remains significantly lower than that of conventional heat-resistant alloys. Electronic-material grades such as potassium-doped tungsten, lanthanum tungsten, and cerium tungsten have coefficients of thermal expansion that are generally close to that of pure tungsten, so they retain excellent dimensional stability. The coefficient of thermal expansion is not an absolutely constant value and increases slightly with temperature. For example, the coefficient of thermal expansion of pure tungsten is approximately $4.5 \times 10^{-6}/K$ near room temperature and may increase to approximately $5.5-6.0 \times 10^{-6}/K$ above 1000 °C. However, the overall increase is relatively small, allowing tungsten to maintain good thermal dimensional stability over a wide temperature range.

The engineering advantages of low thermal expansion are mainly reflected in several areas. First, it can reduce thermal stress. When different materials operate together, smaller differences in thermal expansion result in lower thermal stress at interfaces, thereby reducing the risk of cracking, delamination, and deformation. Second, it helps improve positioning accuracy. Single-crystal silicon growth furnaces, optical systems, electron-beam equipment, and other systems need to maintain precise positional relationships over long periods. Low-expansion materials can effectively reduce dimensional drift caused by temperature changes. Third, it can improve thermal-cycle life. During repeated heating and cooling, a smaller thermal expansion amplitude means lower cyclic stress, which helps extend component service life. Approximate comparisons of the coefficients of thermal expansion of different engineering materials are shown below.

Material	Linear Coefficient of Thermal Expansion ($\times 10^{-6}/K$)	Dimensional Stability
Tungsten	Approximately 4.5	Extremely high
TZM	Approximately 5.0-5.5	Extremely high
Molybdenum	Approximately 5.0	Extremely high
Invar alloy	Approximately 1-2	Ultra-low expansion
Carbon steel	Approximately 12	Moderate
304 stainless steel	Approximately 16	General
Copper	Approximately 17	Relatively high expansion
Aluminum	Approximately 23	High expansion



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

In the semiconductor industry, tungsten and TZM are widely used to manufacture support rods, connectors, positioning components, and thermal-field frameworks in single-crystal silicon growth furnaces, sapphire crystal growth equipment, and compound-semiconductor thermal systems. This is precisely because of their low thermal expansion, high-temperature strength, and creep resistance, which enable equipment to maintain stable geometric dimensions during long-term operation at temperatures of 1400–1700 °C. In the aerospace sector, these characteristics are used in the manufacture of nozzle components, high-temperature thermal structures, and electronic-device supports to reduce structural deformation caused by temperature variations.

Overall, the low coefficient of thermal expansion of tungsten alloy rods, combined with their high melting point, high elastic modulus, and excellent high-temperature mechanical properties, makes them one of the most important high-temperature structural materials for extreme environments. In modern semiconductor manufacturing, aerospace, nuclear industry, and precision equipment manufacturing, low thermal expansion means not only small dimensional changes, but also higher machining accuracy, better thermal stability, and longer service life.

Q15: Is Tungsten Alloy Rod Corrosion Resistant?

Tungsten alloy rods generally have excellent corrosion resistance and are widely used in high-temperature, vacuum, chemical, electronic, semiconductor, aerospace, and other fields. Their corrosion resistance mainly comes from the extremely high chemical stability of tungsten (W) itself. Tungsten has a relatively high standard electrode potential, and its surface can readily form an extremely thin and stable oxide film at room temperature. This oxide film can effectively prevent further oxidation and corrosion, giving tungsten good resistance to attack by most industrial media.

At room temperature, tungsten and most tungsten alloys have almost no reaction with air, water, or water vapor, and they have high resistance to dilute sulfuric acid, concentrated sulfuric acid, hydrochloric acid, nitric acid, and most organic acids. Even when exposed to humid air for long periods, their corrosion rate remains very low. Tungsten alloys also exhibit good corrosion resistance in seawater, weakly alkaline solutions, and most neutral salt solutions. Therefore, they are often used for high-temperature structural components and precision components that require long-term stable operation.

However, tungsten alloys do not have absolute corrosion resistance in all media. In high-temperature oxidizing environments, tungsten gradually oxidizes to form tungsten trioxide (WO_3). When the temperature exceeds approximately 400–500 °C, the oxidation rate begins to increase significantly. Above approximately 600 °C, the oxide layer gradually thickens and may begin to volatilize, resulting in continuous material loss. Therefore, tungsten alloys operating at high temperatures for extended periods generally need to be used under vacuum or in protective atmospheres such as hydrogen or argon rather than being directly exposed to air.

Fluorine-containing media also require particular attention when using tungsten materials. Hydrofluoric acid, fluorine gas, and certain high-temperature fluorine-containing compounds can react with tungsten to form volatile tungsten fluorides, causing a significant reduction in corrosion resistance. Tungsten may also undergo some degree of corrosion in molten alkalis, molten nitrates, and certain molten-metal environments. Therefore, material selection should be based on the specific operating conditions.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

For common high-density tungsten alloys, such as W-Ni-Fe and W-Ni-Cu, corrosion resistance is affected not only by the tungsten matrix but also by the binder phase. The nickel-iron binder phase has slightly lower corrosion resistance than pure tungsten in certain acidic media. Therefore, the overall corrosion resistance of high-density tungsten alloys is generally slightly lower than that of pure tungsten or molybdenum-based high-temperature alloys such as TZM, but it remains significantly better than that of ordinary carbon steel and most low-alloy steels. The corrosion resistance of different tungsten materials can be compared as follows:

Material Type	Room-Temperature Acid Resistance	Room-Temperature Alkali Resistance	High-Temperature Oxidation Resistance	Typical Applications
Pure tungsten	Excellent	Excellent	Moderate; protection required in air	Vacuum furnaces, electronic components
TZM molybdenum alloy	Good	Good	Better than pure molybdenum	Semiconductor thermal fields, high-temperature structural components
W-Ni-Fe high-density tungsten alloy	Good	Good	Moderate	Counterweights, shielding components
W-Ni-Cu high-density tungsten alloy	Good	Good	Moderate	Electrical applications, medical shielding

The main factors affecting the corrosion resistance of tungsten alloys include material purity, alloy composition, grain size, sintered density, and surface condition. In general, higher purity, lower porosity, and a denser surface result in better corrosion resistance. Tungsten alloys subjected to precision grinding, polishing, or chemical cleaning generally exhibit improved stability in corrosive media because surface defects are reduced.

Based on many years of production and application experience, CTIA GROUP considers tungsten alloy rods to have excellent corrosion resistance in the vast majority of industrial environments. The main concerns are not ordinary corrosion at room temperature, but rather high-temperature oxidation and the effects of special chemical media, particularly fluorine-containing media. Therefore, in applications such as semiconductors, vacuum heat treatment, electronic industries, and aerospace, vacuum conditions, protective atmospheres, or surface protection technologies are generally used in combination to maintain stable dimensions, performance, and service life of tungsten alloy components over extended periods.

Q16: How Do Different Dopants Affect Performance?

The performance of tungsten materials depends not only on the purity of tungsten itself, but also closely on the trace dopant elements added to the material. Modern high-performance tungsten materials commonly use oxide or alloying-element doping. By improving grain structure, enhancing electron emission capability, increasing high-temperature strength, or improving machinability, these dopants enable tungsten materials to meet the requirements of different industrial applications. Different doping systems have different strengthening mechanisms, resulting in a variety of specialized tungsten materials.

The most widely used doping systems currently include lanthanum (La), cerium (Ce), thorium (Th), rhenium (Re), yttrium (Y), and composite rare-earth systems. Among them, lanthanum-doped tungsten (WLa) is one of the most widely used non-radioactive tungsten materials internationally. Lanthanum is generally added in the form of La_2O_3 . Its main functions are to inhibit grain growth during sintering, increase the recrystallization



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

temperature, and improve electron emission performance. Compared with pure tungsten, lanthanum-doped tungsten electrodes can generally increase electron emission capability by approximately 30%–50%, making arc initiation easier, improving arc stability, and reducing electrode consumption. Therefore, they are widely used in automated TIG welding, robotic welding, and both AC and DC welding equipment.

(1) Cerium-doped tungsten (WCe) uses CeO_2 as the primary additive. It has a relatively low work function and excellent low-current arc-starting performance. It performs particularly well in low-current precision welding, sheet-metal welding, and automated welding. Compared with conventional thoriated tungsten electrodes, cerium-doped tungsten is non-radioactive, safer, and more environmentally friendly. It is therefore widely used in electronic industries, stainless-steel welding, and precision manufacturing.

(2) Thoriated tungsten (WTh) was long regarded as a tungsten electrode material with excellent overall performance. ThO_2 can significantly reduce the electron work function and increase electron emission capability, resulting in stable arcs and strong current-carrying capacity. It performs particularly well in high-current DC welding. However, because ThO_2 is a naturally radioactive substance, thorium-containing dust may be generated during grinding, creating higher occupational health requirements. At present, manufacturers in Europe, the United States, Japan, and many modern manufacturing enterprises are gradually replacing thoriated tungsten electrodes with lanthanated tungsten, ceriated tungsten, or composite rare-earth tungsten electrodes.

(3) Rhenium-doped tungsten (WRe) is a different type of tungsten alloy designed for entirely different applications. Rhenium can significantly improve the high-temperature ductility, toughness, and thermal-shock resistance of tungsten while lowering its ductile-to-brittle transition temperature, making the material less susceptible to cracking during high-temperature thermal cycling. WRe alloys are widely used in high-temperature thermocouples, aerospace engines, electron-beam equipment, and scientific experimental equipment. The most typical examples are W-5Re/W-26Re thermocouples, which can be used for long-term measurement of ultra-high temperatures above 2000 °C.

In recent years, yttrium-doped tungsten (WY) and composite rare-earth tungsten materials have also gradually developed. Yttrium oxide has relatively high thermal stability and can further improve the high-temperature structural stability of tungsten materials. Composite rare-earth systems, meanwhile, combine the advantages of multiple rare-earth elements to achieve a better balance among electron emission performance, service life, and resistance to electrode erosion. The main characteristics of different doping systems are as follows:

Doping System	Main Additive	Main Functions	Typical Applications
WCe	CeO_2	Good arc-starting performance, stable arc, environmentally friendly	TIG welding, precision welding
WLa	La_2O_3	Improved electron emission capability, long service life	Automated welding, robotic welding
WTh	ThO_2	Excellent high-current performance, but radioactive	Conventional DC welding; applications gradually declining
WRe	Re	Improves high-temperature strength, toughness, and thermal stability	Thermocouples, aerospace, high-temperature measurement
WY	Y_2O_3	Improves high-temperature structural stability	Advanced electronics, scientific equipment
Composite rare-earth tungsten	Multiple rare-earth oxides	Balanced overall performance	Advanced welding and specialized industrial applications



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

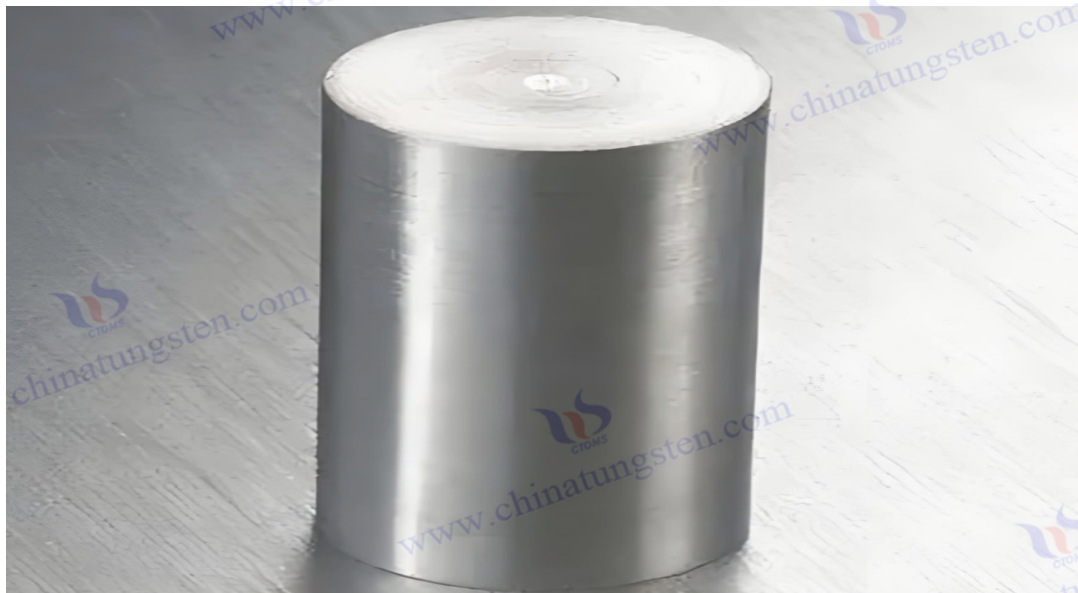
ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

In addition to welding applications, dopants also affect the recrystallization temperature, grain size, machinability, and service life of tungsten materials. For example, appropriate rare-earth oxides can effectively inhibit grain-boundary migration, allowing the material to maintain a fine-grained structure during long-term exposure to high temperatures. Rhenium, on the other hand, primarily improves material ductility, enabling the material to withstand greater thermal and mechanical stresses.

CTIA GROUP considers that the development of modern tungsten materials is gradually shifting from single-element doping toward composite doping and functionalized material design. In the future, high-performance tungsten materials will need not only excellent electron emission capability, but also high-temperature stability, long service life, environmental safety, and compatibility with intelligent manufacturing requirements. Therefore, non-radioactive materials such as lanthanated tungsten, ceriated tungsten, and composite rare-earth tungsten will continue to be major industrial materials, while specialized tungsten alloys such as WRe will play an increasingly important role in aerospace, fusion energy, and ultra-high-temperature measurement applications.





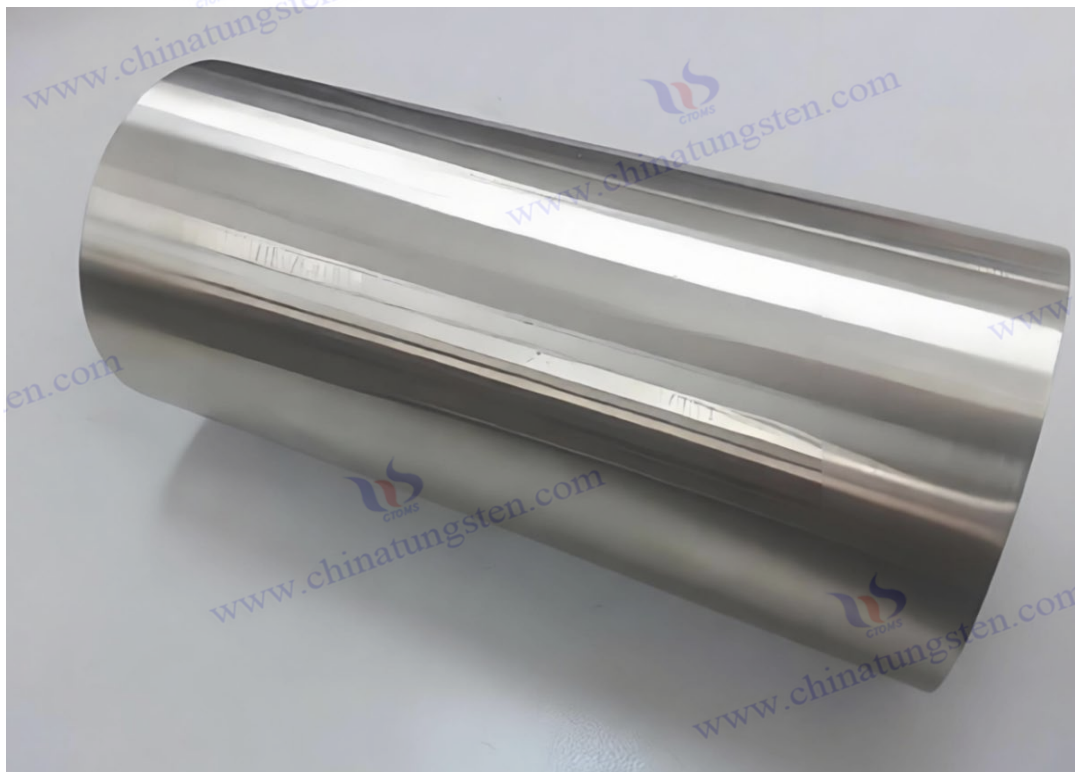
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



III. Manufacturing Processes of Tungsten Alloy Rods

Q17: What Are the Main Manufacturing Processes for Tungsten Alloy Rods?

Tungsten alloy rods are one of the most common product forms of high-density tungsten alloys, tungsten-nickel-iron alloys, tungsten-nickel-copper alloys, and some refractory tungsten-based alloys. They are widely used in aerospace, defense, radiation shielding for medical applications, oil well logging, electrical discharge machining, electrical vacuum equipment, and high-temperature equipment. Since tungsten has an extremely high melting point of 3422 °C, conventional melting processes are difficult to implement for industrial production. Therefore, modern tungsten alloy rods are almost entirely manufactured using powder metallurgy technology, combined with hot working, precision machining, and other processes according to product dimensions, performance requirements, and application fields, thereby forming a complete manufacturing process.

(1) Powder Metallurgy

Powder metallurgy is currently the most mature and widely used method for manufacturing tungsten alloy rods and is the standard manufacturing process for the vast majority of high-performance tungsten alloy rods. The basic process includes raw material preparation, powder mixing, compaction, liquid-phase sintering, heat treatment, and mechanical machining.

During production, tungsten powder is first uniformly mixed with nickel, iron, copper, or other alloying element powders according to the specified formulation. The mixture is then compacted into a green compact by die pressing or cold isostatic pressing, followed by liquid-phase sintering under a protective atmosphere or vacuum conditions. During sintering, the lower-melting-point binder phase melts first, causing the tungsten particles to rearrange and gradually densify, ultimately producing a microstructure approaching theoretical density.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Depending on product requirements, the sintered material may subsequently undergo rotary swaging, hot rolling, drawing, turning, grinding, and other processes to improve dimensional accuracy and overall mechanical properties. This process offers advantages such as uniform microstructure, high density, high material utilization, and suitability for mass production, making it the mainstream manufacturing route for tungsten alloy rods.

(2) Metal Injection Molding (MIM)

Metal Injection Molding (MIM) is primarily used to manufacture small tungsten alloy components with complex geometries and is less commonly used directly for long rods. Its basic principle is to mix ultrafine metal powders with organic binders to form feedstock, inject the feedstock into a mold to produce a green part, and then obtain the final product through debinding and sintering.

Compared with conventional powder compaction, MIM can produce complex external geometries and thin-wall structures with good dimensional repeatability. It is suitable for medical devices, electronic components, miniature counterweights, and similar products. Since long rods are prone to deformation during debinding and sintering, MIM is generally not used for the production of large tungsten alloy rods. However, it still has certain applications for small-diameter short rods or specially shaped rods.

(3) Infiltration Process

The infiltration process is mainly used to manufacture tungsten-copper alloy rods (W-Cu Alloy Rods). The process first involves preparing a porous tungsten skeleton with a certain level of porosity, after which molten copper infiltrates the tungsten skeleton through capillary action, fully filling the pores and forming a continuous tungsten-copper composite structure.

This process retains tungsten's excellent high-temperature resistance and ablation resistance while providing the good thermal and electrical conductivity of copper. It is therefore widely used in electrical discharge machining electrodes, high-voltage electrical equipment, resistance welding electrodes, and electronic packaging. It should be noted that copper infiltration is a composite-material manufacturing process and differs significantly from the liquid-phase sintering process used for high-density tungsten-nickel-iron alloy rods.

(4) Plastic Deformation Strengthening Processes

For high-performance tungsten alloy rods, plastic deformation processes such as hot forging, rotary swaging, hot rolling, or drawing are generally required after sintering.

Plastic deformation can close residual micropores, refine the microstructure, increase strength, hardness, and fatigue performance, and improve the straightness and dimensional consistency of the rods. After processing with a relatively large deformation ratio, the internal microstructure becomes more uniform, and the tensile strength, yield strength, and impact toughness can generally be further improved. For aerospace applications, high-speed rotating components, and high-reliability products, plastic deformation is often an indispensable manufacturing step.

(5) Near-Net-Shape Forming and Additive Manufacturing

In recent years, with the development of additive manufacturing technologies, processes such as Selective Laser Melting (SLM) and Electron Beam Melting (EBM) have begun to be applied in research on tungsten-based materials. Due to tungsten's high melting point, high



thermal conductivity, and significant thermal stresses, large tungsten alloy rods are still mainly manufactured through powder metallurgy. However, additive manufacturing has certain development potential for complex preforms, small-batch customized products, and similar applications.

In addition, some high-end manufacturers have begun adopting Near-Net-Shape processes to directly obtain preforms close to the final dimensions during sintering, thereby reducing subsequent machining and improving material utilization.

Comparison of Main Manufacturing Processes for Tungsten Alloy Rods

Manufacturing Process	Main Characteristics	Applicable Products
Powder metallurgy liquid-phase sintering	Mature process, high density, stable performance	Various high-density tungsten alloy rods, tungsten-nickel-iron rods, tungsten-nickel-copper rods
Metal Injection Molding (MIM)	Suitable for complex shapes and small-sized components	Small short rods, complex specially shaped components
Infiltration process	Produces tungsten-copper composite structures	Tungsten-copper rods, electrode materials
Hot forging, rotary swaging, drawing	Improves strength and microstructure	High-performance precision rods
Additive manufacturing	Suitable for complex structures and small-batch production	Special customized products

Modern tungsten alloy rod manufacturing has developed into a process framework centered on powder metallurgy, strengthened through plastic deformation, and supplemented by near-net-shape forming and additive manufacturing. Powder metallurgy liquid-phase sintering remains the core technological route determining material quality and the level of industrial application.

Q18: How Much Does the Sintering Process Affect the Quality of Tungsten Alloy Rods?

Sintering is one of the most critical processes in the powder metallurgy production of tungsten alloy rods, and its importance can even exceed that of compaction. Sintering not only determines whether the material can achieve high densification, but also directly affects grain structure, porosity, microstructural uniformity, and final mechanical properties. In other words, even with the same raw materials and the same formulation, the final product may exhibit significant differences in performance if different sintering schedules are used. For high-density tungsten alloys produced by liquid-phase sintering, sintering quality generally determines the upper limit of product quality.

(1) Determining Material Density

The most important function of sintering is to increase material density. As the temperature rises, binder phases such as nickel, iron, and copper gradually melt. The liquid phase wets the tungsten particles, causing them to rearrange and progressively fill the pores, ultimately forming a highly dense microstructure. Industrial products generally require a sintered density of 98%–99% or more of theoretical density. If the sintered density is too low, a relatively large amount of residual porosity remains inside the material. This not only reduces material strength but can also affect thermal conductivity, electrical conductivity, and corrosion resistance.

(2) Affecting Grain Size

Sintering temperature and holding time jointly determine the extent of grain growth. If the temperature is too low, diffusion is insufficient and the microstructure remains porous. If the temperature is too high or the holding time is too long, excessive grain coarsening may



occur. Excessively large grains can reduce material strength and fatigue resistance. Therefore, modern high-end tungsten alloys generally use optimized sintering curves to achieve sufficient densification while controlling grain growth.

(3) Affecting Mechanical Properties

High-quality sintering can produce a continuous and uniform metallic binder structure, giving the material high tensile strength, yield strength, elongation, and impact toughness. If pores, inclusions, or uneven liquid-phase distribution exist during sintering, they can easily become sources of stress concentration, leading to crack initiation during service and reducing material reliability.

(4) Affecting Microstructural Uniformity

Sintering determines not only density but also the distribution of tungsten particles and the binder phase. In a high-quality sintered microstructure, tungsten particles are relatively uniform in size and continuously distributed, while the binder phase sufficiently surrounds the tungsten particles. If sintering is improperly controlled, liquid-phase segregation, microstructural layering, or localized coarse grains may occur, resulting in inconsistent properties in different regions of the material.

(5) The Sintering Atmosphere Is Also Important

Industrial production generally uses vacuum sintering or hydrogen-atmosphere sintering. Vacuum sintering helps remove impurities such as oxygen and nitrogen and improves material purity, while hydrogen-atmosphere sintering can effectively reduce oxides and minimize oxygen contamination. If the atmosphere is poorly controlled, the oxygen content of the material may increase, which can reduce ductility and may also affect subsequent machining performance.

(6) Post-Sintering Processing

After sintering, high-performance tungsten alloy rods generally undergo additional processes such as heat treatment, rotary swaging, hot rolling, and drawing to further improve their microstructure and properties. In other words, sintering establishes the fundamental microstructure of the material, while subsequent plastic deformation further optimizes its overall performance.

Effects of Sintering Processes on Tungsten Alloy Rod Performance

Sintering Parameter	Possible Problems from Improper Control	Effect on Final Performance
Sintering temperature	Insufficient densification at excessively low temperatures; grain coarsening at excessively high temperatures	Reduced strength and toughness
Holding time	Incomplete sintering if too short; microstructural coarsening if too long	Reduced microstructural uniformity
Sintering atmosphere	Increased oxidation and inclusions	Reduced ductility and reliability
Heating and cooling schedule	Increased thermal stress and microstructural instability	Reduced dimensional stability
Degree of densification	Increased residual porosity	Reduced strength and fatigue life

From an engineering perspective, the sintering process essentially determines the microstructural foundation of tungsten alloy rods. Modern high-end manufacturing places increasing emphasis on controlling the entire sintering process, including precise regulation of temperature-field uniformity, vacuum level, purity of the protective atmosphere, heating



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

rate, and holding schedule. Combined with digital sintering control technology, this enables the simultaneous achievement of high densification, fine grains, uniform microstructure, and batch-to-batch consistency, thereby meeting the long-term reliability requirements for tungsten alloy materials in high-end applications such as aerospace, nuclear industry, medical equipment, and semiconductor manufacturing.

Q19: What Is Rotary Swaging? How Does It Improve the Performance of Tungsten Alloy Rods?

Rotary swaging is a precision forging process that uses high-speed radial hammering to continuously plastically deform rods, tubes, or wires. It is also one of the most important subsequent processing methods in the production of high-performance tungsten alloy rods. For heavy tungsten alloys such as W-Ni-Fe and W-Ni-Cu, although the sintered material already has a relatively high density, the internal grain structure remains relatively randomly distributed, and some residual microporosity and structural non-uniformity may still exist. Rotary swaging can further improve the internal structure and enhance the overall mechanical properties of the material. Therefore, most high-performance tungsten alloy rods used in aerospace, defense, medical shielding, counterweight systems, and high-end precision manufacturing are processed by rotary swaging or rotary swaging combined with subsequent heat treatment.

Rotary swaging equipment usually consists of several dies or hammer blocks rotating rapidly around the workpiece and continuously striking it in the radial direction toward the center. The workpiece gradually moves forward under the action of the feeding mechanism and gradually decreases in diameter while increasing in length under thousands or even tens of thousands of continuous impacts, thereby achieving plastic deformation. Compared with conventional free forging or die forging, this processing method offers more uniform deformation, higher dimensional accuracy, better material utilization, and higher processing efficiency. It is particularly suitable for high-hardness, high-density, and difficult-to-deform metallic materials.

From the perspective of microstructure, the greatest effect of rotary swaging is grain refinement and improvement of grain orientation. In the sintered state, tungsten particles are distributed relatively randomly. After rotary swaging with a relatively large deformation amount, the tungsten particles become elongated to a certain extent along the axial direction, resulting in a denser and more uniform structure. Residual pores are further reduced, and grain boundary bonding becomes stronger. At the same time, plastic deformation introduces a large number of dislocations, causing work hardening and thereby significantly increasing strength and hardness. The main performance improvements after rotary swaging are reflected in the following aspects.

(1) First, the tensile strength increases significantly. The tensile strength of ordinary sintered heavy tungsten alloys is typically about 900–1100 MPa, while after rotary swaging with a relatively large deformation amount, it can increase to approximately 1200–1400 MPa. Some special grades can even exceed 1500 MPa.

(2) Second, hardness increases. As the degree of work hardening increases, the hardness of the material can typically reach approximately 35–40 HRC, while some high-strength products can exceed 40 HRC. This increase in hardness gives the material better wear resistance and resistance to local plastic deformation.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(3) The elastic limit also increases. After rotary swaging, the material is less likely to undergo permanent deformation under load, resulting in better dimensional stability. This is particularly important for high-speed rotating components, dynamic-balance counterweights, and precision mechanisms.

(4) Fatigue performance is improved. Because the structure becomes more uniform and porosity is reduced, the probability of fatigue crack initiation is significantly reduced. Therefore, the cyclic life is generally higher than that of materials in the ordinary sintered state.

(5) Rotary swaging can also improve material consistency. Because the entire rod undergoes continuous and relatively uniform deformation along its length, structural differences between different sections are reduced, which is beneficial for subsequent CNC machining and precision assembly.

However, a larger rotary swaging deformation amount is not always better. If the deformation amount is too small, the strengthening effect is limited. If the deformation amount is excessive, work hardening may become too severe, resulting in reduced ductility and increased machining difficulty. Therefore, industrial production generally controls the total deformation ratio according to the intended application and arranges intermediate annealing when necessary to restore a certain degree of ductility before continuing with subsequent rotary swaging.

The degree of rotary swaging also varies according to the intended application. For example, high-strength armor-piercing materials generally use a relatively large rotary swaging deformation amount to achieve maximum strength. Medical shielding components place greater emphasis on dimensional stability and machinability, so a moderate degree of rotary swaging is generally used. Aerospace counterweight components are typically subjected to precision grinding after rotary swaging to achieve a balance among strength, dimensional accuracy, and surface quality. The following table summarizes the typical effects of rotary swaging on the properties of tungsten alloy rods.

Property	Sintered State	Typical Level After Rotary Swaging	Improvement
Density	Close to theoretical density	More uniform	Further reduction of internal porosity
Tensile strength	Approx. 900–1100 MPa	1200–1400 MPa	Increase of approx. 15%–35%
Hardness	Approx. 28–35 HRC	35–40 HRC	Improved wear resistance
Fatigue performance	General	Significantly improved	Reduced crack initiation
Dimensional stability	Good	Higher	More suitable for precision machining

Overall, rotary swaging is not merely a dimensional forming process, but also an important structural strengthening process. Through plastic deformation, structural refinement, and work hardening, it enables tungsten alloy rods to achieve higher strength, better wear resistance, superior fatigue performance, and improved dimensional stability. It is therefore an indispensable process in the manufacture of high-performance tungsten alloys.

Q20: Can Tungsten Alloy Rods Be Heat Treated?

Many people may compare tungsten alloys with steel and assume that heat treatment means quenching, tempering, or age hardening. In fact, this understanding does not apply to most powder-metallurgy tungsten alloy rods. Because the strengthening mechanisms of tungsten alloys are completely different from those of steel, their properties mainly originate from the high-melting-point tungsten particles, nickel-iron or nickel-copper binder phase, powder-metallurgy sintered structure, and subsequent plastic deformation, rather



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

than the martensitic phase transformation used in steel. Therefore, most tungsten alloy rods have already undergone sintering, densification, and necessary plastic processing before delivery, and users generally do not need to perform conventional heat treatment.

From the perspective of the manufacturing process, tungsten alloy rods have already undergone several high-temperature stages during production, including sintering, liquid-phase sintering, vacuum sintering, and necessary hot-working processes. These processes have already established a stable microstructure. If the material is subjected to additional high-temperature treatment, it may not further increase strength and may instead cause grain growth, redistribution of the binder phase, or even microstructural degradation, thereby reducing overall performance. However, this does not mean that tungsten alloys cannot undergo heat treatment at all. Under certain special circumstances, heat treatment still has important applications, but its purpose is not strengthening. Instead, it is used to improve structural stability, relieve residual stress, or restore machinability.

The most common treatment is stress-relief annealing. During EDM, laser cutting, laser drilling, heavy cutting, precision grinding, and other processes, tungsten alloys may develop a certain amount of residual stress in the surface layer. If the material is put directly into service, slight deformation may occur during subsequent operation, affecting dimensional accuracy. Therefore, for high-precision components, vacuum stress-relief annealing at approximately 600–800 °C is generally recommended when necessary. This allows internal stress to be released while maintaining the original microstructure essentially unchanged. For materials subjected to rotary swaging or cold working, intermediate annealing may also be used. When the deformation amount is large, work hardening can significantly reduce ductility, making continued processing prone to cracking. In such cases, annealing at an appropriate temperature can restore part of the ductility before rotary swaging or drawing is continued. This type of annealing is mainly used during manufacturing rather than during the end-user stage.

In addition, vacuum electronic devices, semiconductor equipment, and aerospace components may undergo stabilization heat treatment. Its main purpose is to release minor internal microstructural changes in advance so that components can achieve better dimensional stability during long-term high-temperature operation. Such heat treatment generally requires strict control of temperature, time, and vacuum level. In production practice, tungsten alloys must not be quenched in the same manner as steel. Steel quenching relies on the transformation of austenite into martensite, whereas tungsten alloys do not possess this strengthening mechanism.

Rapid cooling not only fails to increase hardness, but may also cause cracks, local spalling, or even complete component failure due to excessive thermal stress. This is particularly true for large tungsten alloy rods or complex-shaped components. Rapid cooling after high-temperature treatment can rapidly increase internal temperature gradients and easily cause irreversible damage. Similarly, prolonged high-temperature holding above the recommended temperature is not recommended. If the holding temperature is too high or the holding time is too long, the binder phase may coarsen, grains may grow, and structural uniformity may decrease, thereby reducing tensile strength, impact toughness, and fatigue life.

The different heat treatment methods and their functions can be referenced in the



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

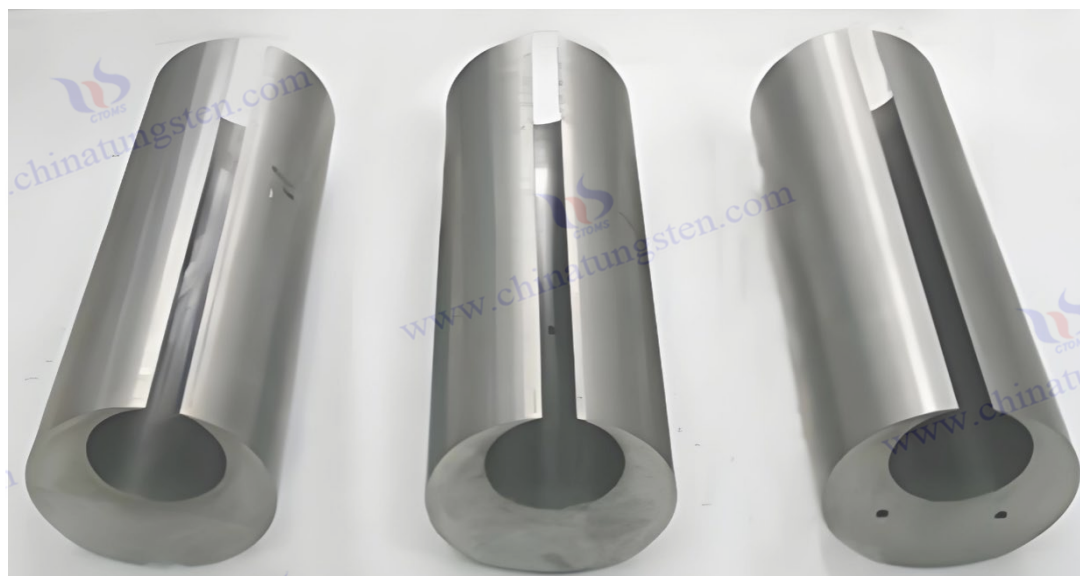
TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

following table.

Heat Treatment Method	Typical Temperature	Main Purpose	Recommendation
Stress-relief annealing	600–800 °C	Eliminate residual machining stress and improve dimensional stability	Recommended
Intermediate annealing	Determined according to the processing method	Restore ductility and facilitate continued processing	Used during manufacturing
Stabilization treatment	Determined according to product requirements	Improve long-term dimensional stability	Used for high-end products
High-temperature prolonged holding	Above the recommended temperature	May cause microstructural degradation	Not recommended
Quenching	Rapid cooling	No strengthening effect and may cause cracking	Strictly prohibited

For end users, most standard tungsten alloy rods can be directly machined and put into service without additional heat treatment. Vacuum stress-relief annealing is recommended only when the material has undergone extensive cutting, EDM, laser processing, or when extremely high dimensional stability is required. In summary, the core concept of heat treatment for tungsten alloys is not strengthening, but structural stabilization and stress control. Proper heat treatment can improve dimensional stability, reduce residual stress, and extend service life. Improper high-temperature treatment or the incorrect application of steel heat-treatment practices may cause irreversible damage to material properties. Therefore, in practical applications, an appropriate heat-treatment plan should be developed according to the material grade, processing condition, and final application rather than simply applying experience derived from conventional steel.





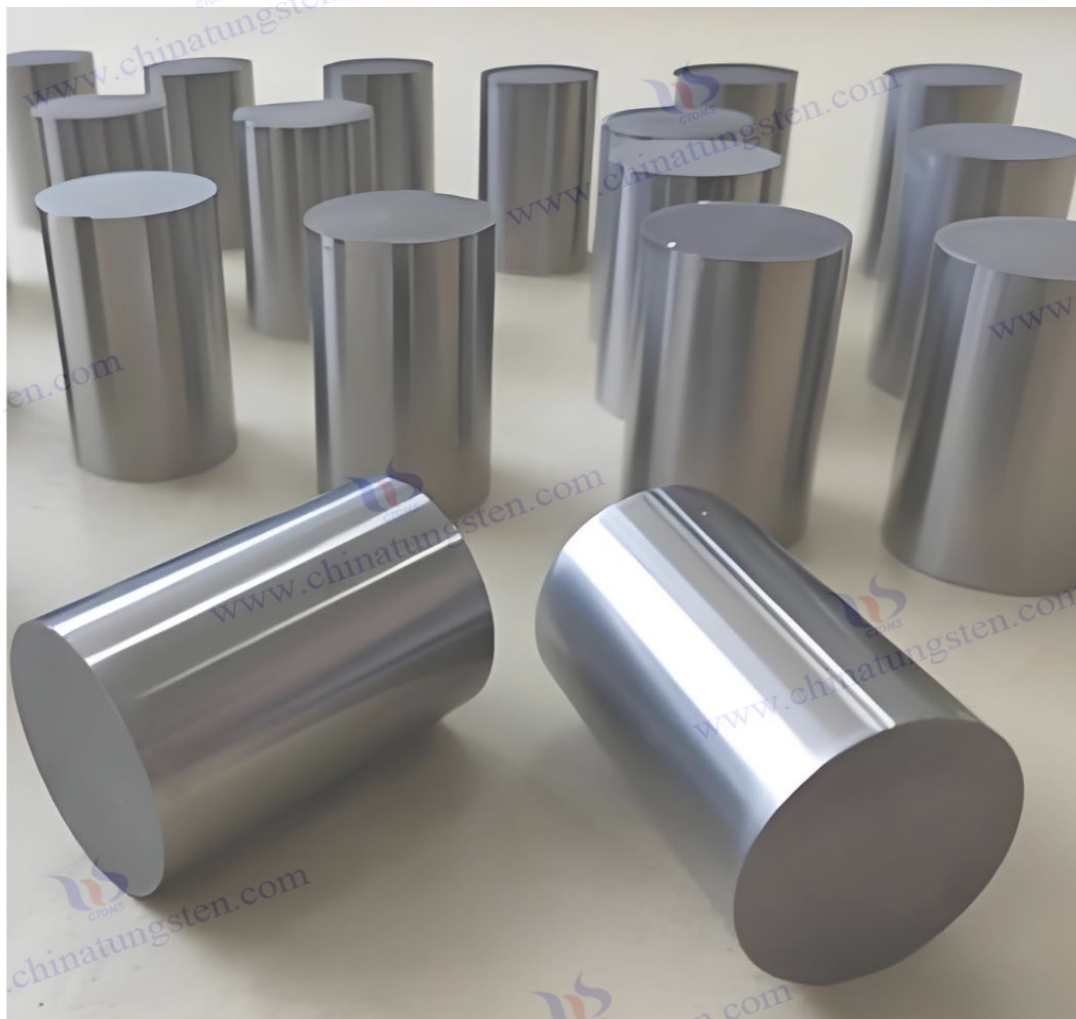
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



IV. Product Standards for Tungsten Alloy Rods

Q21: What International Standards Apply to Tungsten Alloy Rods?

Tungsten alloy rods are widely used in aerospace, semiconductor manufacturing, electronics, medical equipment, welding, electrical vacuum devices, military applications, and the nuclear industry. Since different applications have significantly different requirements for material purity, chemical composition, dimensional tolerances, mechanical properties, high-temperature performance, and inspection methods, several international standards systems have been established, including ISO International Standards, ASTM standards issued by ASTM International, AWS standards issued by the American Welding Society, JIS Japanese Industrial Standards, as well as DIN and EN European standards. For exported products, manufacturers generally need to comply with the applicable standards required by the customer's country or industry, and in some cases, products may need to satisfy two or more standards simultaneously.

ISO standards mainly focus on general technical requirements and consistency in international trade. Among them, ISO 24370 specifies general technical requirements for tungsten rods and tungsten products, including dimensional tolerances, surface quality, chemical composition, inspection methods, packaging, transportation, and other requirements. It provides a unified basis for product recognition among different countries.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

For general industrial tungsten rods used in international trade, ISO standards have significant reference value.

AWS standards primarily serve the welding industry. For example, AWS A5.12, Specification for Tungsten and Tungsten-Alloy Electrodes for Arc Welding and Cutting, is one of the most widely used tungsten electrode standards worldwide. It establishes uniform requirements for the color identification, chemical composition, performance requirements, and applicable welding processes of pure tungsten, thoriated tungsten, lanthanated tungsten, ceriated tungsten, zirconiated tungsten, yttriated tungsten, and composite rare-earth tungsten electrodes. For doped tungsten rods used in TIG welding and plasma arc welding, AWS standards generally place greater emphasis than general industrial standards on arc-starting performance, current-carrying capacity, and electrode service life.

ASTM standards place greater emphasis on material properties and engineering applications. Among them, ASTM B777 is an important international standard for heavy tungsten alloys, mainly covering high-density tungsten alloys such as tungsten-nickel-iron and tungsten-nickel-copper alloys. These materials are widely used in aerospace counterweights, medical shielding, inertial components, and other applications. Although this standard is primarily intended for heavy tungsten alloys, its inspection methods, dimensional control, and performance evaluation requirements are also frequently used as important references for related tungsten alloy products. In addition, the ASTM system includes other standards covering pure tungsten, tungsten wire, and powder-metallurgy tungsten products.

Japanese JIS standards generally impose relatively stringent requirements on dimensional accuracy and processing quality. For example, JIS Z 3211 mainly concerns tungsten electrodes for welding and specifies relatively strict requirements for product dimensions, tolerances, surface quality, and welding performance. Japanese manufacturers of semiconductor equipment, precision electronics, and automated equipment generally give priority to JIS standards. Therefore, tungsten rod products exported to the Japanese market require particular attention to dimensional consistency and surface appearance.

In addition to the standards mentioned above, European DIN and EN standards, as well as internal standards established by certain aerospace companies, are also widely used. For example, when purchasing tungsten rods, European manufacturers of high-end vacuum equipment and research institutions often add stricter internal technical specifications on the basis of ISO standards, including requirements for grain size, microstructure, impurity element content, ultrasonic inspection, and other parameters. The main focus of different standards can be summarized as follows:

Standard	Application	Main Characteristics
ISO 24370	Tungsten rods and tungsten products	General international technical requirements; suitable for international trade
AWS A5.12	Tungsten electrodes for welding	Focuses on doped tungsten rods, arc performance, and color identification
ASTM B777	Heavy tungsten alloys	Emphasizes density, mechanical properties, and engineering applications
JIS Z 3211	Tungsten rods for welding in Japan	Strict dimensional tolerances and high processing-quality requirements
DIN / EN	European industrial markets	Emphasizes manufacturing quality, inspection, and traceability

With the development of semiconductor, nuclear fusion, aerospace, and other industries, international standards are continuously being updated, with increasing emphasis on material purity, microstructural uniformity, batch-to-batch consistency, and environmental requirements. For example, non-radioactive rare-earth tungsten electrodes are gradually replacing traditional thoriated tungsten electrodes, while the control of impurity elements



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

such as oxygen, carbon, and nitrogen in high-purity tungsten rods is becoming increasingly stringent. Therefore, when purchasing or exporting tungsten alloy rods, it is necessary to determine the applicable standard not only by referring to the standard number, but also by considering the final application, the customer's technical agreement, and the required inspection specifications.

Q22: What National Standards Apply to Tungsten Rods in China?

China is the world's largest holder of tungsten resources and the world's largest producer of tungsten products. It has established a relatively comprehensive standards system for tungsten materials, including national standards (GB), non-ferrous metal industry standards (YS), machinery industry standards (JB), and enterprise standards. These standards cover pure tungsten, high-purity tungsten, doped tungsten, tungsten alloys, and related processed products, providing unified requirements for the design, production, inspection, and application of tungsten rods.

At present, pure tungsten rods and high-purity tungsten rods mainly comply with GB/T 4187-2017, Tungsten and Molybdenum Bars and Rods. This standard specifies the classification, dimensions, tolerances, chemical composition, surface quality, inspection methods, packaging, marking, and transportation requirements for pure tungsten and tungsten rod products. It applies to applications in electronics, electrical vacuum devices, lighting, semiconductors, thermal fields, high-temperature industries, and other fields. For high-purity tungsten rods, the contents of impurities such as oxygen, carbon, iron, and nickel are further restricted to ensure excellent high-temperature performance and machinability.

GB/T 3459-2017, Tungsten and Tungsten Alloy Products, is another important national standard with a relatively broad scope. It provides unified specifications for various tungsten and tungsten alloy products, including pure tungsten products, tungsten alloy rods, plates, and products for special applications. Although its scope is not limited to tungsten rods, it provides important guidance for tungsten alloy products used in aerospace counterweights, military armor-piercing materials, high-temperature structural components, and other applications.

For welding materials, China mainly adopts the YS/T 695 series of standards for Tungsten Electrodes. These standards specify the chemical composition, dimensional specifications, color identification, performance requirements, and inspection methods for pure tungsten, thoriated tungsten, lanthanated tungsten, ceriated tungsten, zirconiated tungsten, yttriated tungsten, and other rare-earth composite tungsten electrodes. They are broadly consistent with AWS A5.12 while incorporating certain requirements based on domestic manufacturing practices. At present, most domestically manufactured tungsten electrodes for TIG welding are produced according to these standards.

In addition, numerous YS industry standards are available for powder-metallurgy raw materials, high-purity tungsten powder, tungsten carbide powder, and sintered materials. These standards specify requirements for raw material particle size, powder purity, sintered density, microstructural uniformity, and other parameters. Although these standards are not directly intended for tungsten rods, they have an important influence on the quality of the final products.

The Chinese standards system related to tungsten rods can be summarized as follows:



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Standard No.	Standard Title	Main Applicable Products
GB/T 4187-2017	Tungsten and Molybdenum Bars and Rods	Pure tungsten rods and high-purity tungsten rods
GB/T 3459-2017	Tungsten and Tungsten Alloy Products	Tungsten and tungsten alloy rods, structural components, etc.
YS/T 695	Tungsten Electrodes	Pure tungsten and various doped tungsten electrodes
Relevant standards	YS Tungsten powders and processed tungsten materials	Powder-metallurgy raw materials and supporting products

In recent years, with the development of semiconductors, photovoltaics, new energy, and high-end equipment manufacturing, Chinese standards have also continued to evolve. The main directions include: improving purity-control requirements for high-purity tungsten and high-performance tungsten alloys; adding evaluation items such as microstructure, grain size, and non-destructive testing; strengthening product consistency and traceability management; and gradually aligning domestic standards with international standards such as ISO and ASTM to facilitate product exports and international certification.

China's tungsten rod standards system now covers the complete industrial chain from raw materials, powder metallurgy, processing and manufacturing to final product inspection. For general industrial applications, products can generally be manufactured according to applicable national standards. For high-end applications such as semiconductors, aerospace, medical equipment, and the nuclear industry, however, additional enterprise technical agreements or customer-specific specifications are typically required on the basis of national standards to meet higher levels of performance and quality requirements.

Q23: How Strict Are the Dimensional Tolerances for Tungsten Alloy Rods?

Tungsten alloy rods are widely used in aerospace, semiconductor equipment, medical devices, electronic vacuum components, defense, and precision machinery. Their dimensional accuracy directly affects subsequent machining efficiency, assembly precision, and the final performance of the finished product. Therefore, dimensional tolerance is not only an important indicator of product quality but also a key measure of a manufacturer's machining capability and quality control system. In general, the dimensional tolerance of tungsten alloy rods is determined by factors such as rod diameter, manufacturing process, delivery condition, and customer requirements, with significant differences among various precision grades.

For general industrial applications, standard-grade tungsten alloy rods typically have a diameter tolerance of approximately ± 0.10 mm. These products are generally manufactured through powder metallurgy, sintering, forging, rotary swaging, and turning. They are suitable for common mechanical components, electrode materials, counterweights, and structural parts while offering relatively low manufacturing costs and short delivery times.

For industries such as precision machinery, electronics, and mold manufacturing, much tighter dimensional tolerances are usually required. Precision-grade tungsten alloy rods commonly achieve diameter tolerances of approximately ± 0.05 mm. Manufacturing these products requires high-precision CNC turning equipment, combined with online inspection, straightening, and precision finishing processes to ensure consistent dimensions throughout the entire rod.

When centerless grinding or precision centerless grinding is used to produce ground tungsten rods, dimensional accuracy can be improved even further. Ground tungsten rods with diameters ranging from approximately 1.0 mm to 50 mm typically achieve diameter tolerances between ± 0.03 mm and ± 0.10 mm. Smaller-diameter rods generally achieve



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

tighter tolerances, while larger diameters allow proportionally wider tolerance ranges.

For fine-diameter tungsten rods widely used in the electronics and semiconductor industries, such as rods with diameters between 0.5 mm and 3.0 mm, continuous drawing, precision straightening, and centerless grinding can consistently achieve diameter tolerances within ± 0.03 mm. In addition to dimensional accuracy, these products also require excellent straightness and roundness to satisfy the requirements of automatic feeding systems, high-speed machining, and precision assembly.

Dimensional tolerance for tungsten alloy rods extends beyond diameter control. It also includes geometric tolerances such as roundness, straightness, concentricity, and length tolerance. For example, straightness is often more critical than diameter tolerance for automatic lathe materials, while roundness and concentricity directly influence rotational accuracy and bearing fit in high-precision shaft components.

The dimensional tolerance achievable for tungsten alloy rods is influenced by numerous factors, including powder metallurgy quality, forging uniformity, heat treatment, machining equipment accuracy, and inspection capability. More uniform powder microstructures and higher sintering density result in more stable deformation during machining, making tighter dimensional consistency easier to achieve. High-precision CNC lathes, centerless grinding machines, and online laser diameter measurement systems also play essential roles in maintaining dimensional tolerances. The table below summarizes the typical dimensional tolerance ranges for tungsten alloy rods in different delivery conditions.

Product Type	Typical Diameter Range	Typical Diameter Tolerance	Primary Manufacturing Process
Standard tungsten alloy rod	$\Phi 3-100$ mm	± 0.10 mm	Turning, forging
Precision tungsten alloy rod	$\Phi 2-80$ mm	± 0.05 mm	Precision turning, finishing
Ground tungsten rod	$\Phi 1.0-50$ mm	± 0.03 to ± 0.10 mm	Centerless grinding
Straightened tungsten rod	$\Phi 0.5-3.0$ mm	± 0.03 mm	Drawing, straightening, grinding

In addition to standard tolerances, many high-end applications impose even stricter requirements. High-purity tungsten rods used in semiconductor equipment may require diameter tolerances as tight as ± 0.01 mm to ± 0.02 mm, together with stringent surface roughness specifications. Aerospace and medical radiation shielding components often place greater emphasis on length consistency and overall dimensional stability. Many manufacturers are also capable of producing customized tungsten alloy rods with tighter tolerance grades to satisfy the specialized requirements of precision instruments and automated equipment.

CTIA GROUP believes that, with the continuous advancement of high-end manufacturing, dimensional control of tungsten alloy rods has evolved from merely satisfying standard tolerances to comprehensive control of dimensional accuracy, geometric precision, consistency, and long-term stability. Modern manufacturers rely not only on high-precision machining equipment but also on online measurement systems, Statistical Process Control (SPC), and complete quality traceability throughout the manufacturing process to achieve exceptional batch-to-batch consistency, providing highly reliable base materials for the semiconductor, aerospace, medical, and advanced equipment industries.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Q23A: What Are the Main Factors Affecting the Dimensional Tolerance of Tungsten Alloy Rods?

The dimensional tolerance of tungsten alloy rods depends not only on the accuracy of the final machining equipment but also on multiple factors throughout the entire manufacturing process, including raw material quality, powder metallurgy processing, hot working, machining operations, and inspection capability. For high-precision tungsten alloy rods, every production step influences the final dimensional stability. As a result, modern manufacturing emphasizes comprehensive process control rather than relying solely on final finishing operations.

First, powder quality forms the foundation of dimensional accuracy. The particle size distribution, purity, and oxygen content of tungsten powder all affect the density and microstructural uniformity of the sintered material. Uneven powder particle distribution may cause localized differences in sintering shrinkage, resulting in inconsistent deformation during subsequent forging and machining, thereby increasing the difficulty of tolerance control.

Second, sintering quality directly determines the internal microstructure of the material. Sintering temperature, holding time, and protective atmosphere all influence density and grain structure. The more uniform the sintered density, the more stable the material flow during subsequent hot working, resulting in better dimensional consistency after machining. For high-end products, Hot Isostatic Pressing (HIP) is often employed to eliminate internal porosity and further improve microstructural uniformity.

Hot working is equally important. Processes such as forging, rotary swaging, and rolling determine not only the mechanical properties but also dimensional uniformity. Insufficient deformation may leave the internal structure uneven, while excessive deformation may increase residual stress and cause dimensional changes during subsequent machining. Therefore, deformation schedules and intermediate annealing processes must be carefully optimized. Machining equipment accuracy is another key factor affecting final tolerances. Conventional lathes are generally adequate for standard tolerance requirements, whereas high-precision CNC lathes, centerless grinders, and precision grinding equipment are required to achieve tighter dimensional control. Tool wear also has a direct impact on machining accuracy. Consequently, manufacturers typically implement comprehensive tool life management systems, including regular compensation and scheduled tool replacement.

Temperature control is another important factor that is often overlooked. Although tungsten has a relatively low coefficient of thermal expansion, temperature stability remains critical when manufacturing and inspecting high-precision products. Precision dimensional measurements are generally conducted in temperature-controlled rooms maintained at $20 \pm 1^\circ\text{C}$ to eliminate measurement errors caused by thermal expansion.

Inspection equipment and measurement methods also determine the tolerance level a manufacturer can consistently achieve. Modern manufacturers commonly employ laser diameter measurement systems, Coordinate Measuring Machines (CMMs), roundness measuring instruments, and automated online inspection systems to monitor dimensions continuously. Statistical Process Control (SPC) techniques are then used to adjust machining parameters in real time, ensuring excellent consistency across production batches. The primary factors influencing the dimensional tolerance of tungsten alloy rods



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

are summarized below.

Influencing Factor	Primary Effect	Typical Control Method
Tungsten powder quality	Uniformity of sintering shrinkage	High-purity powder with uniform particle size
Sintering process	Density and microstructural uniformity	Optimized sintering schedule, HIP treatment
Hot working process	Dimensional stability	Optimized forging and intermediate annealing
Machining equipment	Final dimensional accuracy	High-precision CNC machining and centerless grinding
Tool condition	Dimensional consistency	Regular tool compensation and replacement
Ambient temperature	Measurement accuracy	Temperature-controlled machining and inspection
Inspection capability	Tolerance control	Online inspection and SPC

Different industries also prioritize different aspects of dimensional tolerance. Automated manufacturing equipment places greater emphasis on rod straightness and length consistency. The semiconductor industry focuses more on dimensional consistency and surface quality, while the aerospace industry requires both dimensional stability and microstructural uniformity. Consequently, manufacturers often develop customized production and inspection plans according to the intended application.

CTIA GROUP believes that dimensional tolerance control for tungsten alloy rods reflects the comprehensive capability of material preparation, manufacturing processes, production equipment, and quality inspection. With the rapid development of digital manufacturing, intelligent inspection systems, and real-time process monitoring, tungsten alloy rod production has evolved from traditional end-of-line inspection to comprehensive process-wide dimensional control. This enables manufacturers to achieve higher precision, superior consistency, and greater reliability, providing premium tungsten alloy materials for precision manufacturing and advanced engineering applications.





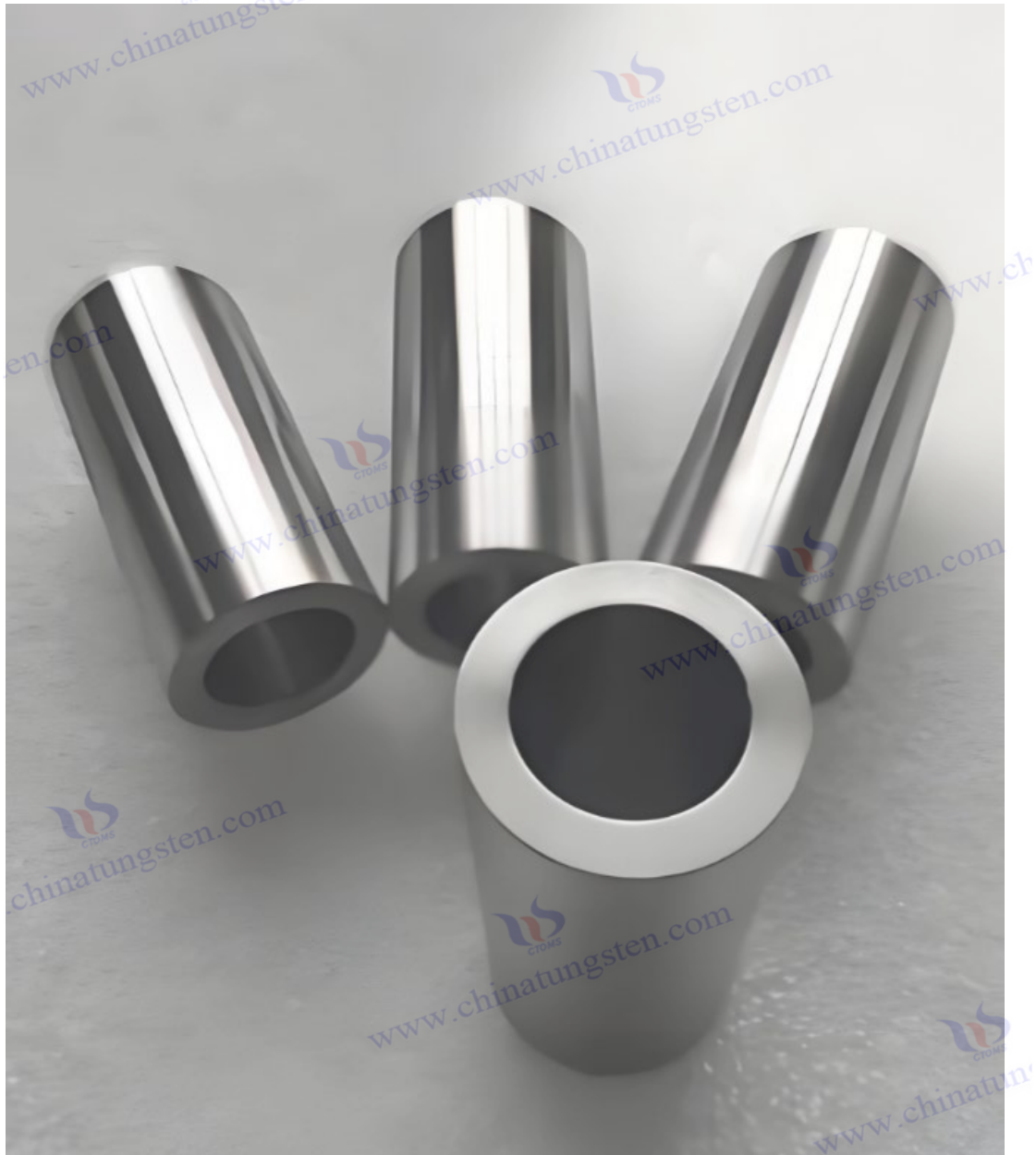
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



Part V Inspection Methods for Tungsten Alloy Rods

Q24: How Is the Density of Tungsten Alloy Rods Measured?

Density is one of the most important indicators for evaluating the quality of tungsten alloy rods. It is also a key parameter for determining whether the material has achieved its designed densification, whether the sintering process has been properly completed, and whether internal defects such as porosity, inclusions, or insufficient densification are present.

For high-density tungsten alloys such as W-Ni-Fe and W-Ni-Cu, the theoretical density generally ranges from approximately 17.0 to 18.8 g/cm³, depending on the tungsten content and the proportion of the binder phase. During manufacturing, density testing is used not only for final product acceptance but also throughout sintering, heat treatment, machining,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

and other production stages, making it an essential component of the quality control system.

The most widely used industrial method is the Archimedes Method, which is based on Archimedes' principle of buoyancy. According to this principle, the buoyant force acting on an object immersed in a liquid equals the weight of the displaced liquid. During testing, the specimen is first weighed in air using an analytical balance with an accuracy of at least ± 0.001 g. It is then weighed while completely immersed in deionized water or another specified liquid of known density.

The difference between the two measurements is used to calculate the specimen volume, from which the material density is determined. According to standards such as GB/T 1423, ASTM B962, and ISO 2738, specimens are typically cleaned and degreased before testing, while vacuum immersion or ultrasonic treatment is employed to eliminate surface air bubbles and improve measurement accuracy. For aerospace, defense, and medical tungsten alloy products requiring high density consistency, the measurement error of the Archimedes method can generally be controlled within ± 0.02 g/cm³.

For regularly shaped rods, the dimensional-mass method may also be used as a supplementary verification technique. In this approach, the rod diameter and length are measured using a micrometer, the geometric volume is calculated, and the density is obtained by combining the measured mass with the calculated volume. This method is simple and efficient and is suitable for rods with regular geometry and high dimensional accuracy. However, because its accuracy is affected by diameter tolerances, roundness deviations, and end-face flatness, it is generally less accurate than the Archimedes method and is therefore primarily used for rapid production-floor inspection.

With the advancement of nondestructive testing technologies, X-ray density meters, Industrial Computed Tomography (Industrial CT), and Digital Radiography (DR) have gradually been introduced for inspecting high-end tungsten alloy products. X-ray density meters estimate local density by measuring the attenuation of X-rays within the material, providing rapid, non-contact inspection.

Industrial CT not only evaluates overall density distribution but also detects internal porosity, cracks, inclusions, and sintering defects, making it particularly suitable for high-value components with complex geometries. However, due to their high equipment cost, these technologies are typically employed by research institutes and advanced manufacturing enterprises.

For powder metallurgy tungsten alloys, density evaluation is often combined with metallographic analysis. When the measured density is significantly lower than the design value, metallographic examination typically reveals unsintered pores, interconnected porosity, or localized porous regions. When the material approaches its theoretical density, the microstructure generally exhibits uniformly distributed tungsten particles, a continuous binder phase, and minimal porosity, ensuring excellent mechanical properties and fatigue resistance.

Since each inspection method has its own advantages and limitations, the appropriate technique should be selected according to product type and inspection objective.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Inspection Method	Principle	Advantages	Typical Applications
Archimedes Method	Volume determination by buoyancy	High accuracy, widely accepted	Final inspection, laboratory testing
Dimensional-Mass Method	Density calculated from geometric volume	Simple and efficient	Rapid inspection of regular rods
X-ray Density Meter	Density estimated from X-ray attenuation	Non-contact, high speed	Online inspection, batch screening
Industrial CT	Three-dimensional tomographic scanning	Detects internal defects and density distribution	High-end components, research analysis

CTIA GROUP believes that density is not merely a physical property but also a direct reflection of sintering quality, microstructural integrity, and overall material performance. For high-performance tungsten alloy rods, satisfying the average density specification alone is far from sufficient; density uniformity and internal compactness are equally important. As Industrial CT, digital radiography, and intelligent online inspection technologies continue to evolve, density evaluation of tungsten alloys is expected to transition from conventional sampling inspection toward full-size, full-life-cycle nondestructive inspection, providing more reliable quality assurance for advanced equipment manufacturing.

Q25: How Is the Hardness of Tungsten Alloy Rods Tested?

Hardness is an important mechanical property used to evaluate the wear resistance, resistance to plastic deformation, and microstructural condition of tungsten alloy rods. It is also one of the most frequently measured parameters during production quality control and material acceptance. Because tungsten alloys contain a high proportion of tungsten and possess excellent high-temperature properties, their hardness is generally much higher than that of ordinary structural steels. However, hardness is also influenced by numerous factors, including tungsten content, binder-phase composition, sintering conditions, heat treatment, and subsequent plastic deformation. Consequently, selecting an appropriate hardness testing method is essential for accurately evaluating material performance.

The most widely adopted method is the Vickers Hardness (HV) test. This method employs a diamond pyramid indenter that is pressed into the material surface under a specified load, after which the hardness value is calculated from the diagonal length of the indentation. For tungsten alloy rods, commonly used loads are 10 to 50 kgf (HV10, HV30, and HV50), providing stable measurements while preventing excessively large indentations. Vickers testing is suitable for small-diameter rods, thin-walled products, and microstructural studies. Its advantages include high accuracy, broad applicability, and good comparability across different loads, making it the preferred hardness testing method in many international standards.

For larger-diameter rods and thicker cross-sections, the Brinell Hardness (HBW) test may be employed. This method uses a cemented carbide ball indenter under loads ranging from 500 to 3000 kgf, with hardness determined from the diameter of the resulting indentation. Because the indentation area is relatively large, Brinell testing better represents the average hardness of the material and is especially suitable for large rods and forgings with relatively uniform microstructures. However, due to the deep indentation produced, this method is generally unsuitable for small specimens or products with thin sections.

For finished products or components that have undergone precision machining, the Rockwell Hardness (HRA, HRB, or HRC) test is sometimes used for rapid inspection. Since Rockwell testing does not require optical measurement of indentation size, it offers high



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

testing efficiency and is well suited for shop-floor quality control. Nevertheless, for high-density tungsten alloys, Vickers hardness remains the primary evaluation method internationally, while Rockwell hardness is mainly used for rapid process comparison.

Before hardness testing, the specimen surface should be flat and free from oxide scale, oil contamination, and obvious machining marks. Grinding or polishing is typically performed to achieve the required surface finish and eliminate surface defects that could affect indentation measurements. In addition, sufficient spacing should be maintained between adjacent indentations and between indentations and specimen edges to prevent interaction between stress fields and ensure representative results.

In addition to conventional macrohardness testing, Micro Vickers Hardness testing is frequently used during material development. This technique measures the local hardness of individual tungsten particles and the surrounding binder phase, enabling detailed evaluation of sintering quality, microstructural uniformity, and strengthening effects. Such information is particularly valuable for optimizing powder metallurgy processes and investigating material failure mechanisms. Different hardness testing methods are suitable for different product sizes and inspection objectives.

Hardness Test Method	Indenter Type	Typical Load	Suitable Applications	Main Features
Vickers Hardness (HV)	Diamond pyramid	10–50 kgf	Small-diameter rods, precision products	High accuracy, broad applicability
Brinell Hardness (HBW)	Cemented carbide ball	500–3000 kgf	Large rods, forgings	Represents average bulk hardness
Rockwell Hardness (HRA/HRC)	Diamond cone or steel ball	Standard loads	Rapid shop-floor inspection	Fast and efficient
Micro Vickers Hardness	Diamond pyramid	10 g–1 kgf	Microstructural analysis	Measures local microstructural hardness

CTIA GROUP believes that hardness reflects not only a material's resistance to indentation but also indirectly indicates sintering quality, microstructural condition, and heat treatment effectiveness. In practical production, the appropriate testing method should be selected according to product dimensions, inspection objectives, and applicable standards.

Furthermore, hardness results should be evaluated together with density, tensile strength, metallographic examination, and other inspection data. For high-end tungsten alloy rods, a single hardness value alone cannot comprehensively represent material performance; only a multi-parameter evaluation can reliably ensure product quality and long-term service performance.

Q26: How Are Internal Defects in Tungsten Alloy Rods Detected?

Tungsten alloy rods are widely used in aerospace, defense, medical radiation shielding, nuclear engineering, electronic packaging, and high-end tooling. Their internal quality directly affects mechanical properties, machinability, dimensional stability, and service reliability. Because tungsten alloys possess high density and a high elastic modulus, improper control during sintering, hot working, or subsequent machining may result in internal defects such as pores, shrinkage cavities, inclusions, cracks, delamination, and microstructural inhomogeneity. Therefore, before delivery, comprehensive quality evaluation is typically performed using a combination of non-destructive testing (NDT) methods and metallographic analysis. Common industrial inspection techniques include ultrasonic testing, X-ray radiography, industrial computed tomography (CT), magnetic particle testing (for certain magnetic tungsten alloys), and metallographic examination, each offering distinct advantages for specific types of defects.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(1) Ultrasonic Testing (UT)

Ultrasonic testing is one of the most widely used methods for detecting internal defects in tungsten alloy rods. During inspection, a transducer emits high-frequency ultrasonic waves into the material. When these sound waves encounter discontinuities such as cracks, pores, inclusions, or delamination, reflected echoes are generated. By analyzing the position, amplitude, and travel time of these echoes, inspectors can determine the location and approximate size of internal defects.

Because tungsten alloys have relatively high acoustic impedance, industrial inspections generally employ probes with frequencies between 5 and 10 MHz. For larger-diameter rods, lower-frequency probes in the range of 2 to 5 MHz may be selected to improve penetration depth by reducing signal attenuation. Ultrasonic testing offers fast inspection speed, relatively low cost, and excellent suitability for production-line inspection. It is particularly sensitive to internal cracks, shrinkage cavities, and incompletely sintered regions, making it one of the primary acceptance methods for tungsten alloy rod production.

(2) Industrial X-ray Radiographic Testing (RT)

For defects that are difficult to characterize using ultrasonic testing, industrial X-ray radiography is commonly employed. X-ray systems operating at approximately 100–300 kV are used to penetrate the rod. Since different internal regions absorb X-rays differently according to their density, variations appear as grayscale contrasts on digital radiographic images, allowing inspectors to identify internal pores, inclusions, shrinkage porosity, and localized structural abnormalities.

For thick cross-sections or very high-density tungsten alloys, higher-energy industrial CT systems or gamma-ray sources may be used to achieve greater penetration. Compared with ultrasonic testing, radiography provides a direct visual representation of defect morphology and is particularly effective for detecting volumetric defects. However, its sensitivity to extremely fine cracks is generally lower than that of ultrasonic inspection.

(3) Industrial Computed Tomography (Industrial CT)

Industrial CT has become increasingly important for inspecting high-end tungsten alloy products. Unlike conventional radiography, CT reconstructs the complete three-dimensional internal structure of a component. Besides identifying pores and cracks, it accurately measures defect size, volume, morphology, and spatial distribution.

For aerospace, premium medical devices, precision electronics, and other applications requiring exceptional reliability, industrial CT has become an indispensable quality assurance tool. Although its inspection cost is relatively high, it offers outstanding advantages for complex components, high-value parts, prototype evaluation, and failure investigations.

(4) Magnetic Particle Testing (MT)

Magnetic particle testing is applicable primarily to W-Ni-Fe heavy tungsten alloys that exhibit a certain degree of ferromagnetism. It is generally unsuitable for pure tungsten, TZM alloys, and most molybdenum-based alloys.

During inspection, the workpiece is magnetized and magnetic particles are applied to the surface. Surface-breaking or near-surface cracks disturb the magnetic field, causing the



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

particles to accumulate at defect locations and form visible indications. MT offers high sensitivity and simple operation but is limited to surface and near-surface defects. It cannot detect deep internal discontinuities and is therefore generally used as a supplementary inspection method.

(5) Metallographic Analysis

For tungsten alloy rods requiring stringent quality control, metallographic examination is also performed. Samples are sectioned, mounted, ground, polished, and chemically etched before observation using optical microscopes or scanning electron microscopes (SEM). Metallographic analysis can evaluate: Grain size and grain uniformity, Binder phase distribution, Porosity, Sintering quality, Distribution of second-phase particles, Crack propagation characteristics. Besides verifying whether the sintering process has been properly controlled, metallographic analysis also provides valuable information for failure analysis and process optimization.

(6) Defect Classification and Acceptance Evaluation

In industrial production, inspection involves more than simply determining whether defects are present. Defects must also be evaluated according to applicable product specifications and acceptance standards. Typical evaluation criteria include: Defect size, Number of defects,

Defect distribution density, Orientation relative to principal loading direction, Potential influence on service performance, Products intended for aerospace, medical, and nuclear applications generally follow much stricter acceptance criteria, with clearly defined limits on both defect size and allowable defect quantity.

Comparison of Common Internal Defect Inspection Methods for Tungsten Alloy Rods

Inspection Method	Detectable Defects	Advantages	Limitations
Ultrasonic Testing (UT)	Cracks, pores, delamination, shrinkage cavities	Fast, economical, suitable for mass production	Limited capability for complex geometries and very small volumetric defects
X-ray Radiography (RT)	Pores, inclusions, shrinkage porosity	Direct visualization, excellent for volumetric defects	Lower sensitivity to very fine cracks
Industrial CT	Three-dimensional pores, cracks, inclusions	Quantitative 3D evaluation with high accuracy	Higher inspection cost and lower throughput
Magnetic Particle Testing (MT)	Surface cracks	High sensitivity and easy operation	Applicable only to magnetic tungsten alloys
Metallographic Analysis	Grain structure, microstructure, microcracks	Reveals microstructural evolution and failure mechanisms	Destructive testing method

Based on decades of manufacturing experience, CTIA GROUP believes that quality inspection of modern tungsten alloy rods has evolved from relying on a single non-destructive testing method to adopting comprehensive multi-technology inspection systems. For conventional industrial products, ultrasonic testing combined with dimensional inspection is generally sufficient. However, aerospace, medical, nuclear, and advanced electronic applications typically require a combination of ultrasonic testing, X-ray radiography, industrial CT, and metallographic analysis to achieve comprehensive quality evaluation. Looking ahead, advances in artificial intelligence-assisted image recognition, digital non-destructive inspection, and online inspection technologies will continue driving internal defect detection toward higher sensitivity, greater automation, and improved reliability.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Q27: How Is the Chemical Composition of Tungsten Alloy Rods Analyzed?

Chemical composition is one of the most fundamental parameters determining the performance of tungsten alloy rods. Whether the material is pure tungsten, heavy tungsten alloy, TZM titanium-zirconium-molybdenum alloy, or another tungsten-based high-temperature alloy, its density, strength, thermal conductivity, high-temperature properties, and corrosion resistance are all closely related to its chemical composition. Consequently, chemical analysis is an indispensable part of raw material acceptance, process control, and final quality inspection.

Depending on the analytical objectives, modern industry employs a variety of techniques, including X-ray fluorescence spectroscopy (XRF), inductively coupled plasma optical emission spectroscopy (ICP-AES), inductively coupled plasma mass spectrometry (ICP-MS), glow discharge mass spectrometry (GD-MS), inert gas fusion analysis, and carbon-sulfur analyzers.

(1) X-ray Fluorescence Spectroscopy (XRF)

XRF is one of the most widely used rapid analytical methods in tungsten alloy production. When irradiated by X-rays, each element emits characteristic fluorescent X-rays. By analyzing the energy and intensity of these characteristic peaks, the major elemental composition can be rapidly determined.

Its major advantages include fast analysis, minimal sample preparation, and non-destructive testing. XRF is especially suitable for: Incoming material screening, Alloy grade identification,

Production process monitoring, Finished product sampling inspection. However, its capability for detecting trace impurities at ppm levels is relatively limited.

(2) ICP Optical Emission Spectroscopy (ICP-AES)

ICP-AES uses high-temperature plasma to excite atoms, which then emit characteristic optical spectra for quantitative elemental analysis. For tungsten alloys, ICP-AES accurately determines alloying and impurity elements such as: Ni, Fe, Cu, Co, Ti, Zr, Cr, Mn, V, Al. Typical analytical precision reaches the ppm level, making it highly suitable for routine quality control.

(3) ICP Mass Spectrometry (ICP-MS)

ICP-MS combines inductively coupled plasma with mass spectrometry. Compared with ICP-AES, it offers much higher analytical sensitivity, reaching ppb levels or even lower. Consequently, ICP-MS is particularly suitable for: High-purity tungsten, Semiconductor-grade tungsten materials, Nuclear-grade materials, Ultra-trace impurity analysis. It can simultaneously quantify dozens of trace elements with excellent sensitivity.

(4) Glow Discharge Mass Spectrometry (GD-MS)

GD-MS is internationally recognized as one of the most effective techniques for impurity analysis in high-purity tungsten materials. Its major characteristics include: Direct analysis of solid samples, No complicated sample dissolution, Broad elemental coverage, Detection limits reaching ppm levels or lower. GD-MS has therefore become one of the primary analytical techniques for semiconductor materials, high-purity sputtering targets, and electronic-grade tungsten products.

(5) Inert Gas Fusion Analysis



Oxygen, nitrogen, and carbon are critical interstitial elements that significantly influence tungsten material performance. In this method, the sample is melted in a graphite crucible under an inert gas atmosphere, releasing dissolved gases. The evolved gases are then measured using infrared or thermal conductivity detectors. The technique is primarily used to determine: Oxygen (O), Nitrogen (N), Carbon (C). For high-temperature tungsten alloys such as TZM, the concentrations of these interstitial elements directly influence recrystallization behavior, high-temperature strength, and ductility, making strict control essential.

(6) Carbon and Sulfur Analysis

For carbon-strengthened tungsten alloys such as TZM, carbon content directly determines the formation of TiC and ZrC strengthening phases. Insufficient carbon results in inadequate precipitation strengthening, whereas excessive carbon may produce coarse carbides that reduce ductility. Therefore, dedicated carbon-sulfur analyzers are routinely used during production to ensure accurate carbon control.

(7) Evaluation of Analytical Results

Chemical composition analysis involves not only measuring elemental concentrations but also evaluating compliance with applicable material standards and specifications. Typical evaluation includes:

Whether principal elements conform to the specified alloy grade

Whether alloying elements fall within the designed composition range

Whether harmful impurities exceed permissible limits

Whether interstitial element concentrations satisfy technical specifications

For aerospace, semiconductor, and nuclear materials, complete analytical records are generally maintained to ensure full quality traceability throughout production.

Comparison of Common Chemical Composition Analysis Methods for Tungsten Alloy Rods

Analytical Method	Primary Targets	Main Advantages	Typical Applications
XRF	Major and alloying elements	Rapid, non-destructive	Incoming inspection, alloy grade identification
ICP-AES	Conventional alloying elements	Multi-element analysis with ppm-level accuracy	Routine quality control
ICP-MS	Trace impurities	Extremely high sensitivity down to ppb levels	High-purity & electronic-grade tungsten
GD-MS	Ultra-low-level impurities	Direct solid analysis with broad elemental coverage	Semiconductor and ultra-high-purity tungsten
Inert Gas Fusion	O, N, C	Dedicated analysis of interstitial elements	High-temperature tungsten alloy quality control
Carbon-Sulfur Analyzer	C, S	Accurate carbon determination	TZM and other carbon-containing tungsten alloys

According to CTIA's experience, modern chemical composition analysis of tungsten alloys has evolved into a comprehensive multi-technique analytical system. XRF serves as an efficient screening tool, ICP-based techniques provide routine quantitative elemental analysis, GD-MS is indispensable for ultra-high-purity materials, and inert gas fusion remains the essential method for controlling critical interstitial elements such as oxygen, nitrogen, and carbon. As semiconductor manufacturing, fusion energy, and aerospace technologies continue to advance, increasingly stringent requirements for tungsten purity and impurity control will further drive chemical analysis toward higher sensitivity, greater automation, and fully digital quality traceability throughout the entire manufacturing process.



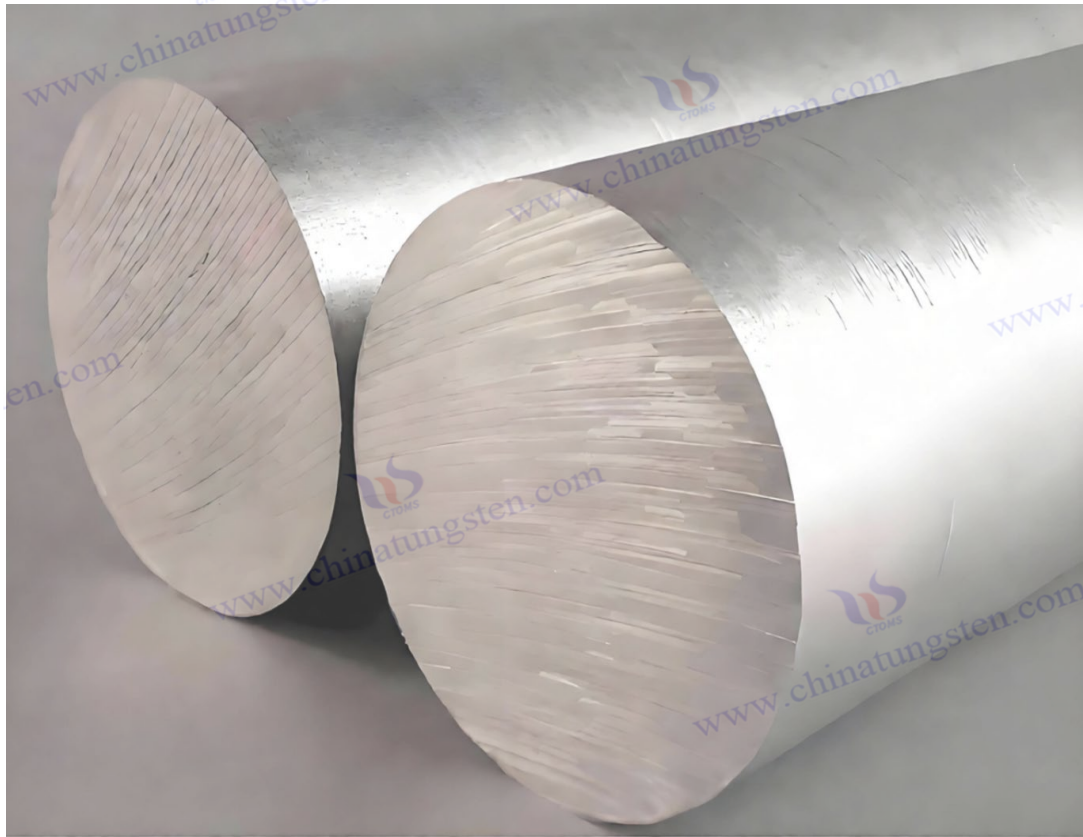
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



Q28: How Is the Grain Size of Tungsten Alloy Rods Measured?

Grain size is one of the most important indicators for evaluating the microstructural quality of tungsten alloy rods. It directly affects material strength, toughness, thermal shock resistance, and high-temperature service stability. Since tungsten alloys are generally manufactured through powder metallurgy, sintering, hot working, and related processes, their final microstructure is determined not only by chemical composition but also by multiple processing parameters, including powder particle size, sintering temperature, holding time, deformation ratio during hot working, and heat treatment schedules. Consequently, grain size evaluation is an essential step in quality control and process optimization for tungsten alloy rod production.

Grain size measurement generally involves specimen sampling, mounting, grinding, polishing, chemical etching, and microscopic examination. Because tungsten and its alloys possess high hardness and excellent chemical stability, specimen preparation is considerably more difficult than for conventional steels. Diamond abrasives are typically used for precision grinding and polishing, while appropriate chemical etchants are applied to reveal grain boundaries. After proper preparation, the grain morphology, grain boundary distribution, and average grain size can be clearly observed under a microscope.

(1) Metallographic Microscopy Is the Most Common Industrial Method

The most widely used technique for measuring the grain size of tungsten alloy rods is optical metallographic microscopy. The principle is to reveal grain boundaries by chemical etching, creating contrast between grains and boundaries. Image analysis software is then used to determine the average grain size.



The typical inspection procedure is shown below:

Inspection Step	Main Procedure	Purpose
Sampling	Cut specimens from transverse or longitudinal sections of the rod	Ensure representative sampling
Mounting	Embed the specimen in resin	Facilitate specimen preparation
Grinding	Sequential grinding with diamond abrasive papers	Remove damaged surface layers
Polishing	Polish with diamond suspension to obtain a mirror finish	Improve image clarity
Etching	Apply chemical etchants to reveal grain boundaries	Expose grain structure
Microscopic Analysis	Measure grain size using optical microscopy	Evaluate microstructural condition

For industrial-grade tungsten alloy rods, typical grain sizes generally range from approximately 10 to 50 μm . With optimized powder metallurgy processes and carefully controlled heat treatment, high-performance tungsten alloys can achieve finer and more uniform grain structures. Finer grains generally increase the number of grain boundaries, thereby improving strength and crack resistance. However, excessively fine grains may adversely affect high-temperature structural stability. Therefore, industrial manufacturing does not simply pursue the smallest possible grain size but instead aims for an optimum grain structure tailored to the intended application.

(2) Electron Microscopy for High-Precision Analysis

For high-performance tungsten alloys used in aerospace, nuclear engineering, and high-temperature equipment, conventional optical microscopy may not provide sufficient resolution. In such cases, Scanning Electron Microscopy (SEM) and Electron Backscatter Diffraction (EBSD) are employed for more detailed microstructural characterization.

SEM enables observation of finer grain structures, second-phase particle distributions, and grain boundary morphology. EBSD further provides crystallographic information, including grain orientation, grain boundary character, and crystallographic texture. In tungsten-copper alloys, tungsten-nickel-iron alloys, and advanced refractory tungsten alloys, grain orientation significantly influences thermal conductivity, plastic deformation behavior, and fatigue performance. Consequently, EBSD has become an indispensable analytical tool in advanced materials research.

(3) X-Ray Diffraction (XRD) for Grain Size Measurement

Besides microscopic observation, X-ray diffraction (XRD) is another important technique for evaluating grain size. XRD determines grain size by analyzing diffraction peak broadening using the Scherrer equation: $D = K\lambda / \beta \cos\theta$

where D is the crystallite size, K is the shape factor, λ is the X-ray wavelength, β is the full width at half maximum (FWHM) of the diffraction peak, and θ is the Bragg diffraction angle.

This method is particularly suitable for nanocrystalline and ultrafine-grained materials. It should be noted, however, that XRD measures crystallite size, whereas metallographic microscopy measures observable grain size. The two values may differ depending on the material and its microstructure.

(4) Major Factors Affecting Grain Size in Tungsten Alloy Rods

The final grain size of tungsten alloy rods is primarily determined by the manufacturing process.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Influencing Factor	Effect on Grain Size
Initial powder particle size	Finer powders generally produce finer grain structures
Sintering temperature	Excessively high temperatures accelerate grain growth
Holding time	Longer holding times promote grain coarsening
Hot working deformation	Appropriate deformation refines grain structure
Heat treatment schedule	Controls recrystallization behavior and grain stability

For high-temperature applications, attention should be paid not only to the initial grain size but also to long-term grain stability. For example, thermal field components operating above 2000°C may experience significant grain growth during service, resulting in reduced strength and diminished creep resistance.

(5) Importance of Grain Size Measurement in Quality Control

Grain size measurement serves not only as a final product inspection method but also as an important tool for process optimization. During sintering, grain size analysis helps determine whether the sintering temperature has been properly controlled. During hot working, it evaluates whether forging or rolling has effectively refined the microstructure. During heat treatment, it confirms whether abnormal grain growth has occurred.

For applications such as semiconductor thermal fields, vacuum furnace components, and high-temperature structural parts, grain size is generally evaluated together with density, purity, hardness, and mechanical properties to provide a comprehensive assessment of material quality.

CTIA GROUP believes that grain size evaluation is a core component of the quality assessment system for tungsten alloy rods. Modern manufacturing of high-performance tungsten alloys has evolved beyond simply controlling chemical composition to precisely controlling powder characteristics, sintering behavior, grain size, and microstructural stability. By integrating metallographic analysis, SEM, EBSD, and XRD, manufacturers can comprehensively characterize the microstructure and provide strong technical support for the production of highly reliable tungsten alloy products.

Q29: How Is the High-Temperature Performance of Tungsten Alloy Rods Evaluated?

Thanks to their extremely high melting point, excellent high-temperature strength, and outstanding thermal resistance, tungsten alloy rods are widely used in high-temperature furnace components, aerospace systems, nuclear equipment, plasma devices, and semiconductor thermal field assemblies. During service, these materials must not only withstand elevated temperatures but also maintain strength, dimensional stability, and resistance to deformation over extended periods. Therefore, evaluating high-temperature performance is essential for determining whether tungsten alloy rods satisfy engineering requirements.

High-temperature performance evaluation generally includes high-temperature tensile testing, creep testing, high-temperature hardness measurement, thermal stability analysis, and microstructural characterization. Among these methods, high-temperature tensile testing and creep testing are the most important.

(1) High-Temperature Tensile Testing Evaluates Instantaneous Strength

High-temperature tensile testing measures the immediate load-bearing capacity of tungsten alloys at elevated temperatures. During testing, the specimen is heated to the



target temperature in a vacuum or high-purity argon atmosphere before tensile loading is applied. Tensile strength, yield strength, and elongation are then measured. Typical testing conditions are summarized below.

Test Item	Typical Conditions
Temperature range	1000–2500°C
Atmosphere	Vacuum or argon protection
Measured properties	Tensile strength, yield strength, elongation
Primary objective	Evaluate high-temperature load-bearing capability

Although tungsten alloys possess very high strength at room temperature, their strength gradually decreases as temperature increases. High-temperature tensile data therefore directly indicate how much mechanical strength the material retains under actual service conditions. For example, tungsten alloy rods used as structural supports in high-temperature furnaces must maintain sufficient strength even at temperatures around 1500°C or higher to prevent bending, deformation, or structural failure.

(2) Creep Testing Evaluates Long-Term High-Temperature Stability

For components operating continuously at elevated temperatures, instantaneous strength alone is insufficient. Long-term creep resistance must also be evaluated. Creep refers to the gradual plastic deformation that occurs when a material is subjected to constant stress at elevated temperature over an extended period. Typical creep testing conditions include:

Test Parameter	Typical Range
Temperature	Above 1200–2000°C
Applied stress	For example, 100 MPa
Test duration	100–1000 hours
Measured parameters	Strain evolution, creep rate, rupture time

Superior creep resistance indicates better long-term structural stability under high-temperature service conditions. For support structures used in semiconductor single-crystal growth furnaces and vacuum sintering furnaces, creep deformation may alter the position of the thermal field, reducing equipment accuracy. Consequently, creep resistance is often considered even more important than short-term high-temperature strength.

(3) Evaluation of High-Temperature Microstructural Stability

The high-temperature performance of tungsten alloys depends not only on mechanical strength but also on microstructural stability. During prolonged exposure to elevated temperatures, materials may undergo grain growth, second-phase particle coarsening, pore evolution, and elemental diffusion. Accordingly, high-temperature performance evaluations are commonly combined with the following analytical methods:

Analysis Method	Evaluation Objective
Metallographic analysis	Grain growth behavior
SEM observation	Second-phase particle morphology
XRD analysis	Crystal structure evolution
Density measurement	Pore evolution



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

For tungsten alloys strengthened with rare-earth elements or carbides, particular attention is paid to the long-term stability of the strengthening phases.

(4) Thermal Cycling Tests

Many tungsten alloy components do not operate under constant temperatures but instead experience repeated heating and cooling cycles. Thermal cycling tests therefore constitute another important evaluation method.

These tests involve repeatedly heating specimens to their service temperature, holding them for a specified period, cooling them to lower temperatures, and repeating the cycle numerous times. The specimens are then examined for cracking, deformation, and performance degradation.

Thermal cycling evaluation is particularly important for high-temperature furnace components, plasma equipment, electrode materials, and hot-section aerospace components.

(5) Relationship Between High-Temperature Evaluation and Practical Applications

Different industries emphasize different aspects of high-temperature performance.

Application Field	Primary Performance Requirements
Semiconductor thermal fields	Creep resistance and dimensional stability
Aerospace	High-temperature strength and thermal fatigue resistance
Nuclear industry	Radiation stability and high-temperature reliability
Vacuum furnaces	High-temperature load-bearing capability and cleanliness
Electrode materials	Electrical conductivity and thermal stability

Therefore, no single property can adequately characterize the overall high-temperature performance of tungsten alloy rods. A comprehensive evaluation must consider service temperature, loading conditions, and expected service life.

CTIA GROUP believes that the essence of evaluating the high-temperature performance of tungsten alloy rods lies not merely in determining the maximum temperature they can withstand, but in assessing their long-term structural stability under extreme operating conditions. By combining high-temperature tensile testing, creep testing, thermal cycling experiments, and microstructural stability analysis, manufacturers can comprehensively evaluate the service performance of tungsten alloy rods and provide reliable engineering data for semiconductor manufacturing, high-temperature furnaces, aerospace, nuclear engineering, and other demanding applications.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



PART VI Applications of Tungsten Alloy Rods

Q30: What Are the Main Applications of Tungsten Alloy Rods in the Military Industry?

Tungsten heavy alloy rods are among the most important high-performance metallic materials used in modern defense systems. They are primarily composed of tungsten as the matrix, alloyed with elements such as nickel, iron, and copper to form a high-density alloy system. Pure tungsten has a density of approximately 19.3 g/cm^3 , while tungsten heavy alloys typically have densities ranging from 17.0 to 18.8 g/cm^3 . In addition to their extremely high density, these materials also offer high strength, excellent toughness, outstanding high-temperature performance, and superior impact resistance. As a result, they are extensively used in armor-piercing projectiles, kinetic energy weapons, high-temperature structural components, and precision inertial devices.

Compared with conventional steels, the greatest advantage of tungsten heavy alloys lies in the combination of high density and high mechanical strength. Their high density provides greater mass within the same volume, allowing projectiles to deliver significantly higher kinetic energy. Meanwhile, their high strength and good ductility enable them to maintain structural integrity during high-speed impact, thereby improving penetration efficiency. Consequently, tungsten alloy rods have become indispensable materials for modern advanced weapon systems and protective equipment.

(1) Armor-Piercing Projectile Cores: High-Density Penetration Materials

Armor-piercing projectile cores represent one of the most important military applications of tungsten alloy rods. Modern armored vehicles increasingly employ multilayer composite armor, ceramic armor, and explosive reactive armor, placing higher demands on penetrator materials.

Utilizing their high density, high compressive strength, and excellent dynamic mechanical properties, tungsten alloy penetrators maintain superior longitudinal stability during high-velocity impact, concentrating kinetic energy into a very small contact area to achieve deep penetration. Compared with conventional steel-core projectiles, tungsten alloy penetrators generally offer approximately 30%–40% greater penetration capability.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

In addition, tungsten alloys possess relatively high elastic wave velocity and excellent resistance to compressive deformation. Under extreme impact conditions, they are less susceptible to catastrophic fragmentation, allowing the penetrator to maintain a stable shape and significantly improve penetration against heavily armored targets.

(2) Kinetic Energy Penetrators and Electromagnetic Railgun Projectiles

With the rapid development of advanced kinetic energy weapons and electromagnetic launch technologies, tungsten alloys have become ideal materials for high-velocity projectiles due to their exceptional density and strength.

As projectile velocity increases, material strength and impact resistance become increasingly critical. Tungsten alloys are capable of withstanding extremely high acceleration loads while maintaining structural integrity during both launch and impact.

For future electromagnetic railgun systems, projectile materials must also possess adequate electrical conductivity and erosion resistance. Because tungsten has an extremely high melting point of approximately 3422 °C, tungsten alloys exhibit excellent resistance to thermal damage generated during ultra-high-speed launch, thereby improving continuous operational capability.

(3) Rocket Engines and Aerospace High-Temperature Components

Tungsten alloy rods are also used in rocket engines, high-temperature nozzles, and aerospace thermal protection components.

Rocket engine combustion temperatures may exceed 3000 °C while simultaneously exposing components to high-velocity gas flow and severe thermal cycling. Conventional engineering materials cannot withstand such conditions for extended periods. Owing to their extremely high melting point, outstanding high-temperature strength, and excellent thermal shock resistance, tungsten alloys are used to manufacture: High-temperature nozzle liners, High-temperature support structures, Ablation-resistant engine components, Thermal protection structures for spacecraft.

Although pure tungsten possesses the highest melting point, tungsten heavy alloys provide significantly improved toughness and machinability through alloying with nickel, iron, and other elements, making them more suitable for manufacturing complex structural components.

(4) Inertial Navigation and Precision Counterweights

Because tungsten alloys combine extremely high density with compact size, they are widely used as precision counterweights and inertial components in military systems.

In aerospace equipment, missile guidance systems, and precision mechanical assemblies, high-density materials are required to achieve precise mass balancing within limited installation space. Compared with traditional high-density materials such as lead, tungsten alloys are non-toxic, mechanically stronger, and more environmentally stable, making them increasingly preferred for these applications.

(5) Protective and Radiation Shielding Components

Tungsten alloys also exhibit excellent radiation shielding capability, making them valuable



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

for specialized protective structures. Because tungsten has both a high atomic number and high density, it effectively attenuates X-rays and gamma rays. Consequently, tungsten alloys are widely used in military inspection systems, nuclear-related equipment, and specialized radiation shielding assemblies.

Typical Military Applications of Tungsten Alloy Rods

Application	Primary Function	Advantages of Tungsten Alloy
Armor-piercing projectile cores	High-speed penetration of composite armor	High density, high strength, excellent dynamic stability
Kinetic energy ammunition	Deliver maximum impact energy	Excellent compressive and impact resistance
Electromagnetic railguns	High-speed projectiles	Good electrical conductivity and erosion resistance
Rocket engines	High-temperature erosion-resistant components	High melting point and outstanding high-temperature strength
Aerospace equipment	Precision counterweights and inertial components	High density with compact dimensions
Protective equipment	Radiation shielding	High density and excellent radiation attenuation

CTIA GROUP believes that the core value of tungsten alloy rods in military applications lies not merely in their high density, but in their balanced combination of high density, high strength, excellent high-temperature stability, and good machinability. As modern defense systems continue to evolve toward higher speeds, higher operating temperatures, and greater precision, tungsten alloys will continue to play an indispensable role in next-generation armor-piercing weapons, aerospace systems, and advanced protective equipment.

Q31: What Are the Applications of Tungsten Alloy Rods in the Electronics Industry?

Tungsten alloy rods and tungsten-based high-density materials play an important role in the electronics industry, particularly in equipment operating under high-temperature, high-vacuum, high-precision, and high-radiation environments. Although electronic applications generally require significantly higher dimensional accuracy and material cleanliness than conventional industrial products, tungsten alloys have become indispensable materials for numerous critical components because of their high melting point, high density, low vapor pressure, excellent electrical conductivity, and outstanding dimensional stability.

Today, tungsten alloys and tungsten-based materials are widely used in semiconductor manufacturing, vacuum electronic devices, lighting equipment, electrical discharge machining (EDM), and precision electronic equipment.

(1) Filaments and High-Temperature Support Wires

Tungsten alloy rods and tungsten wire have long been used in traditional lighting and vacuum electronic devices. With an exceptionally high melting point of approximately 3422 °C, tungsten retains excellent mechanical strength at elevated temperatures and is therefore widely used in: Incandescent lamp filaments, Halogen lamp filaments, Electron tube cathode support structures, Xenon lamp electrodes.

These applications require materials capable of maintaining dimensional stability under prolonged high-temperature operation while resisting thermal expansion and creep. Compared with conventional metallic materials, tungsten-based materials substantially improve service life and overall reliability.

(2) Semiconductor Sputtering Targets



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

In semiconductor manufacturing, tungsten is one of the most important thin-film deposition materials. Tungsten and tungsten alloy sputtering targets are primarily used in magnetron sputtering systems to deposit conductive layers, barrier layers, and interconnect structures on semiconductor wafers.

For advanced integrated circuits, tungsten films are commonly employed in: Contact plug filling, Metal interconnect layers, Diffusion barrier structures. Because tungsten possesses relatively low electrical resistivity, an extremely high melting point, and excellent chemical stability, it satisfies the stringent reliability requirements of advanced semiconductor devices. As semiconductor technology advances toward increasingly smaller process nodes, much stricter requirements are imposed on sputtering target purity, grain structure, and impurity control.

(3) Ion Implanter Collimators and Shielding Components

Ion implantation is one of the key processes in semiconductor fabrication, requiring materials capable of withstanding continuous bombardment by high-energy ions. Due to their high density and excellent sputtering resistance, tungsten alloys are used to manufacture: Ion beam collimators, Ion beam shielding components, High-temperature positioning structures. Compared with conventional molybdenum materials, tungsten alloys offer higher density and significantly improved sputtering resistance. Under certain operating conditions, their resistance to sputtering may be approximately three times greater, thereby extending equipment service life and reducing maintenance frequency.

(4) Electrical Discharge Machining Electrodes

Tungsten alloy rods are also widely used as electrode materials for precision electrical discharge machining (EDM). Because tungsten alloys combine excellent electrical conductivity, high hardness, and superior wear resistance, they are suitable for manufacturing: Micro-hole EDM electrodes, Precision mold electrodes, Electrodes for machining complex profiles. Using precision manufacturing technologies, tungsten alloy electrodes can be produced with diameters as small as 0.05 mm or even smaller, satisfying the requirements of precision electronic components, micro-molds, and micro-electromechanical systems (MEMS).

(5) Electronic Packaging and High-Temperature Connectors

High-power electronic devices require materials that simultaneously provide excellent electrical conductivity, thermal resistance, and dimensional stability. Because tungsten-based materials possess a low coefficient of thermal expansion that matches well with ceramics and semiconductor materials, they are widely used in: Electronic packaging bases, High-temperature conductive connectors, Power device support structures. Particularly in high-power semiconductor devices, radio-frequency equipment, and vacuum electronic systems, tungsten materials effectively reduce structural failures caused by repeated thermal cycling.

Typical Applications of Tungsten Alloy Rods in Electronics

Application	Typical Components	Primary Performance Requirements
Lighting equipment	Filaments, electrodes, support wires	High melting point and high-temperature strength
Semiconductor manufacturing	Sputtering targets	High purity and low defect density
Ion implantation equipment	Collimators and shielding components	Sputtering resistance and high-temperature capability
EDM machining	Electrodes	Electrical conductivity and wear resistance
High-power electronics	Packaging components and connectors	Thermal stability and low thermal expansion



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

CTIA GROUP believes that the primary advantage of tungsten alloy rods in the electronics industry lies in their ability to simultaneously satisfy demanding requirements for high temperature, vacuum compatibility, electrical conductivity, and dimensional stability. As semiconductor manufacturing continues toward higher temperatures, tighter tolerances, and smaller device dimensions, tungsten alloys and tungsten-based composite materials will remain essential materials for advanced electronic manufacturing, particularly in high-end semiconductor equipment, precision electronic devices, and microfabrication technologies.

Q32: What Is the Role of Tungsten Alloy Rods in High-Temperature Furnaces?

Tungsten alloy rods are among the most important heat-resistant structural and thermal field materials used in high-temperature industrial equipment. They are widely employed in vacuum furnaces, Czochralski (CZ) single-crystal silicon growth furnaces, sapphire crystal growth furnaces, powder metallurgy sintering furnaces, and various other high-temperature heat-treatment systems. Their primary functions include serving as heating elements, thermal field support components, electrical connection parts, and high-temperature load-bearing structures, ensuring stable operation under extreme temperature conditions.

Tungsten alloys are generally based on tungsten and strengthened by alloying elements such as nickel, iron, copper, or molybdenum, or are produced as systems such as tungsten-nickel-iron (W-Ni-Fe) and tungsten-nickel-copper (W-Ni-Cu), depending on the application. Compared with conventional engineering metals, tungsten alloys offer high density, an extremely high melting point, excellent mechanical strength, a low coefficient of thermal expansion, and outstanding high-temperature stability. With a melting point of 3,422°C, tungsten has one of the highest melting points among all industrial metals, making tungsten alloys suitable for continuous service at temperatures above 1,500°C and, in many applications, exceeding 1,800°C.

One of the most common applications of tungsten alloy rods in vacuum furnaces and single-crystal silicon growth furnaces is as heating elements or heater support structures. During furnace operation, electrical resistance heating is used to generate a stable heat source. Tungsten alloy rods can continuously produce heat while carrying electrical current because of their combination of electrical resistance and exceptional high-temperature capability. More importantly, they retain their mechanical strength without significant softening or deformation, helping maintain a stable thermal field throughout long operating cycles.

For example, in Czochralski (CZ) silicon crystal growth furnaces, temperatures typically exceed 1,400°C to melt silicon feedstock and sustain crystal growth. The heating system must withstand prolonged exposure to high temperatures, high vacuum, and repeated thermal cycling. Conventional metallic materials tend to oxidize, creep, or experience dimensional instability under these conditions, whereas tungsten alloy rods retain excellent mechanical strength and dimensional stability. High-quality tungsten alloy thermal field components can achieve service lives exceeding 10,000 hours in inert atmospheres at temperatures above 1,800°C.

Another important advantage is the relatively low coefficient of thermal expansion. High-temperature furnace assemblies consist of numerous precision components, and excessive thermal expansion during heating can alter thermal field geometry, change



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

clearances, and even compromise furnace performance. Tungsten alloys typically exhibit a coefficient of thermal expansion of approximately $4-6 \times 10^{-6}/K$, considerably lower than that of most high-temperature alloys, enabling excellent dimensional stability throughout furnace operation.

Typical Applications of Tungsten Alloy Rods in High-Temperature Furnaces

Application Location	Primary Function	Technical Advantages
Heating elements	Generate high-temperature heat through electrical resistance	Excellent high-temperature resistance, long service life, outstanding thermal stability
Heater support rods	Support and secure heating assemblies	High-temperature strength, excellent resistance to bending
Thermal field supports	Maintain thermal field geometry	Low thermal expansion, superior dimensional stability
Electrical connection components	Provide electrical conductivity at elevated temperatures	Good electrical conductivity and excellent thermal cycling resistance
Sintering furnace support components	Support high-temperature workpieces	High rigidity and excellent resistance to deformation

In addition to heating-related applications, tungsten alloy rods are widely used as structural support members inside high-temperature furnaces. For example, powder metallurgy sintering furnaces often operate above 1,800°C, where internal support structures must withstand not only extreme temperatures but also continuous mechanical loading and repeated thermal cycling. Owing to their high elastic modulus and compressive strength, tungsten alloy rods effectively minimize high-temperature bending and deformation.

In the semiconductor industry, the transition toward 300 mm and future 450 mm wafer manufacturing has imposed increasingly stringent requirements on thermal field uniformity and furnace stability. Tungsten alloy rods help maintain consistent thermal field geometry, improving temperature control accuracy during crystal growth, enhancing crystal quality, and reducing defect rates.

Different furnace applications place different demands on tungsten alloy rods. Heating elements emphasize electrical resistance stability and long-term high-temperature durability, while support components prioritize strength, stiffness, and creep resistance. Consequently, selecting the appropriate tungsten alloy grade and processing condition requires careful consideration of operating temperature, furnace atmosphere, mechanical loading, and expected service life.

CTIA GROUP believes that the value of tungsten alloy rods in high-temperature furnaces extends far beyond their ability to withstand extreme temperatures. Their greatest contribution lies in maintaining stable thermal field geometry and precise dimensional accuracy throughout long-term operation. As semiconductor manufacturing, advanced vacuum equipment, and next-generation materials processing technologies continue to evolve, increasingly stringent requirements will be placed on tungsten alloy purity, microstructural uniformity, machining precision, and long-term reliability. High-performance tungsten alloys will therefore continue to play a vital role in future high-temperature equipment.

Q33: How Are Tungsten Alloy Rods Used in the Medical Industry?

Owing to their high density, high atomic number, excellent radiation attenuation capability, and outstanding machinability, tungsten alloy rods have become valuable engineering materials in modern medical equipment, particularly in radiotherapy systems, medical linear accelerators, and precision radiation shielding components. Compared with traditional lead-based materials, tungsten alloys provide higher density, greater mechanical strength,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

and superior environmental stability, making them increasingly preferred for advanced medical equipment requiring both effective radiation shielding and long-term structural reliability.

The density of tungsten alloys generally ranges from 17 to 19 g/cm³, approaching that of pure tungsten (19.25 g/cm³) and significantly exceeding that of steel or copper alloys. Because radiation shielding effectiveness is closely related to material density and atomic number, tungsten alloys can provide equivalent shielding performance using thinner and more compact structures. This characteristic is especially advantageous in medical systems where installation space is limited and equipment miniaturization is important.

One of the most important medical applications of tungsten alloy rods is in the manufacture of radiotherapy collimators. Radiation therapy systems must precisely focus high-energy radiation on tumor tissue while minimizing exposure to surrounding healthy tissue. Consequently, collimator materials must provide exceptional radiation attenuation together with excellent machining accuracy.

For example, in gamma-ray radiotherapy systems, tungsten alloys can achieve shielding efficiencies exceeding 99.9% for 1.33 MeV gamma rays, effectively restricting the radiation beam and improving treatment precision. Because tungsten alloys possess excellent mechanical strength and dimensional stability, they maintain precise collimator aperture geometry throughout long-term clinical operation.

Tungsten alloy rods are also widely used in the target assemblies of medical linear accelerators (LINACs). In these systems, high-energy electron beams strike a metallic target, generating therapeutic X-rays through rapid electron deceleration.

Target materials must withstand continuous bombardment by electron beams while rapidly dissipating the resulting heat. Thanks to their high density, extremely high melting point, and excellent thermal conductivity, tungsten alloys can tolerate the intense energy input produced by electron beams operating at energies typically ranging from 6 to 18 MeV, making them indispensable materials in modern medical X-ray generation systems.

Major Applications of Tungsten Alloy Rods in the Medical Industry

Application Area	Typical Component	Primary Function
Radiation therapy	Radiotherapy collimators	Precisely control radiation beams & improve treatment accuracy
Gamma Knife systems	Core shielding components	Efficiently absorb gamma radiation and reduce leakage
Medical linear accelerators	Electron targets	Generate high-energy X-rays (typically 6–18 MeV)
Multi-leaf collimators (MLCs)	Leaf assemblies	Enable dynamic radiation field shaping
Radiation protection equipment	Shielding structural components	Reduce radiation exposure to personnel and the environment

In multi-leaf collimator (MLC) systems and Gamma Knife equipment, tungsten alloy rods also serve as precision motion and radiation-control components. MLCs consist of numerous independently movable shielding leaves that rapidly adjust the treatment field with extremely high positioning accuracy. Tungsten alloys can be machined into complex geometries with micron-level precision, making them highly suitable for these demanding applications.

Compared with lead, tungsten alloys also offer significant environmental advantages. Lead is toxic and requires careful management throughout manufacturing, use, and disposal,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

whereas tungsten alloys are chemically stable and present substantially lower environmental concerns. As a result, they are becoming increasingly attractive to medical equipment manufacturers seeking environmentally responsible solutions.

Medical applications generally impose stricter material requirements than conventional industrial uses. Tungsten alloy components for radiotherapy systems require not only high density but also excellent material homogeneity, minimal internal defects, tight dimensional tolerances, and superior surface quality. Precision components such as multi-leaf collimator leaves and radiotherapy collimators are typically subjected to precision grinding, lapping, and surface finishing processes to ensure highly accurate beam control.

CTIA GROUP believes that the principal value of tungsten alloy rods in medical applications lies in their unique combination of exceptional radiation shielding performance and outstanding precision manufacturing capability. As precision radiotherapy, heavy-ion therapy, proton therapy, and intelligent medical equipment continue to advance, demand for high-performance tungsten alloy materials is expected to increase steadily. Particularly in compact, high-precision, and highly reliable medical systems, tungsten alloys will remain indispensable engineering materials for many years to come.





CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



Q34: What Role Do Tungsten Heavy Alloy Rods Play in Aerospace?

Tungsten heavy alloy rods are among the most important high-density, high-strength functional materials used in the aerospace industry. Typically composed primarily of tungsten and strengthened with alloying elements such as nickel, iron, and copper, tungsten heavy alloys generally have a density of 16.5–19.0 g/cm³, approaching that of pure tungsten and approximately 2 to 2.5 times the density of steel. At the same time, they offer excellent mechanical strength, impact resistance, high-temperature performance, and outstanding dimensional stability. As a result, tungsten heavy alloy rods are widely used in aerospace equipment for critical functions including mass balancing, inertia control, high-temperature protection, and load-bearing under extreme service conditions. Compared with traditional high-density materials such as steel and lead, tungsten heavy alloys provide the major advantage of achieving greater mass within a much smaller volume while offering significantly superior mechanical properties and environmental compatibility. Since aerospace systems demand optimal space utilization, precise weight distribution, and exceptional reliability, tungsten heavy alloy rods have become an ideal solution for accurate mass control within limited installation space.

Counterweights and Balance Components for Improved Flight Stability

One of the most common aerospace applications of tungsten heavy alloy rods is as balancing and counterweight materials for aircraft, helicopters, and spacecraft. During aircraft manufacturing, control surfaces such as wings, ailerons, elevators, and rudders



must maintain extremely precise mass balance. An improperly positioned center of gravity can increase vibration, reduce control responsiveness, and even compromise flight safety. Consequently, engineers frequently install compact tungsten heavy alloy counterweights or rods inside control surfaces. Compared with conventional lead counterweights, tungsten heavy alloys offer significant advantages.

Comparison Item	Tungsten Heavy Alloy Counterweight	Lead Counterweight
Density	Approx. 16.5–19.0 g/cm ³	Approx. 11.3 g/cm ³
Required Volume	Smaller	Larger
Mechanical Strength	High, resistant to deformation	Relatively low
Environmental Safety	Stable, no significant contamination concerns	Potential lead pollution
High-Temperature Resistance	Excellent	Limited

In helicopter rotor systems, tungsten heavy alloy rods are also widely used for rotor blade balancing. Since rotor blades rotate at extremely high speeds, even a mass deviation of only a few grams can generate substantial centrifugal forces and vibration. Precision-machined tungsten alloy balancing components effectively improve dynamic rotor balance, enhancing flight comfort while extending structural service life. In addition, tungsten heavy alloys are widely used in aircraft navigation equipment, inertial measurement units (IMUs), and precision control systems for mass adjustment and structural balancing, ensuring stable operation under complex vibration environments.

Gyroscope Rotors for Higher Inertial Navigation Accuracy

Inertial navigation systems are essential components of modern aerospace equipment. Their core elements include gyroscopes, accelerometers, and inertial measurement assemblies. The performance of the gyroscope rotor directly determines navigation accuracy, requiring materials with high density, high strength, and excellent dimensional stability.

Because of their exceptional density, tungsten heavy alloys provide greater rotational inertia within a compact volume. According to rotational dynamics, larger moments of inertia improve a gyroscope's resistance to external disturbances and produce more stable angular velocity. Consequently, tungsten heavy alloy rotors significantly enhance inertial stability and navigation precision.

For aerospace applications, tungsten heavy alloy gyroscope rotors offer several important advantages. First, they provide highly concentrated mass distribution, enabling larger moments of inertia within compact designs. Second, their low coefficient of thermal expansion ensures excellent dimensional stability under varying temperature conditions.

Third, their high mechanical strength allows them to withstand substantial centrifugal forces during high-speed rotation, reducing the risk of structural failure. Precision-machined tungsten heavy alloy rods are therefore widely used in manufacturing high-accuracy inertial components such as gyroscope rotors, balancing rings, and inertial mass blocks.

Rocket Engine Nozzle Throats and Jet Vanes for Extreme High-Temperature Service

Rocket engines operate under extremely harsh conditions, particularly in nozzle throat regions where combustion gas temperatures commonly exceed 2,500°C, with localized temperatures approaching or even exceeding 3,000°C in advanced propulsion systems. Conventional metals rapidly melt or lose strength under such conditions, making



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

ultra-high-temperature materials essential.

Tungsten and tungsten-based alloys possess the highest melting point of all metallic elements at 3,422°C. Consequently, tungsten heavy alloy rods are used to manufacture nozzle throat liners, jet vanes, high-temperature support structures, and protective components exposed to severe ablation environments.

The nozzle throat experiences the highest thermal flux inside a rocket engine while being subjected to high-temperature, high-velocity gas flow. Owing to their exceptional melting point and high-temperature strength, tungsten-based materials maintain structural integrity, reduce ablation rates, and extend engine operating duration. Likewise, jet vanes must retain mechanical strength while operating within extremely hot, high-speed exhaust streams to provide effective attitude control. The excellent impact resistance and high-temperature stability of tungsten heavy alloys make them an important alternative to conventional heat-resistant alloys.

Overall Value of Tungsten Heavy Alloy Rods in Aerospace

As aerospace equipment continues to evolve toward lighter weight, higher performance, and greater compactness, demand for high-density functional materials continues to increase. Tungsten heavy alloy rods are far more than simple high-density materials; they are advanced engineering materials that simultaneously provide structural functionality and performance optimization. Their principal aerospace applications include the following:

Application Area	Typical Components	Primary Function
Aircraft Systems	Control surface counterweights, balance weights	Improve flight stability
Helicopter Systems	Rotor balancing components	Reduce vibration and improve reliability
Navigation Systems	Gyroscope rotors, inertial components	Enhance inertial navigation accuracy
Space Propulsion	Nozzle throat liners, jet vanes	Resist extreme-temperature ablation
Aerospace Structures	High-temperature load-bearing components	Maintain dimensional stability

CTIA GROUP believes that the core value of tungsten heavy alloy rods in aerospace lies in combining high density, high strength, and excellent high-temperature stability to optimize space utilization, improve system performance, and enhance overall reliability. As advanced aircraft, deep-space exploration vehicles, and next-generation propulsion systems continue to develop, high-performance tungsten heavy alloys will remain indispensable materials for future aerospace equipment.

Q35: What Are the Advantages of Using Tungsten Heavy Alloy Rods for Welding Electrodes?

Tungsten heavy alloy rods and doped tungsten rods are among the most important electrode materials used in modern high-end welding technologies, particularly Gas Tungsten Arc Welding (GTAW/TIG) and Plasma Arc Welding (PAW). Owing to tungsten's exceptionally high melting point of 3,422°C, low vapor pressure, and outstanding high-temperature electron emission capability, tungsten electrodes maintain stable geometry under intense arc temperatures, making them ideal non-consumable electrodes.

Although pure tungsten electrodes provide excellent heat resistance, their arc ignition characteristics and arc stability are relatively limited. Consequently, modern industrial welding commonly employs rare-earth-doped tungsten electrodes, including ceriated tungsten (EWCe), lanthanated tungsten (EWLa), and yttriated tungsten (EWY), to further



enhance welding performance.

Superior Arc Stability for Improved Weld Quality

One of the most important properties of a welding electrode is its ability to maintain a stable welding arc. During TIG welding, the electrode tip continuously emits electrons to sustain the arc. Insufficient electron emission can lead to difficult arc starting, arc wandering, and inconsistent weld quality. The addition of cerium oxide or lanthanum oxide improves electron emission efficiency, providing several important advantages: Lower arc ignition voltage,

Better arc concentration, Longer arc stability, Reduced welding fluctuations.

Stable arc characteristics are especially important in precision welding, stainless steel fabrication, and thin-wall aerospace components, where consistent arc behavior directly determines weld formation quality.

Lower Burn-Off Rate and Longer Electrode Life

During welding, the electrode tip remains continuously exposed to extremely high temperatures. Excessive material evaporation accelerates electrode consumption and requires frequent replacement.

Rare-earth-doped tungsten electrodes exhibit lower burn-off rates because their modified microstructure and improved electron emission characteristics reduce electrode erosion. Compared with pure tungsten electrodes, they generally provide the following benefits:

Performance	Advantage of Doped Tungsten Electrodes
Arc Starting	Easier
Arc Stability	Higher
Electrode Life	Longer
Welding Efficiency	Higher
Weld Quality Consistency	More Stable

For automated welding production lines, extended electrode life translates directly into reduced downtime and improved manufacturing efficiency.

Radiation-Free, Safer, and More Environmentally Friendly

Traditional thoriated tungsten electrodes contain thorium oxide (ThO_2), which provides excellent electron emission and has therefore been widely used for decades. However, thorium oxide is a naturally radioactive material. Although radiation exposure during normal welding is generally very low, grinding operations can generate thorium-containing dust that requires strict occupational exposure control.

By comparison, ceriated and lanthanated tungsten electrodes contain no radioactive elements, providing significant advantages in both occupational safety and environmental protection. Many countries and regions are gradually promoting the replacement of radioactive tungsten electrodes with non-radioactive alternatives to meet increasingly stringent occupational health and environmental regulations.

Ideal for Automated and Precision Welding

Modern manufacturing increasingly depends on robotic welding, automated production, and high-precision welding technologies, all of which require long-term electrode performance stability. Lanthanated tungsten electrodes provide excellent heat resistance



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

and outstanding resistance to electrode consumption, making them particularly suitable for: Automated TIG welding, Aerospace structural welding, Precision stainless steel welding, Vacuum equipment manufacturing

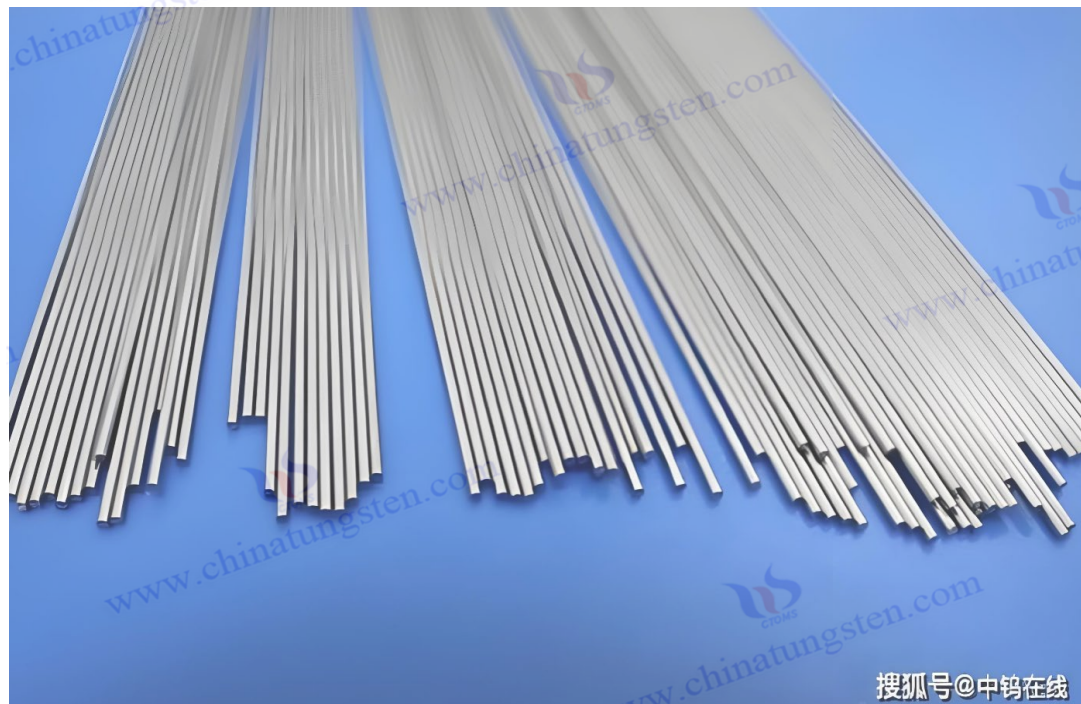
Nuclear industry equipment fabrication

Ceriated tungsten electrodes offer particularly strong performance under low-current conditions and are widely used for welding thin sheets, miniature components, and precision electronic equipment.

Comparison of Different Tungsten Electrode Materials

Electrode Type	Primary Additive	Characteristics	Typical Applications
Pure Tungsten	None	Low cost, moderate performance	General AC welding
Thoriated Tungsten	ThO ₂	Excellent arc performance, radioactive	Traditional industrial welding
Ceriated Tungsten	CeO ₂	Easy arc starting, excellent low-current performance	Precision welding
Lanthanated Tungsten	La ₂ O ₃	Excellent overall performance, non-radioactive	High-end automated welding
Yttriated Tungsten	Y ₂ O ₃	Excellent high-temperature stability	High-load welding

The development of tungsten heavy alloy rods and rare-earth-doped tungsten electrodes is steadily shifting from purely performance-oriented designs toward safer, environmentally friendly, and highly stable products. Compared with thoriated tungsten electrodes, non-radioactive alternatives such as ceriated and lanthanated tungsten not only deliver superior arc stability and lower burn-off rates but also substantially reduce occupational health risks. As a result, they are increasingly preferred for advanced aerospace, energy equipment, electronic manufacturing, and other high-end industrial applications.



搜狐号@中钨在线



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Q36: How Are Tungsten Alloy Rods Used in the Mold Industry?

Tungsten alloy rods are among the most important materials used in the manufacture of modern high-performance molds, particularly for mold components that operate under high temperature, high pressure, severe wear, and repeated thermal cycling. Compared with conventional tool steels, cemented carbides, and copper alloys, tungsten alloys offer high density, high hardness, outstanding wear resistance, a low coefficient of thermal expansion, and excellent thermal conductivity. As a result, they provide unique advantages in die-casting molds, powder metallurgy molds, glass-forming molds, optical fiber drawing molds, and precision forming tools.

One of the greatest challenges in the mold industry is withstanding continuous thermal shock and mechanical loading. For example, aluminum die-casting molds are repeatedly exposed to molten aluminum at temperatures exceeding 700°C while undergoing rapid cooling cycles. If the mold material lacks sufficient thermal fatigue resistance, surface cracking, distortion, and dimensional degradation can occur. Owing to its stable high-temperature mechanical properties, tungsten alloy significantly improves mold service life and production reliability.

(1) Used in Die-Casting Molds to Improve Thermal Fatigue Resistance

Die-casting molds represent one of the most mature application areas for tungsten alloys, with high-performance tungsten-based alloys such as Anviloy 1150 being typical examples. Conventional die-casting molds are generally manufactured from H13 hot-work tool steel. During prolonged high-speed die-casting operations, however, they are susceptible to thermal fatigue cracking, surface erosion, dimensional changes, and premature failure caused by repeated heating and cooling cycles.

Tungsten alloys possess a coefficient of thermal expansion approximately one-half to one-third that of conventional steels, significantly reducing thermal stress generated during repeated heating and cooling. Their relatively high thermal conductivity also enables rapid heat transfer, minimizing temperature gradients across the mold surface. As a result, tungsten alloy mold components operating in high-temperature die-casting environments can effectively: Reduce thermal fatigue cracking, Minimize mold deformation, Improve dimensional stability, Extend mold service life. Under certain operating conditions, the service life of tungsten alloy die-casting components may be several times longer than that of conventional steel molds, with improvements exceeding tenfold in particularly demanding applications.

(2) Used in Powder Metallurgy Molds to Enhance Wear Resistance

During powder compaction, molds are continuously subjected to extremely high compressive loads and abrasive wear, making wear resistance a critical material property. Tungsten alloy rods are commonly used to manufacture: Compaction cores, Punches, High-pressure forming sleeves, Precision locating components.

Because of their high hardness and outstanding wear resistance, tungsten alloys maintain excellent dimensional accuracy throughout long production cycles, minimizing dimensional deviations caused by mold wear.

Compared with conventional cemented carbides, tungsten alloys also offer better toughness and greater resistance to impact fracture in certain applications, making them particularly suitable for large, heavily loaded powder compaction molds.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(3) Used in Optical Fiber Drawing and Precision Forming Molds

During optical fiber manufacturing, drawing towers must maintain extremely stable geometries and thermal conditions over extended operating periods. Mold materials therefore require exceptional dimensional stability, high thermal conductivity, and superior resistance to high-temperature deformation.

Because tungsten alloys exhibit extremely low thermal expansion, they undergo minimal dimensional change at elevated temperatures, improving dimensional consistency during fiber drawing. In addition to optical fiber production, tungsten alloys are also widely used as high-temperature mold materials and structural supports for: Glass forming, Sapphire processing, Precision ceramic forming.

(4) Used in High-Temperature Forming and Hot-Working Tools

In hot forging, hot extrusion, and the forming of advanced engineering materials, tooling must withstand not only high mechanical loads but also oxidation and repeated thermal cycling. Tungsten alloy rods are widely used to manufacture: Hot extrusion mandrels, High-temperature punches, Mold inserts, Hot-working positioning components. Their outstanding high-temperature strength enables molds to maintain structural integrity while minimizing dimensional changes caused by thermal softening and creep.

(5) Summary of Tungsten Alloy Applications in the Mold Industry

Application Area	Typical Components	Primary Advantages
Die-casting molds	Mold cores, inserts, hot-end components	Excellent thermal fatigue resistance and long service life
Powder metallurgy	Punches, mold cores, compaction sleeves	Outstanding wear resistance and dimensional stability
Optical fiber drawing	Forming dies, support components	Low thermal expansion and high dimensional accuracy
Hot-working molds	Extrusion mandrels, mold inserts	Superior high-temperature strength
Precision manufacturing	Positioning components, wear-resistant parts	Excellent long-term dimensional stability

CTIA GROUP believes that the primary value of tungsten alloy rods in the mold industry lies not merely in their high hardness, but in their ability to maintain long-term dimensional and structural stability under high temperatures, heavy loads, and repeated thermal cycling. As industries such as new-energy vehicles, large integrated die-cast components, semiconductor manufacturing, and advanced materials processing continue to evolve, demand for high-precision, long-life mold materials will continue to grow. With their unique combination of thermal and mechanical properties, tungsten alloys will remain indispensable materials for high-end mold manufacturing.

Q37: Where Are Tungsten Alloy Rods Used in the Automotive Industry?

Applications of tungsten alloy rods in the automotive industry are primarily concentrated in high-performance vehicles, motorsports, precision manufacturing, and specialized functional components. Although conventional automotive manufacturing relies heavily on steel, aluminum alloys, and copper alloys, the rapid development of electric vehicles, racing technologies, and intelligent manufacturing has created increasing demand for materials that combine high density, compact size, and outstanding dimensional stability. Tungsten alloys have consequently become an important solution for selected critical components.

With densities typically ranging from 17 to 19 g/cm³—more than twice that of steel—tungsten alloys also provide excellent mechanical strength, corrosion resistance, and dimensional stability. These characteristics make them particularly valuable wherever precise mass distribution, limited installation space, and exceptional reliability are required.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(1) Used as Ballast Weights in High-Performance Racing Vehicles

In motorsports, precise control of vehicle weight distribution, center of gravity, and handling characteristics is essential. Engineers frequently optimize vehicle dynamics by strategically adding or redistributing localized mass. Because of their extremely high density, tungsten alloys provide substantial weight within a very compact volume, making them ideal for manufacturing: Chassis ballast weights, Suspension balancing weights, Vehicle weight adjustment blocks, Dynamic balancing components. Compared with conventional steel ballast, tungsten alloy weights occupy significantly less space while providing the same mass. This gives designers greater freedom to optimize vehicle packaging and structural layouts.

By strategically positioning tungsten alloy ballast during race car tuning, engineers can: Lower the vehicle's center of gravity, Improve high-speed cornering stability, Enhance braking performance, Increase steering responsiveness and handling precision

(2) Used in Precision Automotive Manufacturing Components

Tungsten alloy rods are also employed as functional engineering materials for manufacturing:

High-wear locating components, Precision bushings, Specialized tooling fixtures, Heavy-duty mechanical parts.

Many fixtures used on automotive production lines operate under continuous impact, friction, and repeated positioning cycles. Conventional materials gradually wear, reducing production accuracy over time. The superior wear resistance and dimensional stability of tungsten alloys significantly extend tooling life while maintaining manufacturing precision.

(3) Used in Engine and Powertrain Components

Certain components used in high-performance engines and specialized powertrain systems require exceptional mass stability and high-temperature capability. Tungsten alloys are used to manufacture: Dynamic balancing components, High-speed rotating system counterweights, Specialized inertia components. Their high density enables improved inertia control while reducing component size.

(4) Used in New Energy Vehicle Applications

As electric vehicle technology advances, vehicle designers increasingly emphasize efficient packaging and structural optimization. The combination of compact dimensions and high mass makes tungsten alloys attractive for applications such as: Electric motor balancing components, High-precision vibration control devices, Battery system balancing and structural optimization. In high-performance electric vehicles and electric race cars, optimized weight distribution directly influences driving range, handling, and safety, making high-density materials increasingly valuable.

(5) Used in Automotive Tooling and Manufacturing Equipment

In addition to being incorporated into vehicle components, tungsten alloy rods are also widely used in automotive manufacturing equipment, including: Wear-resistant stamping die inserts, Precision locating pins, Long-life tooling components. Since automotive manufacturing involves continuous high-volume production, tooling experiences significant wear over time. Tungsten alloy wear components reduce replacement frequency, improve manufacturing efficiency, and increase production consistency.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

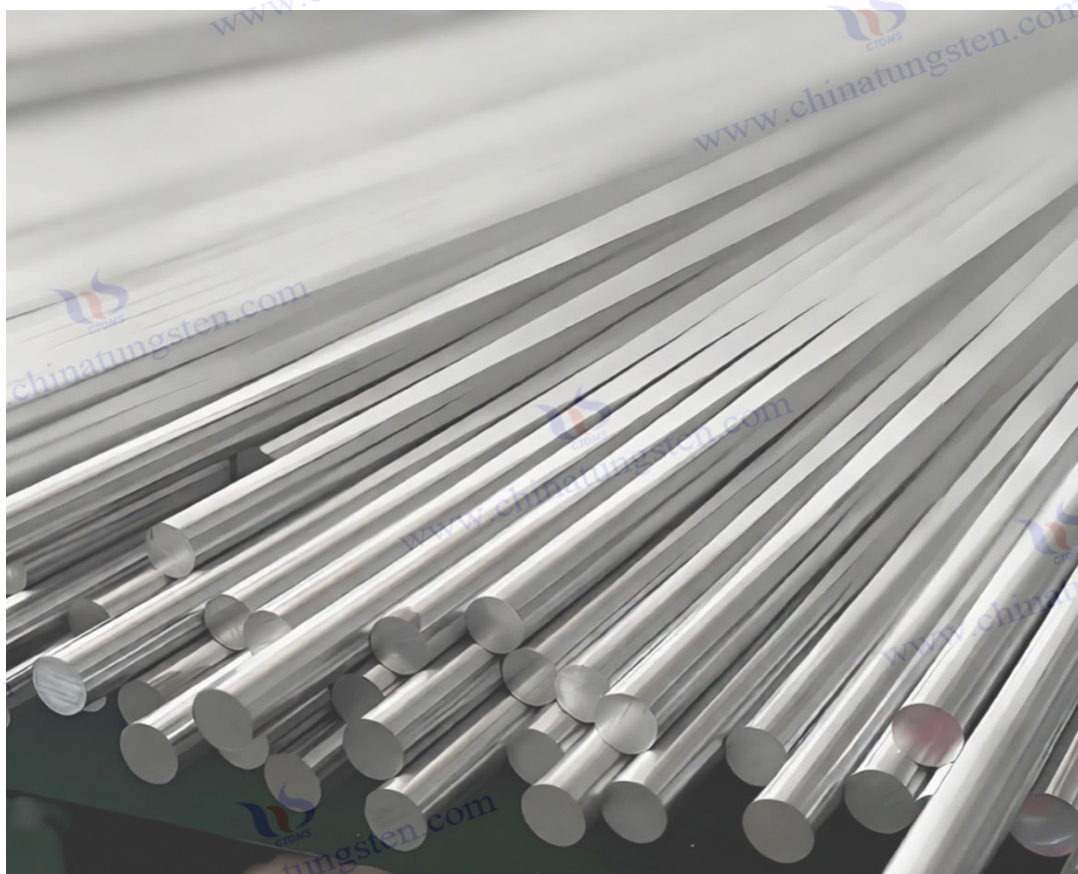
TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Typical Applications of Tungsten Alloy Rods in the Automotive Industry

Application	Typical Components	Engineering Benefits
Racing performance optimization	Ballast weights, balancing components	Optimized weight distribution and improved vehicle handling
Powertrain systems	Inertia components, balancing parts	Enhanced operational stability
Precision manufacturing	Locating components, wear-resistant parts	Extended tooling service life
New energy vehicles	Vibration control components	Improved structural performance
Manufacturing equipment	Die inserts, tooling components	Higher manufacturing efficiency

CTIA GROUP believes that tungsten alloy rods are not intended to replace conventional automotive materials throughout an entire vehicle. Instead, they provide unique advantages in specialized applications requiring high performance, exceptional precision, and advanced functionality. As motorsports, electric vehicles, and high-end manufacturing continue to evolve, increasingly stringent requirements for lightweight engineering and precise mass control will further expand the role of tungsten alloys in vehicle performance optimization, precision manufacturing, and advanced automotive equipment.





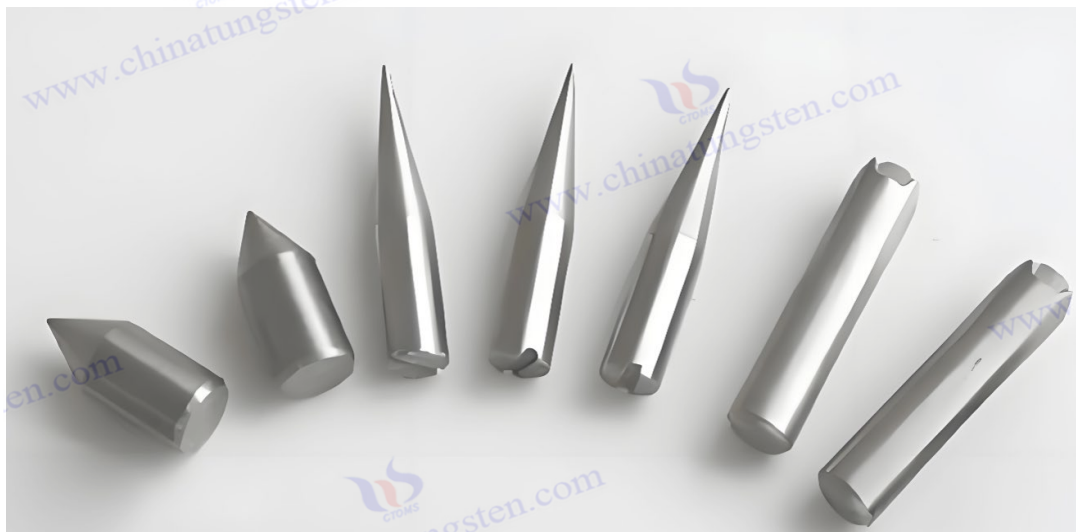
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



VII. Use and Safety of Tungsten Alloy Rods

Q38: Are Tungsten Alloy Rods Toxic?

Tungsten alloy rods are a class of high-density metallic materials in which tungsten is the primary constituent, with alloying elements such as nickel, iron, and copper added to achieve the desired properties. They are widely used in aerospace counterweights, medical shielding, military equipment, precision manufacturing, the automotive industry, and high-temperature industrial applications. From the standpoint of material properties, solid tungsten alloy rods are generally not considered toxic materials. Under normal conditions of use, storage, and transportation, they do not release harmful gases and do not pose a significant toxic hazard to humans.

Tungsten itself is a refractory metal with a very high melting point and stable chemical properties. It is not readily corroded or decomposed under normal-temperature conditions. Tungsten alloy rods used in industry generally exist as dense metallic materials with a stable internal structure. When a person comes into contact with an intact metallic surface, tungsten is essentially not absorbed into the body through the skin. Therefore, for finished tungsten alloy rod products such as counterweights, shielding components, and structural parts, there are generally no special occupational health risks when they are used in accordance with normal industrial practices.

From a toxicological perspective, tungsten and its alloys have relatively low acute toxicity. According to relevant experimental data, the acute oral LD₅₀ of tungsten metal powder and related materials is generally greater than 2,000 mg/kg, placing them in the low-toxicity or practically non-toxic category. At present, there is insufficient evidence to demonstrate that industrial-grade dense tungsten alloy rods have definite carcinogenicity. Therefore, the long-term use of tungsten alloy rods in aerospace, medical equipment, and advanced manufacturing is closely related to their favorable safety and stability.

However, although tungsten alloy rods are generally safe as materials, metal dust generated during processing still requires appropriate occupational protection. In particular, during machining operations such as cutting, grinding, drilling, and polishing, the material is broken down into small particles, generating dust containing tungsten and other alloying elements. Long-term inhalation of large quantities of high-concentration metallic



dust may irritate the respiratory system and potentially affect occupational health. Therefore, tungsten alloy processing facilities generally need to provide local exhaust ventilation, industrial dust collection systems, and appropriate personal protective equipment. The safety characteristics of tungsten alloy rods in different conditions are as follows:

Condition	Main Characteristics	Safety Risk
Intact tungsten alloy rod	Dense metal with stable chemical properties	Very low risk under normal use
Machining chips	Contains metallic particles	Long-term inhalation should be avoided
Grinding dust	Small particles that can enter the respiratory tract	Dust collection and respiratory protection are required
High-temperature processing	May generate oxide fumes and dust	Ventilation control is required

In addition, different types of tungsten materials should be distinguished. For example, ordinary tungsten alloy rods are not exactly the same as thoriated tungsten electrodes. Thoriated tungsten electrodes are welding electrode materials produced by adding a certain proportion of thorium oxide (ThO_2) to tungsten. Because thorium oxide is naturally radioactive, dust generated during their processing requires more stringent control. Although the radiation risk from thoriated tungsten electrodes under normal operating conditions is low, inadequate dust control during extensive grinding or polishing may increase the risk of radioactive material entering the human body.

At present, as environmental regulations and occupational health requirements continue to become more stringent, an increasing number of welding industries are adopting non-radioactive rare-earth tungsten electrodes, such as cerium tungsten electrodes (EWCe), lanthanum tungsten electrodes (EWLa), and yttrium tungsten electrodes (EWY), to replace traditional thoriated tungsten electrodes. These materials not only reduce the requirements for radioactive material management, but also maintain good arc-starting performance, arc stability, and service life.

For ordinary tungsten alloy rods, the primary focus of safety management is the processing operation rather than the material itself. First, prolonged exposure to high concentrations of metallic dust should be avoided. Processing equipment should preferably use wet machining or be equipped with highly efficient filtration and dust collection systems. Second, operators should wear dust masks, protective eyewear, and protective gloves during grinding and cutting to prevent dust from entering the respiratory tract or irritating the eyes. Third, tungsten alloy chips and scrap generated after processing should be collected separately for recycling. Since tungsten is a strategic metal with high recycling value, proper recycling not only benefits environmental protection but can also reduce production costs.

Tungsten alloy rods are generally considered relatively safe engineering materials. Intact solid tungsten alloy rods do not present significant toxicity in normal industrial applications. The main concerns are metallic dust generated during processing and the handling requirements associated with certain special materials containing radioactive elements. With appropriate engineering controls and protective measures, tungsten alloy materials can be safely used for extended periods in aerospace, medical, automotive, advanced manufacturing, and other fields.



Q39: Are There Any Safety Precautions for Processing Tungsten Alloy Rods?

Tungsten alloy rods feature high density, high hardness, high strength, and excellent heat resistance. They are therefore widely used in aerospace counterweights, precision components, high-temperature structural parts, and specialized industrial equipment. However, tungsten alloys are typical difficult-to-machine materials, and their processing can generate substantial cutting forces, machining heat, and metallic dust. Appropriate and standardized safety measures must therefore be implemented.

Compared with ordinary steel, tungsten alloys have higher hardness and lower toughness. During machining, problems such as rapid tool wear, workpiece chipping or cracking, and localized overheating may occur. Therefore, during turning, milling, drilling, grinding, and other operations, both machining quality and safety risks must be strictly controlled.

First, special attention must be paid to metallic dust protection during tungsten alloy grinding. Grinding generates large quantities of fine particles, some of which may be on the micrometer scale and can readily enter the human respiratory system. Long-term inhalation of large amounts of metallic dust may result in occupational health effects. Therefore, dedicated equipment equipped with dust extraction systems should be used when grinding tungsten alloys, and compressed air must not be used directly to blow away dust, as this may cause secondary dispersion.

Operators should generally wear compliant dust masks, such as N95, FFP2, or higher-level respiratory protection, as well as protective eyewear, protective gloves, and work clothing. After processing, the work area should be cleaned promptly, and work clothing contaminated with dust should not be taken into living areas.

Second, safety requirements for grinding machines must be strictly followed. Because tungsten alloys have relatively high hardness, grinding wheels with suitable performance are required, and diamond grinding wheels are commonly used. If an inappropriate grinding wheel is selected, the rotational speed is excessive, or the wheel has cracks, it may break during high-speed operation. Therefore, the condition of the grinding wheel must be inspected before processing, its installation must be confirmed to be secure, and the wheel must be operated strictly within the rotational speed specified for the equipment. The main safety precautions for tungsten alloy processing are as follows:

Processing Operation	Main Risk	Recommended Measures
Grinding	Dust and grinding wheel breakage	Use diamond grinding wheels and activate dust extraction
Cutting	Tool breakage and flying chips	Use appropriate cutting parameters and protective guards
Drilling	High temperature and drill breakage	Control speed and provide adequate cooling
Welding applications	Short circuits and localized overheating	Maintain the correct operating distance
Processing of special electrode	Risk of radioactive dust	Avoid exposure to thoriated tungsten dust

Special attention should be paid to radioactivity when handling thoriated tungsten electrodes. Thoriated tungsten electrodes contain thorium oxide (ThO_2), which is a naturally radioactive material. Although radiation levels from intact thoriated tungsten electrodes during normal welding operations are relatively low, grinding the electrode tip generates dust containing thorium oxide. Therefore, extensive grinding of thoriated tungsten electrodes is not recommended in ordinary working environments.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

At present, many welding companies are gradually adopting cerium tungsten electrodes, lanthanum tungsten electrodes, and composite rare-earth tungsten electrodes as alternatives to thoriated tungsten electrodes. These new electrode materials do not contain radioactive elements while providing good arc-starting performance and current-carrying capability, making them more consistent with modern manufacturing requirements for environmental protection and occupational safety.

In addition, when tungsten alloy rods are used as welding electrodes or high-temperature conductive components, abnormal short circuits between the tungsten rod and the workpiece should be avoided. A short circuit may cause localized current concentration, rapidly increasing the temperature at the tungsten rod tip, resulting in material loss, weld contamination, or even equipment damage. Therefore, during welding operations, the correct electrode distance should be maintained and the welding current should be properly controlled.

For automated processing enterprises, it is recommended to establish a comprehensive tungsten alloy processing safety management system covering equipment protection, dust monitoring, personnel training, waste recycling, and occupational health examinations. Safety management is particularly important in aerospace, semiconductor, and advanced equipment manufacturing, where component values are high and machining precision requirements are stringent.

Overall, tungsten alloy rod processing does not inherently involve unusual hazards. Safe and efficient processing can be achieved by implementing appropriate measures addressing its high hardness, high density, and dust characteristics. The most important principles during processing are to control dust, protect personnel, operate equipment properly, and select appropriate processes according to the material type. For thoriated tungsten materials containing radioactive elements, non-radioactive rare-earth tungsten materials should preferably be considered as substitutes to further improve production safety and environmental performance.

Q40: Are Tungsten Alloy Rods Prone to Fracture?

Whether a tungsten alloy rod is prone to fracture during actual use and processing needs to be evaluated comprehensively based on its composition, manufacturing process, service environment, and loading conditions. In general, compared with pure tungsten materials, the fracture resistance of modern tungsten alloy rods has been significantly improved, and they are not generally considered materials that fracture easily. However, because tungsten alloys remain high-density, high-hardness metallic materials, their ductility and toughness are still somewhat lower than those of conventional structural materials such as steel and nickel-based alloys. Consequently, cracking or fracture may still occur under improper machining conditions, impact loading, or extremely low-temperature environments.

Pure tungsten has an extremely high melting point of approximately 3,422 °C, a high elastic modulus of approximately 410 GPa, and excellent high-temperature strength, but it exhibits significant brittleness at room temperature. This is mainly because tungsten has a body-centered cubic structure, and dislocation movement becomes difficult at low temperatures, resulting in limited plastic deformation capability. Therefore, pure tungsten rods are susceptible to crack initiation and even fracture when subjected to sudden impact, bending loads, or machining-induced stress concentrations.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Tungsten alloys improve the toughness of pure tungsten by introducing ductile metallic phases such as nickel (Ni), iron (Fe), and copper (Cu). Typical heavy tungsten alloys are manufactured using powder metallurgy liquid-phase sintering, in which tungsten particles are uniformly distributed within a nickel-iron or nickel-copper binder phase. The binder phase can absorb external loads, promote crack deflection, and inhibit rapid crack propagation. As a result, tungsten alloys generally exhibit higher impact resistance and fracture toughness than pure tungsten.

For example, common 93W–97W high-density tungsten alloys typically have densities of approximately 17–19 g/cm³, tensile strengths of approximately 700–1,000 MPa or higher, and elongations generally in the range of approximately 5%–20%. These properties are significantly better than those of unreinforced pure tungsten materials, enabling such alloys to be used in aerospace counterweights, armor-piercing penetrators, gyroscope rotors, medical shielding components, and precision inertial components.

Q40A What Are the Main Sources of Fracture Risk in Tungsten Alloys?

Although tungsten alloys are tougher than pure tungsten, their high hardness and high density mean that the following issues still need to be considered during processing and service.

(1) Stress Concentration During Processing

Tungsten alloys have relatively high hardness. During machining, worn tools or inappropriate cutting parameters can readily create microcracks at component edges, hole openings, and sharp corners. In particular, slender rods, small-diameter rods, or components with grooves are more susceptible to crack initiation when sharp corners remain after machining.

(2) Residual Stress Generated by Heat Treatment or Welding

Although tungsten alloys have good thermal stability, internal residual stresses may still develop during sintering and cooling, heat treatment, welding, or laser processing. When residual stress exceeds the local load-bearing capacity of the material, delayed cracking may occur even after long-term storage.

(3) High-Speed Impact Loading

Certain service environments, such as high-speed rotating components, armor-piercing penetrators, or impact structures, impose extremely high requirements on the material's instantaneous load-bearing capability. If pores, microstructural non-uniformity, or internal defects are present, fracture may occur under high-speed impact conditions.

(4) Extremely Low-Temperature Environments

The metallic binder phase in tungsten alloys may experience reduced ductility at extremely low temperatures. Therefore, for special environments such as aerospace applications and deep-space exploration, the appropriate alloy system should be selected according to the specific temperature conditions.

Q40B How Can the Fracture Resistance of Tungsten Alloy Rods Be Improved?

To improve the reliability of tungsten alloy rods, industrial production generally controls three areas: material design, manufacturing processes, and post-processing. First, powder purity and microstructural uniformity should be improved. High-quality tungsten alloys



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

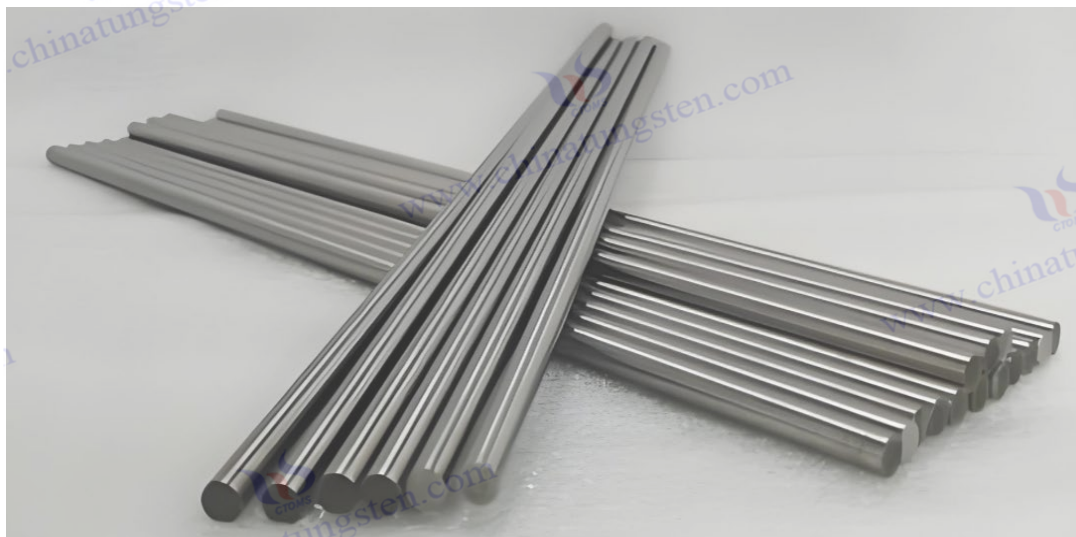
WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

require uniform tungsten particle sizes and a continuous distribution of the binder phase, while avoiding large-particle agglomeration and internal defects. Second, sintering and heat-treatment processes should be optimized. Proper control of liquid-phase sintering temperature, holding time, and cooling rate can reduce porosity while increasing material density and toughness. Third, machining processes should be optimized. For example, the use of appropriate cutting tools, reduction of machining impact, and incorporation of larger radii at corners can reduce stress concentration and improve component reliability.

Comparison of Tungsten Alloy Rods and Pure Tungsten

Item	Pure Tungsten	Tungsten Alloy Rod
Density	Approximately 19.3 g/cm ³	Approximately 17–19 g/cm ³
Room-temperature ductility	Relatively low; prone to brittle fracture	Significantly improved
Impact resistance	Relatively poor	Relatively good
Machinability	Difficult	Relatively improved
Main advantage	Ultra-high-temperature performance	Combined high density, high strength, and good toughness
Typical applications	High-temperature furnace components, electrodes	Counterweights, shielding components, inertial components, structural parts

CTIA GROUP considers tungsten alloy rods to be materials that are not inherently prone to fracture. Their fracture risk mainly arises from their high hardness as well as inadequate stress management during processing and service. Through appropriate alloy composition design, improved manufacturing quality, and optimized machining processes, tungsten alloys can combine high density, high strength, and good toughness, meeting the requirements for long-term reliable use in aerospace, military, medical, electronics, and advanced equipment manufacturing.





Q41: How Should Tungsten Alloy Rods Be Stored?

Tungsten alloy rods are high-density metallic materials with relatively stable chemical properties. Under normal room-temperature conditions, they generally do not require special protection for long-term storage. However, tungsten alloy products are often used in high-precision and high-reliability applications, such as aerospace counterweights, semiconductor equipment, medical shielding components, and precision mechanical parts. Therefore, proper storage remains important. Appropriate storage can not only prevent surface oxidation, contamination, and mechanical damage, but also preserve dimensional accuracy, surface quality, and subsequent machinability.

Tungsten Alloy Rods Have Good Stability at Room Temperature

Tungsten alloys are mainly composed of tungsten together with alloying elements such as nickel-iron or nickel-copper, and generally exhibit good corrosion resistance in normal atmospheric conditions at room temperature. Compared with more reactive metals, tungsten alloys are not prone to significant oxidation and do not undergo rapid corrosion like aluminum or magnesium. Therefore, under normal storage conditions, it is generally sufficient to keep the products dry and clean, avoid prolonged contact with acidic or alkaline media, and prevent mechanical impact.

Storage Environment Requirements

Although tungsten alloys are relatively stable, standardized warehouse conditions are recommended. The recommended storage conditions are as follows:

Storage Item	Recommended Requirement
Temperature	Room temperature; avoid drastic temperature changes
Humidity	Preferably controlled below 60%
Environment	Dry and free from corrosive gases
Packaging	Moisture-resistant packaging or original factory packaging
Placement	Store by category and prevent impact or deformation



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

For high-precision machined rods, particularly small-diameter and long tungsten alloy rods, random stacking should be avoided to prevent bending and deformation.

Prevent Surface Contamination

Some tungsten alloy products are used in semiconductor equipment, vacuum systems, or high-temperature furnace components where high material cleanliness is required. During storage, contamination by oil, dust accumulation, prolonged contact with perspiration, and friction against other metal materials should be avoided. For components intended for vacuum applications, clean packaging is generally recommended, such as vacuum bags, antistatic packaging, or clean plastic protective sleeves.

Storage Precautions for Machined Tungsten Alloy Rods

After turning, grinding, drilling, or other machining operations, the surface condition and internal stress state of tungsten alloy rods may change. Precision-ground components, thin-wall structures, and parts with tight dimensional requirements may retain a certain level of residual stress after machining. If stress-relief annealing is subsequently required, heat treatment must be performed in a vacuum furnace or a protective atmosphere furnace, such as a high-purity hydrogen atmosphere, to prevent high-temperature oxidation.

Although tungsten alloys have excellent high-temperature resistance, they may still undergo surface oxidation in high-temperature environments containing oxygen. This can result in the formation of an oxide layer, dimensional changes, deterioration of surface quality, and increased difficulty in subsequent machining.

Recommendations for Long-Term Storage

For tungsten alloy rods kept in long-term inventory, regular inspections are recommended, including checking packaging integrity, surface contamination, mechanical damage, and whether dimensions remain within the specified requirements. If the storage period is relatively long, surface cleaning and quality re-inspection may be carried out according to the intended application before the products are put into service.

Tungsten Alloy Rod Storage and Maintenance	Recommended Measure	Purpose
Room-temperature storage	Store in a dry environment	Prevent contamination and corrosion
Precision components	Use clean packaging	Maintain surface quality
Long rods	Place horizontally or use dedicated supports	Prevent bending
Machined products	Stress-relief annealing when necessary	Improve dimensional stability
Heat treatment	Vacuum or protective atmosphere	Prevent oxidation

CTIA GROUP believes that tungsten alloy rods are metallic materials with relatively high storage stability and generally do not require special protection under normal conditions. However, cleanliness during storage and stress control after machining must be given particular attention for high-end applications. For tungsten alloy products used in aerospace, semiconductor equipment, medical devices, and precision equipment, proper packaging, environmental control, and necessary heat-treatment management are key measures for maintaining long-term material performance and reliability. As the requirements of advanced manufacturing for material consistency and reliability continue to increase, tungsten alloy storage management will also gradually develop toward standardization, clean storage, and full-process quality control.



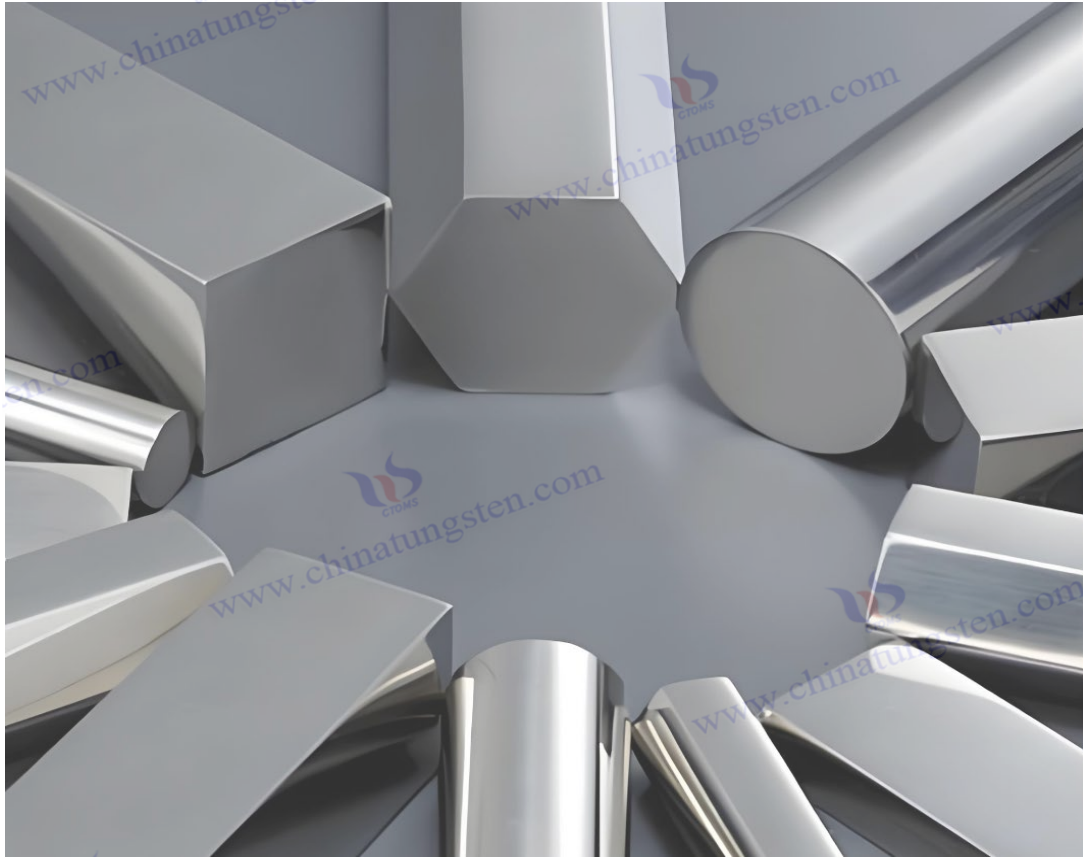
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



VIII. Customization and Procurement of Tungsten Alloy Rods

Q42: What Are the Available Dimensions and Specifications of Tungsten Alloy Rods?

Tungsten alloy rods are a type of high-density metallic material primarily composed of tungsten with alloying elements such as nickel, iron, or copper. They offer high density, high strength, good mechanical properties, and excellent dimensional stability. Their density can typically reach approximately 17.0–18.8 g/cm³, approaching that of pure tungsten, while their toughness and machinability are generally better than those of pure tungsten. As a result, tungsten alloy rods are widely used in aerospace counterweights, medical shielding, military equipment, precision molds, automation equipment, vibration and damping components, and advanced manufacturing applications.

As one of the most common semi-finished forms of tungsten alloys, tungsten alloy rods are generally designed according to material grade, manufacturing process, application field, and customer requirements. Due to the relatively high material cost and machining difficulty of tungsten alloys, industrial production generally supplies standard specifications while also supporting customized machining according to customer drawings.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(I) Diameter Specifications of Tungsten Alloy Rods

Tungsten alloy rods are available in a relatively wide range of diameters. Typical industrial supply ranges include:

Category	Common Range
Small-diameter rods	Φ1.0 mm–Φ10 mm
Medium-size rods	Φ10 mm–Φ50 mm
Large-size rods	Φ50 mm–Φ100 mm and above
Extra-large specifications	Extra-large diameters and lengths can be customized
Special-shaped customized products	Can be machined according to customer drawings

Small-diameter tungsten alloy rods are commonly used for precision counterweights, electronic equipment, medical collimator components, and small mechanical structural parts. Medium- and large-diameter rods are more commonly used for aerospace counterweights, military components, high-temperature molds, and large mechanical balancing components. For special applications, such as inertial components in high-speed rotating equipment, large aerospace counterweights, or specialized protective structures, larger tungsten alloy rods can also be manufactured through rotary swaging, extrusion, or machining.

(II) Length Specifications of Tungsten Alloy Rods

The standard length of tungsten alloy rods is generally determined according to transportation, machining, and customer application requirements. Common market lengths include standard lengths of 100–1000 mm, long rods of 1000–2000 mm, and special lengths customized according to customer requirements.

The longer the rod, the higher the manufacturing requirements. Due to the high density of tungsten alloys, long rods can be affected by their own weight during machining and transportation. Therefore, straightness, roundness, and internal structural uniformity must be strictly controlled. For precision applications, such as gyroscope rotor shafts and high-speed rotating balancing components, requirements may include not only length but also straightness, concentricity, outside-diameter tolerances, surface roughness, and internal defects.

(III) Supply Conditions of Tungsten Alloy Rods

Depending on subsequent application requirements, tungsten alloy rods can be supplied in different processing conditions. The main supply forms include:

Supply Form	Characteristics	Typical Applications
Rotary-swaged rod	Rotary swaging improves density and mechanical properties while providing relatively high dimensional accuracy	High-performance structural components, aerospace counterweights
Turned rod	Machined by turning to obtain a relatively smooth surface	General mechanical components
Ground rod	Cylindrical grinding improves dimensional accuracy & surface quality	Precision components, assembly parts
Straightened rod	Straightened to ensure good straightness	Long shaft-type components

Rotary-swaged rods are one of the more common forms of high-performance tungsten alloy products. The rotary swaging process can improve the internal structure and density of the material as well as its mechanical properties, giving the rods better resistance to bending and improved dimensional stability.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

(IV) Dimensional Tolerances and Precision Machining Requirements

Standard tungsten alloy rods are mainly intended for general machining applications. For aerospace, medical equipment, and precision instrumentation, further machining is usually required. Depending on the machining method, dimensional accuracy can generally reach approximately ± 0.05 mm for conventional turning, ± 0.01 – ± 0.02 mm for precision grinding, and higher levels for high-precision machining.

For high-speed rotating components or precision balancing parts, material uniformity and weight deviation must also be controlled to ensure the required dynamic balancing performance.

(V) Factors Affecting Tungsten Alloy Rod Specification Selection

When selecting tungsten alloy rod specifications, customers should consider more than simply diameter and length. The selection should be based on a comprehensive assessment of several factors.

First, space limitations must be considered. Because tungsten alloys have high density, a smaller component can be designed while still achieving the required weight. Second, the working environment is important. Aerospace, high-temperature equipment, medical shielding, and other applications have different requirements for material stability. Third, the machining method should be considered, as different dimensions are suitable for different manufacturing processes, and large-diameter rods generally require more subsequent machining. Fourth, performance requirements must be evaluated, including density, hardness, strength, toughness, and dimensional stability.

CTIA GROUP believes that the specification design of tungsten alloy rods is not simply a matter of dimensions, but rather a comprehensive balance among material properties, manufacturing capabilities, and application requirements. Modern high-performance tungsten alloy rods have gradually evolved from conventional standard-size supply toward an integrated manufacturing model involving material design, dimensional optimization, and precision machining based on the customer's specific application scenario.

Q43: What Surface Finishes Are Available for Tungsten Alloy Rods?

Tungsten alloy rods have high hardness, high density, and relatively high machining difficulty. Therefore, their final surface condition has an important impact on subsequent processing, assembly accuracy, and service performance. Depending on the application requirements, tungsten alloy rods can be supplied in various surface conditions, including as-sintered, turned, ground, and polished finishes. Different surface treatments not only affect appearance, but also directly influence dimensional accuracy, surface roughness, friction performance, and long-term dimensional stability. Therefore, when customizing tungsten alloy rods, the appropriate surface finish should be selected according to the final application.

(I) As-Sintered Tungsten Alloy Rods

The as-sintered surface is the original surface condition of tungsten alloy rods after sintering or hot working without further precision finishing. Its main characteristics include a retained sintered surface, a grayish-black appearance, relatively large dimensional machining allowance, and relatively high surface roughness.

As-sintered rods are mainly suitable for subsequent machining processes such as turning, milling, drilling, or grinding. Their main advantages are lower cost, high material utilization,



and suitability for large-volume rough machining. Their disadvantages are relatively low dimensional accuracy and surface quality that generally cannot directly meet the requirements of precision assembly. Therefore, the as-sintered condition is usually supplied as a semi-finished product.

(II) Turned Tungsten Alloy Rods

A turned surface is produced by removing surface allowance on a lathe to achieve improved dimensional accuracy. A typical surface roughness is approximately Ra 3.2 μm .

Turned tungsten alloy rods have more accurate outer diameter dimensions, a more uniform surface, and are convenient for subsequent assembly or secondary machining. Turned rods are commonly used for general mechanical structural components, counterweight assemblies, and non-high-precision mounting components. For applications without particularly strict dimensional requirements, the turned condition can already meet the service requirements.

(III) Ground Tungsten Alloy Rods

A ground surface is produced by cylindrical grinding to further improve dimensional accuracy and surface quality. A typical surface roughness is approximately Ra 1.6–3.2 μm .

Compared with turned rods, ground rods provide better roundness, diameter consistency, surface finish, and dimensional stability. Ground tungsten alloy rods are commonly used for precision mechanical components, high-speed rotating components, aerospace counterweights, and high-precision assembly structures. For components requiring strict control of clearances or fit accuracy, the ground condition is generally recommended.

(IV) Polished Tungsten Alloy Rods

Polishing is a higher-grade surface treatment process, including precision mechanical polishing and electropolishing. Its main characteristics are high surface finish, reduced coefficient of friction, and excellent appearance quality.

Polished rods are suitable for high-precision instrument components, optical-related equipment, special electronic equipment, and components with high requirements for surface cleanliness. Polishing can further reduce surface defects and improve corrosion resistance and long-term stability.

Common Surface Finishes of Tungsten Alloy Rods

Surface condition	Surface roughness	Characteristics	Main applications
As-sintered	Relatively high	Original sintered surface with machining allowance retained	Subsequent rough machining
Turned	Approx. Ra 3.2 μm	Improved dimensions, moderate cost	General mechanical components
Ground	Approx. Ra 1.6–3.2 μm	High accuracy and stable surface quality	Precision components
Polished	Lower, with further optimization possible	High surface finish	Special high-end applications

(V) Recommendations for Selecting the Surface Finish

The actual selection should be based on the function of the component. If the product still requires substantial subsequent machining, the as-sintered condition is recommended. For general structural components, the turned condition can be selected. If precision assembly, high-speed rotation, or aerospace applications are involved, the ground condition is generally preferred. If extremely high requirements are placed on surface cleanliness, friction performance, or appearance, polishing can be adopted.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

CTIA GROUP believes that surface treatment of tungsten alloy rods is not simply intended to improve appearance, but is an important manufacturing step that determines whether the material can meet the requirements of the final application. By appropriately selecting the as-sintered, turned, ground, or polished condition, the optimum balance among cost, machining efficiency, and service performance can be achieved, providing more reliable high-density tungsten alloy solutions for aerospace, medical, electronics, defense, and precision manufacturing applications.

Q44: How Should the Type of Tungsten Alloy Rod Be Selected According to the Application?

Tungsten alloy rod is a type of high-density functional material based primarily on tungsten and produced by adding elements such as nickel, iron, copper, or molybdenum. Because tungsten alloys offer high density, high strength, good corrosion resistance, excellent high-temperature stability, and relatively good machinability, they are widely used in aerospace, defense protection, welding, semiconductor equipment, precision counterweights, high-temperature industries, and other fields.

Different applications have significantly different requirements for tungsten alloy rod performance. For example, armor-piercing penetrator cores focus more on density, strength, and penetration performance; welding electrodes focus more on electron emission capability and high-temperature stability; semiconductor targets require extremely high purity and low impurity content. Therefore, tungsten alloy rods should not be selected simply according to density. Instead, material composition, mechanical properties, operating temperature, service environment, and machining requirements should all be considered comprehensively.

I. Selecting the Appropriate Tungsten Alloy System According to Application Requirements
Common industrial tungsten alloy rods currently include high-density tungsten-nickel-iron alloys, high-purity tungsten rods, rare-earth-doped tungsten rods, tungsten-nickel-copper alloys, and special heat-resistant tungsten alloys. Typical material selections for different applications are as follows:

Application	Recommended material type	Main performance requirements
Armor-piercing penetrator core	High-density tungsten-nickel-iron alloy, such as 97WNiFe	High density, high strength, high penetration capability
TIG welding electrode	Cerium tungsten (WCe), lanthanum tungsten (WLa)	Good electron emission performance, arc stability
High-temperature furnace heating element	Rare-earth-doped tungsten rod	High-temperature stability, sag resistance
Counterweight	High-density tungsten alloy (90-97WNiFe)	High density, compact size, dimensional stability
Semiconductor target	High-purity tungsten rod (purity ≥99.95%)	High purity, low impurity content, vacuum stability
Die-casting mold	Anviloy 1150 (90W4Ni4Mo2Fe)	High-temperature strength, wear resistance, thermal fatigue resistance
EDM electrode	Pure tungsten rod	High melting point, high corrosion resistance, stable electrical conductivity

II. Defense and Aerospace: Prioritize High-Density Tungsten Alloys

High-density tungsten alloys such as 97WNiFe are commonly used for armor-piercing penetrator cores, kinetic-energy weapons, and aerospace inertial components. These materials generally contain more than 90% tungsten, with densities reaching approximately 17-19 g/cm³, significantly higher than steel.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

High density enables a greater mass within the same volume, thereby improving kinetic energy, inertia, or counterweight performance. The main advantages of high-density tungsten alloys include, first, a significant density advantage. Compared with conventional steel materials, tungsten alloys can achieve the same weight requirements with smaller dimensions, which is beneficial for equipment miniaturization. Second, they offer good mechanical properties. The nickel-iron binder phase can improve the brittleness of pure tungsten and enhance toughness and impact resistance. Third, they provide excellent dimensional stability. In precision aerospace structures, tungsten alloys can maintain good geometric stability when subjected to long-term vibration and temperature variations. Therefore, high-density tungsten alloys are widely used for counterweights, gyroscope rotors, inertial navigation components, and protective structures.

III. Welding Applications: Select Doped Tungsten Rods Rather Than Conventional Tungsten Rods

TIG welding (GTAW) and plasma arc welding (PAW) require electrodes that can withstand high-temperature arc conditions for extended periods while maintaining stable electron emission. Although conventional pure tungsten has a high melting point, its electron emission performance is relatively weak. Therefore, rare-earth-doped tungsten electrodes are generally used in industrial applications.

Common types include cerium tungsten electrodes (WCe), which are suitable for low-current and precision welding and provide good arc-starting performance; lanthanum tungsten electrodes (WLa), which offer excellent overall performance and are suitable for automatic welding and high-stability welding; and yttrium tungsten electrodes (WY), which are suitable for higher-current applications and special welding environments.

Compared with thoriated tungsten electrodes (WTh), the greatest advantage of rare-earth tungsten electrodes is that they are non-radioactive, making them more consistent with modern manufacturing requirements for occupational health and environmental protection.

IV. High-Temperature Furnaces: Focus on Resistance to High-Temperature Deformation

Applications such as high-temperature furnace heating elements and thermal-field support components commonly operate at temperatures exceeding 2000 °C. Materials must not only withstand high temperatures but also maintain dimensional stability over extended periods.

For these applications, rare-earth-doped tungsten rods, high-purity tungsten rods, and special grain-strengthened tungsten materials are generally selected. At high temperatures, conventional tungsten can undergo recrystallization and grain growth, resulting in reduced strength and bending deformation. The addition of rare-earth oxides can improve grain stability and enhance sag resistance.

V. Semiconductor Industry: Prioritize High-Purity Tungsten Materials

Semiconductor manufacturing equipment has extremely stringent material purity requirements. Particularly under vacuum and high-temperature conditions, impurity elements may contaminate wafers. Therefore, semiconductor targets, thermal-field components, and electrode materials generally use high-purity tungsten with a purity of ≥99.95%.

The key indicators include tungsten content, impurity levels of oxygen, carbon, iron, nickel,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

and other elements, grain structure, vacuum outgassing performance, and surface roughness. Compared with ordinary tungsten alloys, high-purity tungsten does not have outstanding advantages in density and strength, but its cleanliness characteristics make it more suitable for semiconductor applications.

VI. Die-Casting Molds: Select Heat-Resistant Tungsten Alloys

Aluminum alloy die-casting molds are subjected to high-temperature molten-metal impact for extended periods and therefore require materials with resistance to thermal fatigue, wear, and thermal shock.

Anviloy 1150 (90W4Ni4Mo2Fe) is a typical tungsten-based high-temperature alloy with good high-temperature hardness retention, excellent wear resistance, a relatively low coefficient of thermal expansion, and good thermal fatigue resistance. Therefore, it is widely used for die-casting mold cores, hot-work tools, and high-temperature mechanical components.

VII. Factors to Consider When Selecting Tungsten Alloy Rods

In actual procurement, in addition to the application field, the following factors should also be considered:

Factor	Impact
Density requirements	Determines whether a high-density tungsten alloy should be selected
Operating temperature	Determines whether pure tungsten or doped tungsten should be used
Strength requirements	Influences the selection of alloy system
Electrical conductivity	Affects welding and electrode applications
Purity requirements	Particularly important in semiconductor applications
Machining method	Influences the selection of material condition and specifications

CTIA GROUP believes that the key to selecting tungsten alloy rods is not to pursue the highest possible tungsten content, but to find the optimal balance among density, strength, heat resistance, purity, electrical conductivity, and machinability. Different application fields should use targeted material systems in order to fully leverage the advantages of tungsten materials.

Q45: Does CTIA GROUP Offer Custom Tungsten Alloy Rod Services?

Yes. Tungsten alloy rods are highly customizable. CTIA GROUP can customize the material grade, dimensions, surface condition, internal microstructure, and subsequent machining methods according to the customer's specific application requirements, meeting the requirements of aerospace, electronics manufacturing, medical equipment, semiconductor equipment, welding tools, industrial molds, and other fields. Since tungsten alloys are high-performance materials that are difficult to machine, their final performance depends not only on chemical composition, but also closely on powder metallurgy processes, sintering conditions, heat-treatment conditions, and machining methods. Therefore, a professional tungsten alloy supplier generally needs to design the material according to the customer's operating conditions rather than simply supplying standard rods.

I. Main Customization Options

Custom Dimensions and Specifications

Tungsten alloy rods can be customized according to the customer's requirements for diameter, length, and dimensional tolerances. Common forms include round rods, stepped



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

rods, hollow tubes, precision short rods, and special-shaped components. Diameter ranges can cover precision components at the millimeter scale as well as industrial components with diameters of several tens of millimeters or even larger dimensions. For high-precision applications such as gyroscope rotors, counterweights, and electronic equipment components, strict control of diameter tolerance, roundness, straightness, and concentricity is generally required.

II. Customizable Material Composition

The tungsten alloy composition can be adjusted according to the application environment.

For example:

Material Type	Typical Composition	Main Applications
90WNiFe	W-Ni-Fe	Counterweights, structural components
95WNiFe	High tungsten content	High-density applications
97WNiFe	Ultra-high density	Military and aerospace applications
WNiCu	Tungsten-nickel-copper	Applications requiring specific magnetic properties
WCu	Tungsten-copper composite material	Electrodes, thermal management materials

Different compositions affect density, hardness, elongation, thermal conductivity, magnetic properties, and machinability.

III. Customizable Surface Conditions

Different surface conditions can be provided according to customer requirements, including as-sintered or black surface, turned surface, centerless-ground surface, precision-ground surface, and polished surface. For example, precision counterweights generally require high surface accuracy, while welding electrodes require clean surfaces and consistent dimensions.

IV. Special Machining Services

Because tungsten alloys have relatively high hardness, conventional machining can be challenging. Professional manufacturers can therefore provide precision cutting, drilling, chamfering, threading, slotting, special-shaped machining, and CNC precision machining. Through customized machining, customers can obtain components close to their final service condition, reducing the need for secondary machining and associated costs.

V. Quality Inspection According to Requirements

For high-end applications, CTIA GROUP can provide relevant inspection data according to customer requirements, including:

Inspection Item	Purpose
Chemical composition analysis	Confirm the material grade
Density testing	Evaluate material consistency
Hardness testing	Evaluate mechanical properties
Metallographic analysis	Evaluate internal microstructure
Dimensional inspection	Ensure assembly accuracy
Ultrasonic testing	Check for internal defects

VI. What Information Is Required to Customize Tungsten Alloy Rods?

To improve quotation accuracy and shorten communication time, customers are advised to provide complete technical requirements, including: (1) product drawings or 3D models; (2)



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

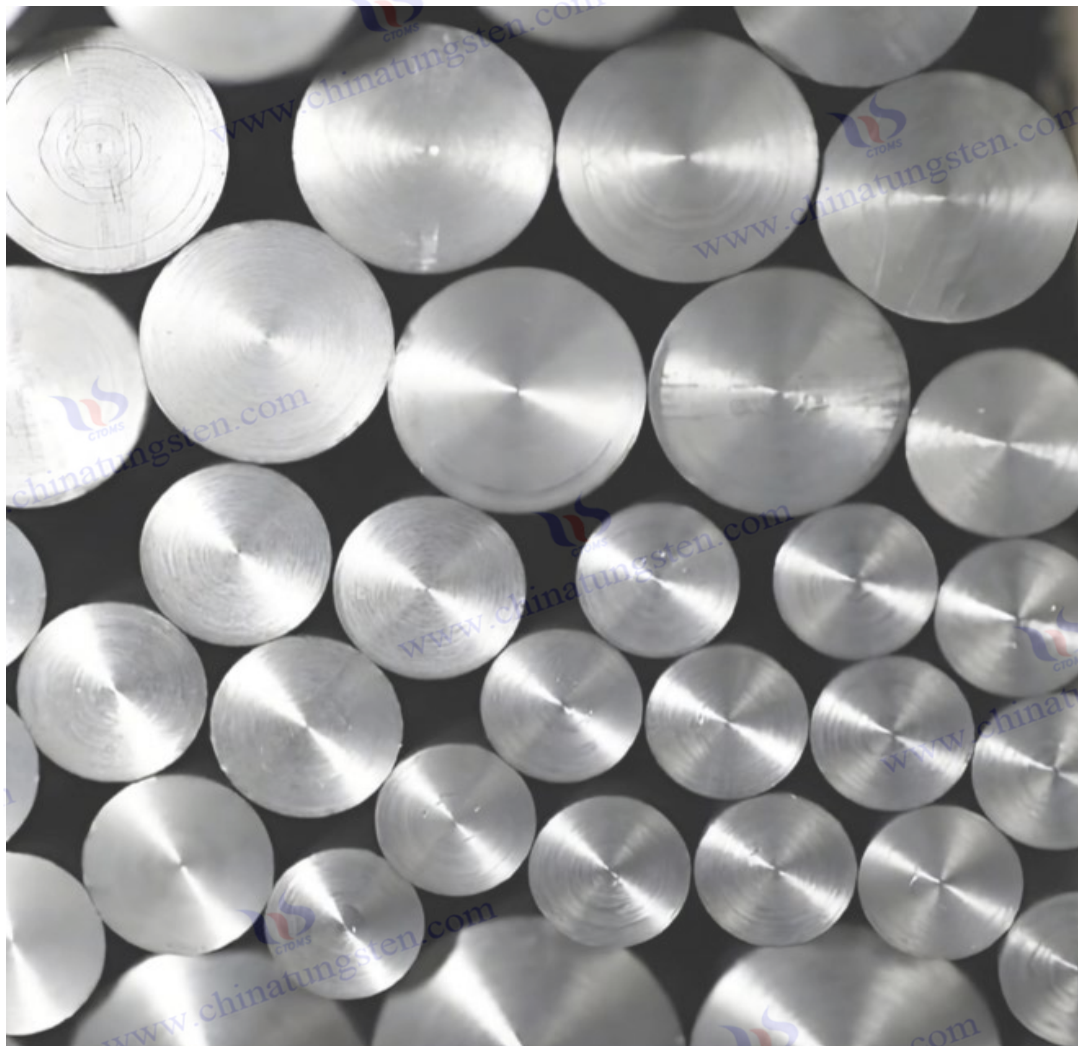
ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

required material grade; (3) dimensions, specifications, and quantity; (4) operating environment, such as temperature, pressure, vacuum, and corrosive conditions; (5) surface and inspection requirements; and (6) delivery schedule and packaging requirements. If the customer cannot determine the specific material, the intended application and operating conditions can also be provided, and engineering personnel can assist in selecting the appropriate tungsten alloy system.

CTIA GROUP believes that the core value of customized tungsten alloy rod services lies in matching material design with the actual application. By appropriately selecting tungsten content, alloy system, manufacturing processes, and quality-control methods, the product can achieve an optimal balance among density, strength, heat resistance, and reliability, providing high-performance tungsten material solutions for aerospace, semiconductor, energy equipment, and precision industrial applications.





CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



IX. Common Misconceptions About Tungsten Alloy Rods

Q46: Are Tungsten Alloy Rods the Same as Cemented Carbide Rods?

No. Tungsten alloy rods (Tungsten Heavy Alloy Rod) and cemented carbide rods (Cemented Carbide Rod, also commonly referred to as tungsten steel rods) both contain tungsten in their names and are high-performance tungsten-based materials, but they are fundamentally different in terms of material systems, manufacturing processes, performance characteristics, and application fields. Since terms such as tungsten rod, tungsten steel rod, and tungsten alloy rod are easily confused in the Chinese market, it is essential to clearly distinguish between them during engineering procurement and material selection.

Tungsten alloy rods mainly belong to the category of high-density tungsten-based alloys. Their primary design objective is to utilize tungsten's high density, high strength, and excellent radiation-shielding capability while improving toughness and machinability through a metallic binder phase. Typical tungsten alloy systems use tungsten (W) as the principal component and add metals such as nickel (Ni), iron (Fe), and copper (Cu) as binder phases.

Common grades generally contain approximately 90%–97% tungsten by weight, with densities typically reaching about 16.5–19.0 g/cm³. For example:

Material Type	Composition	Typical Density	Main Characteristics
Tungsten-nickel-iron alloy	W-Ni-Fe	Approx. 17–18.5 g/cm ³	High strength, good toughness, suitable for structural components
Tungsten-nickel-copper alloy	W-Ni-Cu	Approx. 17–18.5 g/cm ³	Good electrical conductivity and corrosion resistance
High-gravity tungsten alloy	W-based alloy	Above 18 g/cm ³	High density and high inertia

Because tungsten alloys have a density close to that of pure tungsten while offering better ductility and impact resistance than pure tungsten, they are mainly used in applications requiring high mass concentration, inertial control, or high-energy protection. Typical applications include counterweights, aircraft control-system balance weights, gyroscope rotors, and engine vibration-control components in aerospace; armor-piercing cores and



kinetic penetrator materials in military applications; radiation shielding components in the nuclear industry; and radiation protection components in medical applications.

Cemented carbide rods, however, belong to an entirely different material system. They primarily consist of tungsten carbide (WC) as the hard phase and cobalt (Co) as the binder phase. Typical compositions contain approximately 80%–95% WC and about 5%–20% cobalt. The core characteristics of cemented carbide are not high density, but extremely high hardness, wear resistance, and compressive strength. Typical properties and applications of cemented carbide rods include:

Performance Indicator	Typical Range for Cemented Carbide Rods
Hardness	HRA 85–94
Compressive strength	Approx. 4000 MPa or higher
Density	Approx. 14–15.5 g/cm ³
Main advantages	High wear resistance, high hardness, excellent hot hardness
Applications	Cutting tools and wear-resistant components

Cemented carbide rods are mainly used to manufacture cutting tools and wear-resistant components, such as CNC cutting tools, PCB micro drills, solid carbide drills, milling cutters, reamers, stamping dies, wire-drawing dies, and wear-resistant nozzles.

From the perspective of manufacturing processes, the two materials also differ significantly.

Tungsten alloy rods are generally manufactured through powder metallurgy liquid-phase sintering. First, tungsten powder is mixed with metallic powders such as nickel-iron or nickel-copper. The mixture is then compacted and subjected to liquid-phase sintering at approximately 1400–1500 °C. During sintering, the metallic binder phase fills the pores between tungsten particles, forming a high-density alloy structure.

Cemented carbide rods are manufactured by mixing WC powder with cobalt powder, followed by compaction and sintering to form a WC-Co cemented carbide structure. The sintering temperature is generally approximately 1350–1500 °C. The key is to control WC grain size and cobalt-phase distribution in order to achieve an optimal balance between hardness and toughness.

Although both materials contain tungsten, their design concepts are fundamentally different. Tungsten alloys focus on high density, high inertia, and high impact resistance, whereas cemented carbide focuses on high hardness, high wear resistance, and high-temperature cutting capability. A simple comparison is shown below:

Comparison Item	Tungsten Alloy Rod	Cemented Carbide Rod
English Name	Tungsten Heavy Alloy Rod	Tungsten Cemented Carbide Rod
Main Hard Phase	Tungsten, W	Tungsten carbide, WC
Binder Phase	Ni, Fe, Cu, etc.	Mainly Co
Core Properties	High density, high toughness	High hardness, high wear resistance
Density	16.5–19 g/cm ³	14–15.5 g/cm ³
Main Applications	Counterweights, protection, inertia components	Cutting tools, drills, molds
Machining Characteristics	Can be mechanically machined	Requires grinding and electrical machining



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Therefore, in actual procurement, if the customer needs to manufacture aircraft balance weights, gyroscope rotors, radiation shielding components, or high-density structural components, tungsten alloy rods should be selected. If the intended applications are cutting tools, drills, molds, or wear-resistant components, cemented carbide rods should be selected.

CTIA GROUP believes that although tungsten alloy rods and cemented carbide rods are both tungsten-based materials, they belong to two completely different material systems. Correctly understanding the differences between them is essential for ensuring that the materials deliver their intended performance and for reducing manufacturing costs.

Q47: Is a Tungsten Alloy Rod the Same Kind of Weapon as Rods from God?

No. The so-called Rods from God, also known as space-based kinetic weapons or orbital kinetic strike systems, is a conceptual future weapon concept and is not the type of tungsten alloy rod product normally referred to in real-world industrial applications.

The Rods from God concept is based on the idea of using physical kinetic energy for long-range strikes. Its basic principle is to release high-density metal rods from an orbital platform in space, allowing them to enter the atmosphere at high speed under the force of gravity and use the enormous kinetic energy generated by their high-speed motion to strike a target. Because tungsten has an extremely high density, approximately 19.25 g/cm³ for pure tungsten, a high melting point of 3422 °C, and good high-temperature stability, tungsten or tungsten alloys are often considered in theoretical discussions as potential materials for such conceptual weapons.

However, it is important to clarify that actual industrial tungsten alloy rod products have no direct correspondence with this conceptual weapon. In industry, tungsten alloy rods are primarily high-performance engineering materials widely used in civilian and industrial manufacturing applications, such as aerospace counterweights, aircraft and helicopter balancing components, high-precision gyroscope rotors, medical radiation shielding components, nuclear industry shielding materials, welding electrodes, and high-temperature structural components.

These applications focus on material density, mechanical properties, corrosion resistance, dimensional stability, and machinability rather than weapon applications.

From the perspective of material properties, tungsten alloys do have several theoretical advantages. First is their high-density advantage. Tungsten alloys typically have densities of 17–19 g/cm³, so for the same volume, their mass is considerably greater than that of common metals such as steel and copper. This makes them suitable for applications requiring concentrated mass and inertial control. Second is their high-temperature stability. Tungsten has a melting point exceeding 3400 °C and is one of the metals with the highest melting points. It can maintain relatively good structural stability in high-temperature environments. Third is their good mechanical performance. Compared with pure tungsten, tungsten alloys can improve toughness and impact resistance by adding elements such as nickel, iron, and copper, making them more suitable for engineering applications.

However, it is inaccurate to simply equate these material properties with Rods from God. In actual engineering applications, material selection depends not only on density but also on manufacturing cost, machining difficulty, reliability, environmental adaptability, and regulatory requirements. For example, in aerospace applications, tungsten alloys are more



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

commonly used for precise mass control rather than high-speed impact applications. In medical applications, tungsten alloys utilize their high density for radiation shielding. In the welding industry, tungsten-based materials utilize their high melting point as electrode materials. The differences between common industrial tungsten alloy rods and the conceptual weapon are shown below:

Item	Industrial Tungsten Alloy Rod	Rods from God Concept
Nature	Engineering material product	Conceptual weapon design
Main applications	Counterweights, shielding, electrodes, structural com.	Theoretical kinetic-energy strike
Fields of application	Aerospace, medical, industrial manufacturing	Science-fiction and military research concept
Key performance characteristics	Density, strength, machinability	Kinetic energy at high speed
Current status	Widely commercially available	Has not become an actual weapon system

CTIA GROUP believes that tungsten alloy rods are mature high-performance engineering materials whose value lies in using tungsten's high density, high-temperature properties, and stability to solve practical industrial problems. Although tungsten alloys frequently appear in discussions of conceptual weapons such as Rods from God because of their physical properties, actual tungsten alloy rods primarily serve the aerospace, semiconductor, medical, energy, and advanced manufacturing sectors and are important industrial materials rather than specialized weapon products.

Q48: Can Tungsten Alloy Rods Be Used to Make Jewelry?

Yes. Tungsten alloy rods, particularly high-density tungsten alloy materials, can be used to manufacture certain high-end jewelry products after appropriate machining, surface treatment, and decorative design. Examples include gold-plated tungsten rods, tungsten gold bars, tungsten alloy rings, pendants, commemorative jewelry, and personalized collectibles. Although tungsten alloys are not traditional precious-metal jewelry materials, their unique physical properties have created a certain market niche in modern industrial-style, high-tech-style, and men's jewelry products. The greatest advantages of tungsten alloy jewelry are not its precious-metal value, but its extremely high hardness, wear resistance, and long-term stability.

Tungsten alloy density can typically reach 17–19 g/cm³, which is close to that of gold at approximately 19.3 g/cm³. Therefore, tungsten alloy jewelry of the same size can provide a noticeably substantial weight and solid feel. This is also one of the reasons tungsten alloy jewelry is sometimes referred to as tungsten gold jewelry.

(A) Unique tactile quality resulting from high density

The most obvious jewelry advantage of tungsten alloy is its high density. Jewelry made from conventional stainless steel, titanium alloys, and other materials is generally relatively lightweight, whereas tungsten alloys can provide a heavy feel similar to that of precious metals.

Material	Density (g/cm ³)	Characteristics
Aluminum alloy	Approximately 2.7	Lightweight
Stainless steel	Approximately 7.8	Common jewelry material
Copper alloy	Approximately 8.5	Good machinability
Tungsten alloy	17–19	High density and substantial feel
Gold	Approximately 19.3	Precious-metal value



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

Therefore, tungsten alloy jewelry can provide a weight experience similar to gold without using large quantities of precious metals, making it particularly suitable for consumers who prefer a rugged appearance, technological aesthetics, and durability.

(B)Excellent wear resistance and improved service life

Tungsten alloys have relatively high hardness, generally much higher than that of ordinary steels, and therefore offer excellent scratch and wear resistance. Conventional precious metals such as gold and pure silver have high decorative value but relatively low hardness, making them susceptible to surface scratches, edge wear, and deformation during long-term use. In contrast, tungsten alloy jewelry can maintain its surface luster and geometric shape for a relatively long time during daily wear, making it particularly suitable for jewelry such as rings and bracelets that frequently come into contact with the external environment.

(C)Good corrosion resistance

Tungsten alloys have good chemical stability and are not easily oxidized, corroded, or discolored under normal living conditions. Compared with certain traditional metal jewelry materials, tungsten alloys offer several advantages: they are not prone to rust, are resistant to discoloration, have good resistance to sweat and moisture, and can maintain a stable appearance over long periods. Therefore, tungsten alloy jewelry is suitable for long-term wear and does not require frequent maintenance.

(D)Surface treatment provides a wider range of decorative effects

Pure tungsten alloys generally have a gray-black metallic luster. Through different surface treatment processes, a wide range of visual effects can be achieved. Common processes include gold plating to produce a golden-yellow appearance, silver or rhodium plating to increase brightness, polishing to achieve a mirror finish, brushing to create a metallic texture, and laser engraving for personalized designs. Therefore, tungsten alloys can serve not only as industrial materials but also be transformed into decorative consumer products through modern processing technologies.

(E)Differences between tungsten alloy jewelry and gold jewelry

It should be noted that although tungsten alloy has a density close to that of gold, the value attributes of the two materials are completely different. The value of gold jewelry primarily comes from the precious-metal nature of gold, its financial value, scarcity, and traditional cultural significance. The main advantages of tungsten alloy jewelry, by contrast, come from its high-tech material characteristics, high wear resistance, distinctive weight, and modern design concepts. Therefore, tungsten alloy is more suitable for fashion jewelry, commemorative products, and functional jewelry rather than traditional investment-oriented precious-metal jewelry.

(F)Issues requiring attention when machining tungsten alloy jewelry

Although tungsten alloys have excellent properties, they are relatively difficult to machine. Due to their high hardness and limited toughness, processing generally requires diamond tools, precision grinding, laser processing, or electrical discharge machining (EDM). Professional processing equipment and process experience are particularly important when manufacturing complex structures, small-sized components, or high-precision jewelry products.

CTIA GROUP believes that the use of tungsten alloy rods in jewelry manufacturing



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

represents a cross-industry application of the material. Its core value is not to replace gold, but to utilize the high density, high hardness, and high stability of tungsten alloys to provide new design possibilities for modern jewelry. With the development of personalized consumption, high-tech material jewelry, and functional jewelry markets, tungsten alloy jewelry continues to have considerable application potential.

Q49: Is a Heavier Tungsten Alloy Rod Always Better?

Not necessarily. The weight of a tungsten alloy rod mainly depends on its density, while density is related to tungsten content and the alloy system. Although high-density tungsten alloys have significant advantages in many fields, not every application requires the highest possible density. In actual engineering applications, a comprehensive balance must be achieved among density, strength, toughness, machinability, cost, and operating environment according to specific functional requirements. Tungsten alloys are not simply a case of heavier being better. Rather, the most important consideration is the combination of properties that best suits the application requirements.

(A)High-density tungsten alloys are suitable for applications requiring extremely high mass concentration

For certain specialized applications, high density is indeed extremely important. For example, armor-piercing penetrators, kinetic penetrator materials, and high-inertia rotors require the highest possible mass per unit volume. High-tungsten-content alloys generally feature high density, which can reach 18–19 g/cm³ or higher, high momentum, strong inertia, and concentrated mass within a small volume. In armor-piercing penetrator applications, high density can increase the mass per unit cross-sectional area, thereby improving the penetration capability of the penetrator. Similarly, in aerospace gyroscope rotors, inertia wheels, and other components, high density can increase the rotational inertia, allowing greater stability to be achieved within a smaller volume.

(B)For counterweight applications, the highest density is not necessarily the most economical choice

Tungsten alloys are widely used as counterweights in aircraft, automobiles, robots, and precision equipment, including aircraft control-surface counterweights, helicopter rotor balancing weights, spacecraft attitude-adjustment components, and industrial robot counterweights. These applications require accurate mass rather than an unlimited increase in density. Excessively high material density may increase material costs, machining difficulty, and structural design limitations. Therefore, engineering designs generally select an appropriate density grade that meets spatial constraints and weight requirements.

Application field	Primary consideration	Is the highest density pursued?
Armor-piercing penetrators	Penetration capability	Yes
Gyroscope rotors	Inertial stability	Relatively high requirement
Aircraft counterweights	Balancing performance	Appropriate density is sufficient
Robot counterweights	Balance between cost and performance	Not necessarily
Welding electrodes	Arc performance	No

(C)Electrode materials focus more on overall performance than density alone

Tungsten electrodes are a typical example. Tungsten electrodes used for TIG welding and plasma arc welding are also tungsten-based materials, but their evaluation criteria are completely different from those for counterweights. Electrodes are more concerned with electron emission capability, arc stability, burn-off rate, thermionic emission characteristics, and service life. Therefore, cerium tungsten electrodes, lanthanum tungsten electrodes,



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

and yttrium tungsten electrodes do not improve performance simply by increasing density. Instead, they improve electrical performance through the addition of rare-earth oxides. For example, cerium tungsten electrodes offer good arc-starting performance at low current, lanthanum tungsten electrodes provide good stability and service life, while thoriated tungsten electrodes, although offering excellent performance, are gradually being replaced by environmentally friendly rare-earth tungsten electrodes because they contain radioactive thorium oxide.

(D) Increasing density may reduce certain machining properties

Higher tungsten content generally means higher density, but it may also result in reduced ductility, increased machining difficulty, greater forming difficulty, and higher costs. Therefore, when manufacturing complex components, it is not necessarily appropriate to select the material with the highest tungsten content. Instead, the alloy grade with the best overall performance should be selected.

Tungsten content	Density characteristics	Typical characteristics
Approximately 90%	Medium to high density	Relatively good machinability
92-95%	High density	Good balance of overall properties
Above 95%	Ultra-high density	Suitable for specialized high-performance applications

(F) Selecting an appropriate tungsten alloy density grade

When purchasing tungsten alloy rods, the density grade should be determined according to the following factors: (1) intended application, such as counterweight, shielding, penetration, inertia, or machined components; (2) spatial constraints, including whether a small volume with high mass is required; (3) strength requirements, including whether the material will be subjected to impact or high-speed motion; (4) machining requirements, including whether turning, drilling, or grinding is required; and (5) cost requirements, including whether the highest tungsten content is actually necessary.

CTIA GROUP believes that the core value of a tungsten alloy rod is not simply to pursue maximum weight, but to achieve the optimal balance among density, performance, and economic efficiency. For specialized applications such as armor penetration and inertial control, high-density tungsten alloys offer irreplaceable advantages. For counterweights, electrodes, and general industrial applications, however, an appropriate alloy grade should be selected according to actual requirements. The development of advanced tungsten alloy manufacturing has also shifted from simply increasing density toward high performance, multifunctionality, and application-specific customization.



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



Q50: Why Do Tungsten Alloy Rod Prices Vary So Much?

Tungsten alloy rods are typical high-density, high-performance metallic materials widely used in aerospace counterweights, automotive crankshaft balance weights, medical collimators, military equipment, precision molds, welding electrodes, semiconductor equipment, research facilities, and other applications. When purchasing tungsten alloy rods, many users find that quotations from different suppliers can vary considerably. Even when the product names are the same and the specifications are similar, prices may differ by dozens of percentage points or even more. The reasons for these price differences are not determined solely by the price of tungsten raw materials. Instead, they are jointly determined by material composition, manufacturing process, dimensional specifications, machining accuracy, quality grade, and application requirements. Tungsten alloys are typical high-value-added materials, and their prices actually reflect material performance and manufacturing difficulty rather than simply the price per unit weight of the metal.

(A) Tungsten Content Is the Core Factor Affecting Price

The most important factor affecting the price of tungsten alloy rods is tungsten content. In general, the higher the tungsten content, the higher the material density and the higher the cost. Common tungsten alloy grades include 90W, 92.5W, 95W, and 97W. Typical characteristics include:

Tungsten Content	Typical Density	Main Characteristics
90% W	Approximately 17 g/cm ³	Good overall performance and relatively low cost
92.5% W	Approximately 17.5 g/cm ³	Commonly used for counterweights and industrial components
95% W	Approximately 18 g/cm ³	Widely used in high-density, high-performance applications
97% W	Close to 19 g/cm ³	Used in high-end precision applications

Because tungsten itself is relatively expensive, increasing the tungsten content not only raises raw material costs, but also increases the difficulty of powder mixing, sintering densification, and machining. For example, compared with a 90% tungsten alloy rod, a 95% tungsten alloy rod contains only several percentage points more tungsten by composition,



but its density, mechanical properties, and application grade can change significantly, resulting in a noticeable price difference. In aerospace, medical shielding, and high-precision inertial components, users generally pay greater attention to material performance rather than simply pursuing the lowest price, so high-tungsten-content products account for a significant proportion of demand.

(B)Material Purity Affects Manufacturing Cost and Performance Grade

In addition to tungsten content, the purity of the raw material is another important factor affecting the price of tungsten alloy rods. High-purity tungsten powder generally requires a tungsten content of $\geq 99.95\%$, low oxygen content, low levels of impurity elements, and stable particle-size distribution. Compared with ordinary industrial-grade tungsten powder, the production of high-purity tungsten powder requires stricter raw material control, hydrogen reduction processes, screening, and quality inspection, resulting in higher costs.

Particularly in semiconductor equipment, electronics, and aerospace applications, impurities such as oxygen, iron, nickel, and molybdenum can affect high-temperature stability, outgassing rates in vacuum environments, fatigue resistance, and long-term dimensional stability. Therefore, high-end applications generally require higher-purity tungsten raw materials, while ordinary counterweight components may use industrial-grade materials. Naturally, there can be a significant price difference between the two.

(C)Alloying Elements Affect Price

Tungsten alloys are not pure tungsten materials. Elements such as nickel, iron, and copper are added to improve machinability and mechanical properties. Common systems include W-Ni-Fe tungsten heavy alloys, W-Ni-Cu tungsten heavy alloys, and special-purpose tungsten alloys.

Different alloying systems affect both material cost and performance. For example, W-Ni-Fe alloys offer relatively high strength and good machinability and are widely used in aerospace and military applications. W-Ni-Cu alloys provide good electrical conductivity and corrosion resistance and are suitable for electronics and electrical applications.

In addition, some special tungsten alloy rods may contain rare-earth elements such as lanthanum (La), cerium (Ce), and yttrium (Y). Rare-earth-doped tungsten rods are mainly used in welding electrodes and other applications. Their manufacturing costs are generally higher than those of ordinary tungsten rods because they require powder doping, uniform dispersion, and specialized sintering technologies.

(D)Machining Condition Determines the Final Price

Tungsten alloy rods are generally not sold in a single condition. Different machining grades can be supplied according to customer requirements. Common conditions include:

Machining Condition	Characteristics	Cost Level
Sintered as-sintered rod	Sintered surface retained, relatively low dimensional accuracy	Low
Turned rod	Basic dimensional accuracy	Medium
Ground rod	Smooth surface and high dimensional accuracy	Relatively high
Polished rod	Excellent surface quality	High
Precision-machined component	Machined according to drawings to meet assembly requirements	Highest

For example, tungsten alloy rods with the same diameter of 10 mm may have very different prices depending on their condition. As-sintered rods are mainly suitable for subsequent



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

machining, ground rods can be directly used for precision assembly, while mirror-polished rods may be used in high-precision applications such as medical equipment and research instruments. The more machining steps required, the higher the material loss, equipment investment, and labor costs, and therefore the higher the price.

(F)Dimensions and Specifications Affect Manufacturing Difficulty

The dimensions of tungsten alloy rods are also an important factor behind price differences. In general, small-size and standard-size products are easier to manufacture in batches and therefore have lower unit costs. Extra-long rods, extra-large-diameter rods, ultra-fine rods, and products with special proportions are significantly more difficult to manufacture.

The main reasons include increased difficulty in powder compaction, the tendency to develop density gradients during sintering, deformation during machining, and reduced yield. For example, large tungsten alloy rods require stricter control of sintering temperature, atmosphere, and cooling rate; otherwise, internal defects may occur. Ultra-fine tungsten alloy rods, meanwhile, require higher machining precision to prevent bending and dimensional deviations. Therefore, non-standard-size products generally require individually designed manufacturing processes and are priced higher than standard specifications.

(G)Inspection Requirements Also Affect Price

Inspection requirements vary considerably among different application fields. Ordinary industrial applications may only require inspection of dimensions, density, and appearance. Aerospace, medical, and semiconductor applications, however, often require additional chemical composition analysis, density testing, hardness testing, metallographic analysis, ultrasonic testing, non-destructive testing, and 100% dimensional inspection. The greater the number of inspection items required, the higher the production-cycle and quality-control costs, which consequently increases the final price.

(H)Purchase Quantity Affects Unit Price

Tungsten alloy rods are powder-metallurgy products and therefore have significant economies of scale. For large-volume orders, tooling costs can be distributed over more products, material utilization can be improved, and machining efficiency can be increased, thereby reducing the unit cost. Small-batch customized products, on the other hand, generally require separate production scheduling and individual machining, resulting in a higher unit price. Especially when customers require special drawings, non-standard dimensions, or special performance characteristics, the quotation may be relatively high even if the total product weight is small, because of process preparation and setup costs.

Summary of the Main Factors Affecting Tungsten Alloy Rod Prices

Factor	Impact on Price	Main Reason
Tungsten content	Highest	Different raw material costs and performance grades
Material purity	Significant	High-purity powder has higher manufacturing costs
Alloy system	Significant	Different alloying elements and manufacturing processes
Machining accuracy	Significant	Grinding and polishing increase costs
Product dimensions	Significant	Non-standard specifications are more difficult to manufacture
Inspection requirements	Moderate	Strict quality control is required for high-end industries
Purchase quantity	Moderate	Affects production efficiency and cost allocation



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

CTIA GROUP believes that differences in tungsten alloy rod prices essentially reflect differences in material grade, manufacturing difficulty, and application requirements. For users, product quality should not be judged simply by the price per kilogram. Instead, tungsten content, density, purity, machining condition, dimensional accuracy, and actual operating environment should be considered comprehensively.

For example, tungsten alloy rods used for aerospace counterweights place greater emphasis on density consistency and long-term stability; products used for medical collimators place greater emphasis on dimensional accuracy and material uniformity; tungsten rods used as welding electrodes place greater emphasis on dopant distribution and arc performance. Therefore, when purchasing tungsten alloy rods, providing complete technical requirements, operating conditions, and machining requirements enables suppliers to provide a more accurate quotation and a more suitable material solution. For high-end applications, selecting the appropriate material grade is more important than simply reducing the purchase price.



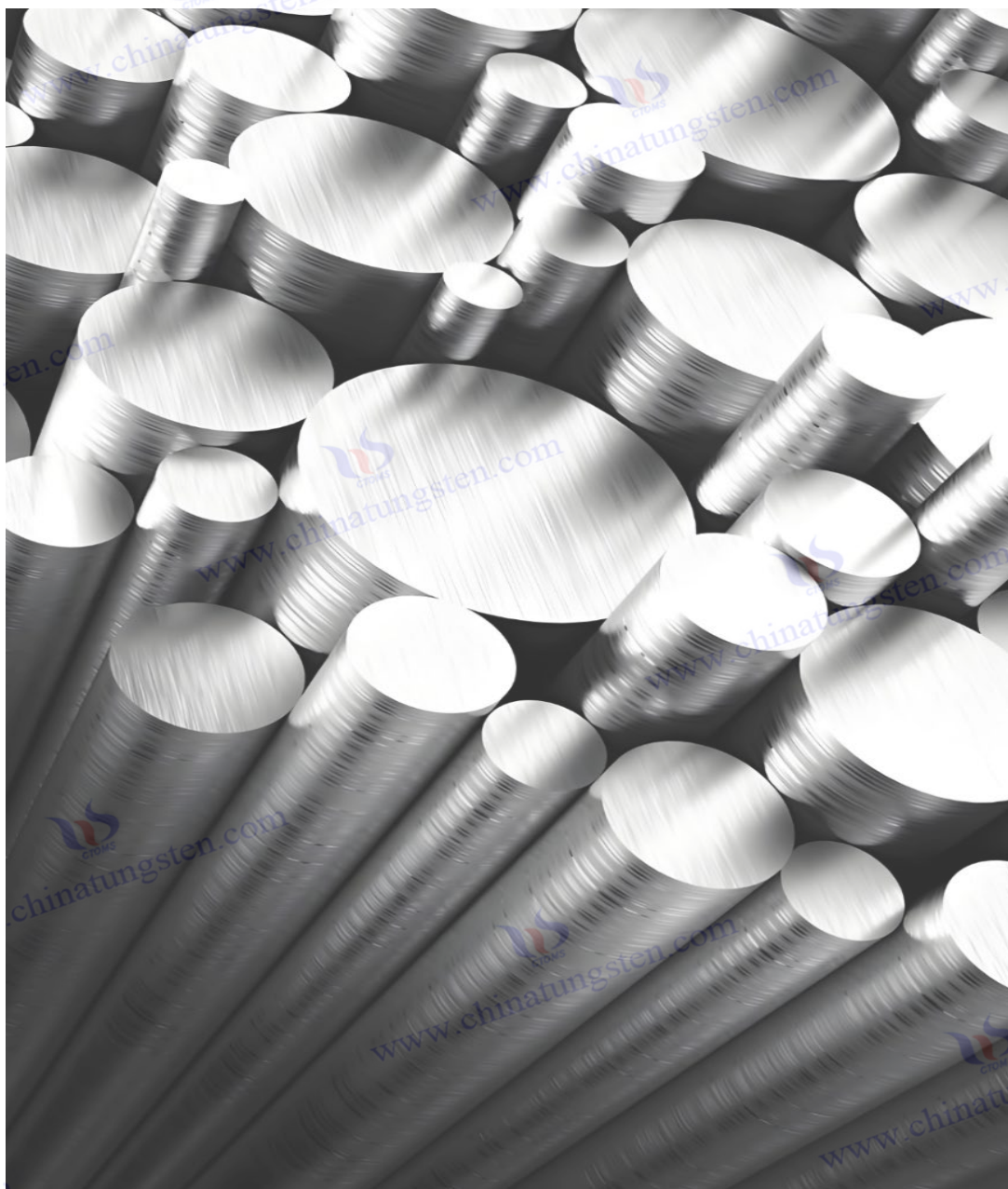
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com




www.chinatungsten.com


www.chinatungsten.com



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

How to Customize and Purchase Tungsten Alloy Rods?

CTIA GROUP LTD.

Tungsten Alloy Rod Customization and Procurement Requirements Checklist

To improve quotation accuracy for customized tungsten alloy rods, shorten technical communication cycles, and ensure that products meet actual application requirements, customers are encouraged to provide the following information whenever possible. If certain parameters are uncertain, customers may provide the intended application, operating conditions, or reference samples, and CTIA GROUP engineers can assist in confirming the requirements.

I. Customer and Project Information

Item	Customer Information
Company name	
Contact person	
Contact information (email/telephone)	
Project name or application field	
Estimated purchase quantity	
Desired delivery date	

II. Tungsten Alloy Rod Product Requirements

Category	Specific Requirements	Customer Information
Product name	Tungsten alloy rod / tungsten rod / tungsten heavy alloy rod / rare-earth tungsten rod, etc.	
Material grade	W-Ni-Fe, W-Ni-Cu, pure tungsten, lanthanum tungsten, cerium tungsten, etc. (if specified)	
Tungsten content	90%, 93%, 95%, 97%, ≥99%, etc.	
Alloy system	W-Ni-Fe, W-Ni-Cu, W-Cu, W-La, W-Ce, etc.	
Main application	Counterweights, shielding, welding electrodes, high-temperature components, molds, electrode materials, etc.	
Applicable standard	National standard, ASTM, customer standard, or other technical specification	

III. Dimensions and Machining Requirements

Category	Specific Requirements	Customer Information
Rod dimensions	Diameter × length, e.g. Φ10 × 200 mm	
Quantity	Quantity per piece and total purchase quantity	
Dimensional tolerance	General tolerance, precision tolerance, or according to drawing requirements	
Straightness	Any special straightness requirement	
Machining condition	As-sintered rod, turned, ground, polished, precision-machined	
Drawings or samples	Please provide PDF drawings, STEP/STP models, or physical samples	

IV. Performance and Quality Requirements

Category	Specific Requirements	Customer Information
Density	≥17.0 g/cm ³ , ≥18.0 g/cm ³ , etc.	
Hardness	HV, HRC, etc., if required	
Mechanical properties	Tensile strength, elongation, compressive strength, etc., if required	
Composition	W content, Ni, Fe, Cu ratios, or other element requirements	
Internal quality	No cracks, no pores, uniform microstructure, etc.	
Inspection reports	Material certificate, inspection report, third-party report, etc.	



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

V. Operating Environment and Service Conditions

Category	Specific Requirements	Customer Information
Operating temperature	Room temperature or high temperature, please specify maximum temperature	
Working environment	Vacuum, air, protective atmosphere, corrosive environment, etc.	
Loading conditions	Static load, impact, rotation, high-speed movement, etc.	
Special performance requirements	Radiation resistance, wear resistance, corrosion resistance, high density, high stability, etc.	
Service life	Continuous operating time or required service life	

VI. Surface Treatment and Packaging Requirements

Category	Specific Requirements	Customer Information
Surface condition	As-sintered, turned, ground, mirror-polished, etc.	
Surface roughness	Ra0.8, Ra0.4, etc.	
Chamfering	Whether end chamfers or radius treatment are required	
Packaging	Moisture-proof, shock-proof, vacuum packaging, export packaging, etc.	
Transportation	Standard transportation, air transportation, or special requirements	

VII. Supporting Documents

Customers may provide the following documents according to actual requirements:

Document Type	Provided
Product drawing (PDF/CAD)	☐
3D model (STEP/STP)	☐
Physical sample or photographs	☐
Material standard or technical specification	☐
Operating environment information	☐
Other technical documents	☐

Tungsten Alloy Rod Procurement Information – Quick Inquiry Form

Item	Customer Information
Material grade / tungsten content	
Dimensions (diameter × length)	
Quantity	
Application	
Operating temperature and environment	
Accuracy and surface requirements	
Drawing/sample available	
Delivery time	

Submission Information

Please send the procurement requirements checklist, product drawings, technical requirements, or sample information to:

CTIA GROUP LTD.

Address: 3F, No. 25-1 Wanghai Rd, Software Park II, Xiamen, Fujian, China 361009

Tel: +86 592 512 9696 / +86 592 512 9595

Email: sales@chinatungsten.com

Web: www.ctia.group / www.ctia.com.cn

Based on the information provided by customers, CTIA GROUP will provide tungsten alloy material selection recommendations, manufacturing process solutions, quality standard confirmation, and formal quotations. For specialized applications in aerospace, electronics manufacturing, nuclear industry, medical shielding, high-end equipment, and other fields, targeted material design and customized manufacturing services can also be provided.



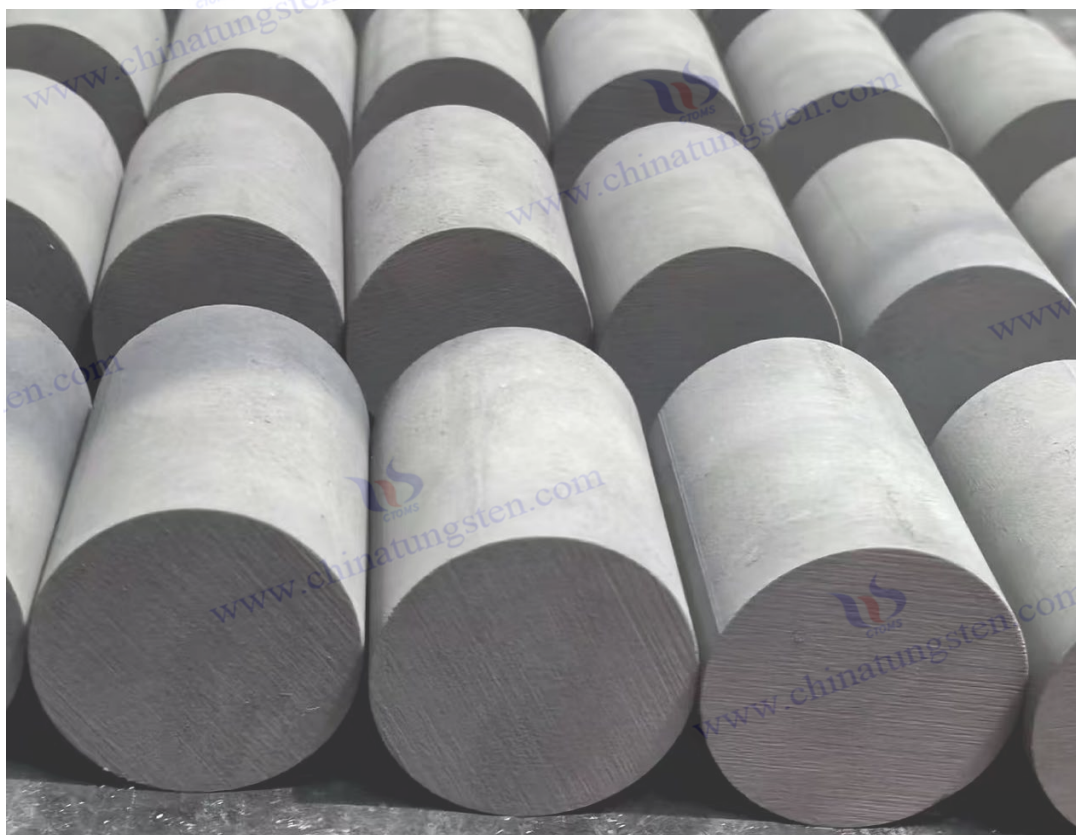
CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com



 www.chinatungsten.com

 www.chinatungsten.com

 www.chinatungsten.com

 www.chinatungsten.com

 www.chinatungsten.com



CTIA GROUP LTD

中钨智造（厦门）科技有限公司

ADD.: 3F, NO.25-1 WH RD, XIAMEN SOFTWARE PARK II, FUJIAN 361008, CHINA

TEL.: +86 592 5129696; +86 592 5129595

WEB: www.chinatungsten.com EMAIL: sales@chinatungsten.com

