



/ [Tungsten Carbide Industry News](#) / By: [admin](#)

Tungsten alloy properties

1.Density

Tungsten has a high density of up to 19.3 g/cm^3 , which consequently imparts high-density characteristics to tungsten alloys. Their densities typically range from 16.5 to 19.0 g/cm^3 . For instance, common tungsten-nickel-iron alloys generally have a density between 17.0 and 18.5 g/cm^3 , while the density of tungsten-copper alloys varies between 16.5 and 18.0 g/cm^3 depending on the copper content. Tungsten-cobalt alloys ([tungsten carbide](#)) usually exhibit densities in the range of 14.0 – 15.0 g/cm^3 . If you want to know [tungsten carbide properties](#) please click here.

2.Tensile Strength

As-sintered state: The tensile strength of [tungsten alloys](#) produced via powder metallurgy sintering typically falls within the range of 600 – 1000 MPa . In this state, the alloy's microstructure is relatively porous, containing certain voids, which limits its strength.

Worked and strengthened state: After strengthening treatments such as forging or rolling, the tensile strength of tungsten alloys can be significantly enhanced, reaching values between 1300 – 2000 MPa or even higher. This improvement is attributed to grain refinement, a more densified microstructure, and an increase in crystal defects (e.g., dislocations) caused by the working process. These factors impede slip deformation under load, thereby increasing tensile strength. For example, the tensile strength of high-performance tungsten alloys subjected to specialized rolling processes can exceed 2000 MPa .





3.Yield Strength

As-sintered state: The yield strength of as-sintered tungsten alloys is usually between 400–800 MPa. The presence of internal pores and relatively weak grain boundary bonding means plastic deformation can initiate at relatively low stress levels.

4.Elongation

As-sintered state: The elongation of as-sintered tungsten alloys is generally between 10%–30%. The insufficiently dense internal structure of the sintered body, containing certain defects, makes it prone to crack propagation during tensile loading, leading to earlier fracture and thus relatively lower elongation.

Worked and heat-treated state: Appropriate processing and heat treatment techniques, such as hot extrusion or annealing, can improve the alloy's microstructure, eliminate some internal defects, and enhance the material's plasticity and toughness. This results in improved elongation, with some tungsten alloys achieving an elongation of 30%–50%. For example, tungsten alloys undergoing carefully designed hot working and annealing treatments can reach an elongation of around 40%.

5.Hardness

Brinell Hardness (HB)

As-sintered state: The Brinell hardness of as-sintered tungsten alloys typically ranges from 200–350 HB. The limited degree of densification in this state results in a relatively lower hardness.

Strengthened state: After strengthening treatments (e.g., adding hard phases, work hardening), alloy's hardness increases significantly, with Brinell hardness values reaching 400–600 HB or higher. For instance, the Brinell hardness of tungsten alloys incorporating high-hardness carbide particles can exceed 600 HB after special processing.



Rockwell Hardness (HRC): The Rockwell hardness of tungsten alloys generally falls within the range of 40-60 HRC. The specific value varies depending on the alloy composition and processing technology. By adjusting alloying elements and heat treatment processes, the Rockwell hardness can be controlled within a suitable range to meet different application requirements.

6. Elastic Modulus

The elastic modulus of tungsten alloys typically lies between 300–400 GPa. This high value indicates a strong resistance to elastic deformation, allowing the alloy to maintain excellent dimensional stability under load. For example, in aerospace components made from tungsten alloys, the high elastic modulus ensures the maintenance of precise dimensions and shapes under complex loading conditions, guaranteeing the proper operation of equipment.

7. Impact Toughness

Impact toughness is a mechanical property that measures a material's ability to absorb energy and resist fracture under high-velocity impact or dynamic loading. It is particularly important for evaluating the brittle tendency of materials. For tungsten alloys, this is a critical yet challenging parameter due to the inherent brittleness of metallic tungsten itself.

Typical Values and Range:

The impact toughness of tungsten alloys is typically measured using the Charpy V-notch impact test, and values generally fluctuate within a wide range of 20 to 150 Joules. The specific value is highly dependent on the following core factors:

Alloy Composition and Microstructure:

Content and Type of Binder Phase: This is the most significant influencing factor. Tungsten alloys usually consist of high-melting-point tungsten particles (brittle phase) and a ductile metal binder phase (e.g., Ni, Fe, Cu, Co).

High Binder Phase Content (e.g., >10%): A higher content of ductile phases like nickel-iron better encapsulates the tungsten particles, absorbing more impact energy through plastic deformation, thereby significantly improving toughness. For instance, the impact energy of a 93W-Ni-Fe alloy is typically much higher than that of a 97W-Ni-Fe alloy.

Type of Binder Phase: Nickel-iron binder phases generally provide better toughness and impact performance than cobalt or copper binder phases.

Morphology and Connectivity of Tungsten Particles: The ideal microstructure features uniformly distributed spherical tungsten particles surrounded by a continuous network of the binder phase. If tungsten particles contact each other directly, forming "tungsten-tungsten grain boundaries," these weak interfaces become easy paths for crack propagation, drastically reducing impact toughness.

Processing and Heat Treatment State:



As-sintered State: Tungsten alloys in the as-sintered state typically possess moderate toughness. Impact toughness is primarily influenced by density and microstructural homogeneity. Residual pores significantly reduce toughness.

Thermomechanically Processed State (Forging, Rolling, Extrusion): These thermomechanical processing techniques can drastically improve impact toughness. They achieve this by:

Fracturing the initial tungsten-tungsten grain boundaries: Breaking up the brittle network of interconnected tungsten grains.

Refining the grain structure: Resulting in finer tungsten particles and binder phase.

Increasing dislocation density: Enhancing strength, which indirectly influences toughness.

Alloys subjected to proper thermomechanical processing can see their impact energy increase multiple times compared to the as-sintered state, reaching the higher end of the range (e.g., over 100 J).

Heat-Treated State: Subsequent treatments like solution treatment or aging can optimize the composition and distribution of the binder phase and relieve processing stresses. This further enhances toughness or achieves an optimal balance between strength and toughness.

Example:

A typical as-sintered 90W-7Ni-3Fe alloy might have a Charpy V-notch impact energy of around 30-50 J.

The impact energy of an alloy of the same composition can be dramatically increased to 100 J or higher after undergoing Hot Isostatic Pressing (HIP) to eliminate residual porosity, followed by forging and appropriate annealing.

Our company is among China's top ten [tungsten carbide products manufacturers](#). Should you require cemented carbide products, please [contact us](#).

[← PreviousPost](#)

[Next Post →](#)

[Home](#)

[About us](#)

[Products](#)

[News](#)

[Contact us](#)



Copyright © Qingdao Bortome

