Hyper Materials

- Powders
- Cemented Carbides
- Tungsten & Molybdenum Materials
- Heatspreader Materials
- Heavy Metals
- Electric Contacts & Electrodes for Electric Discharging

A.L.M.T.

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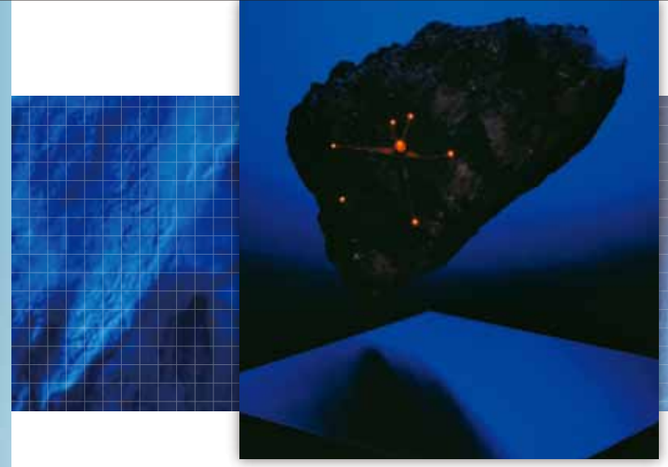
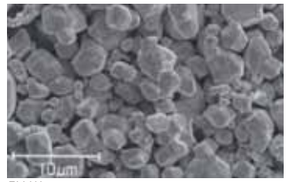
Hyper Materials

Materials chosen to give life to atoms.
Technology of A.L.M.T.

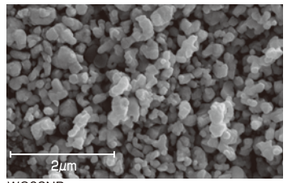




5N-W

1 Tungsten powder (W,WO_3)

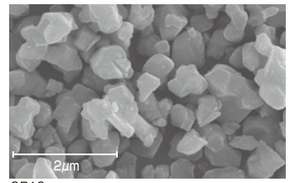
High quality tungsten powder of controlled purity (5N-W / 99.999% min.) and particle size used as electrode materials (metallizing and sputtering targets) of VLSI, tools, sintered parts, raw materials of weights, etc. Tungsten trioxide powder (WO_3) is recommended for optical applications, high dielectric constant ceramics and other new industrial materials.



WC02NP

2 Tungsten carbide powder (WC)

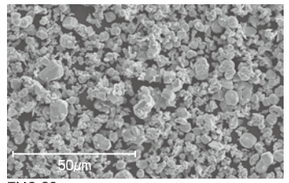
Manufactured under rigorous quality control in a wide range of types; standard, ultrafine (WC02NP / 0.1μm), uniform particle size distribution and low-volume. Used as raw materials of carbide tools according to diversified needs.



OR10

3 Carbide and carbonitride powders

Raw materials of cermets, and additives of carbide tools.



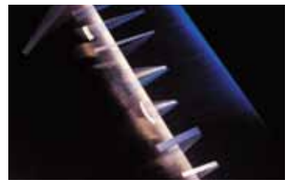
TMO-30

4 Molybdenum powders (Mo,MoO_3)

Purity and composition controlled to meet various needs. Used for such applications as VLSI, ceramic packages, metallizing and sputtering targets. Molybdenum trioxide powder (MoO_3) is recommended for pigments, coloring and catalysts.

5 Cemented carbide precision knife

High-precision, thin-bladed cutters that realize high cutting speed and high efficiency for ceramic green sheets, slitter knives to cut aluminum electrolytic capacitors, magnetic tapes, paper, plastics and metals and other knives.



6 Cemented carbide wires

For dot matrix printers.

7 Cemented carbide tips (various types of shape)

Cutting, wear-resistant, shock-resistant, mining tools.

	LSI computers	Information communications	Electrical machinery electron tube lighting	Automobiles electric trains	Electric power furnace materials structural materials	Tools molds machines	Medical
1 Tungsten powder (W,WO_3)	●	●	●	●	●	●	●
2 Tungsten carbide powder (WC)	●					●	
3 Carbide and carbonitride powders	●	●				●	
4 Molybdenum powders (Mo,MoO_3)	●	●	●		●	●	
5 Cemented carbide precision knife	●	●	●	●		●	
6 Cemented carbide wires	●	●					
7 Cemented carbide tips (various types of shape)	●			●		●	

8 Tungsten/molybdenum wires and rods

Used for lighting, electron tubes, heaters, grids, mandrels, springs, anchors, supports and other various applications. Also the high wear resistance makes these materials suitable for impact dot matrix print wires, probe pins for semiconductor inspection and similar applications.

9 Heat-resistant molybdenum wires and rods (TEM)

High recrystallization temperature, improved shock resistance and high-temperature deformation resistance at room temperature after recrystallization.

10 Coils and boats for vacuum evaporation

Tungsten products with high melting points and excellent corrosion resistance.

11 Plated wires and corona wires

Various kinds of plating such as gold and platinum, corona wires with terminals and oxidized surface. Used for printers, copiers, air cleaners, etc.

12 Platinum clad molybdenum wires and rods

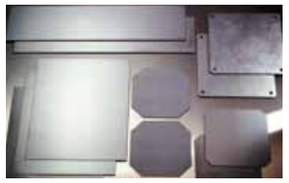
For clad wires, rods and processed products of transmitting tubes. (wire diameter 0.15～3.0mm, platinum coating rate 20wt%)

13 Parts for lamps

Tungsten and molybdenum parts for high pressure mercury, xenon, metal halide, and general halogen lamps.

14 Tungsten and molybdenum sheets/plates

Playing an active role in high-temperature furnaces, electrical and semiconductor fields as high-temperature-resistant materials with small thermal expansion coefficients.



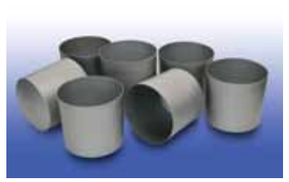
15 Heat-resistant and high-temperature deformation resistant molybdenum sheets / plates (TEM/DMB)

Enhanced recrystallization embrittlement resistance, high-temperature deformation resistance, room-temperature impact resistance (room-temperature plastic working possible) and high-temperature strength.TEM: Used for heaters, reflectors, boats, setters for MIM, etc.DMB: Used for setters for sintering ceramic parts, etc.

16 Ceramic-coated molybdenum sheets/plates

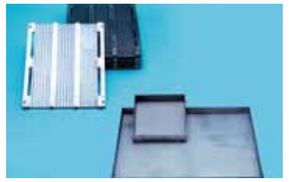
Ceramic-coated molybdenum setters for the purpose of preventing adhesion. (Products developed for sintering MIM parts.)

	LSI computers	Information communications	Electrical machinery electron tube lighting	Automobiles electric trains	Electric power furnace materials structural materials	Tools molds machines	Medical
8 Tungsten/molybdenum wires and rods			●		●		●
9 Heat-resistant molybdenum wires and rods (TEM)			●		●		
10 Coils and boats for vacuum evaporation	●		●	●			
11 Plated wires and corona wires		●	●				
12 Platinum clad molybdenum wires and rods		●	●				
13 Parts for lamps	●		●	●			
14 Tungsten and molybdenum sheets/plates	●	●	●		●		
15 Heat-resistant and high-temperature deformation resistant molybdenum sheets/plates (TEM/DMB)	●	●	●		●		
16 Ceramic-coated molybdenum sheets/plates		●	●		●		



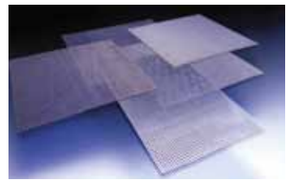
17 Tungsten and molybdenum crucibles

The high-density and uniform metal structure has realized crucibles of larger size and longer life. Most suitable for single crystal growth.
Spun crucibles (molybdenum)
Sintered crucibles (molybdenum, tungsten)



18 Molybdenum trays

For sintering rare-earth magnets, atomic fuels, etc.



19 Molybdenum meshes

Setting for gas venting sintering of ceramics,etc., and furnace parts, such as heaters.

20 High-temperature furnace parts,electrodes, ion implantation and vacuum parts

Special-purpose products of tungsten and molybdenum.

21 Parts for CT scans

High-precision parts made by taking advantage of such characteristics of tungsten and molybdenum as high radiation shielding and stiffness.
Used for medical equipment that requires high reliability such as collimators in CT scanners.

22 High performance heatspreader materials

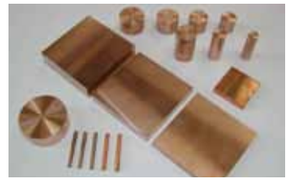
Wide range of materials with high thermal conductivity that can flexibly control the coefficient of thermal expansion matched with peripheral parts.

23 High-density tungsten heavy metal alloys

Heavy metal alloys with high density, high heat resistance, and high mechanical strength. Application suitable for radiation shield, weights, and balances.

24 Electric contacts, ELCON

Compound materials consist of highly conductive metals such as silver, copper, heat & arc resistance materials tungsten-graphite, and other metal oxides.

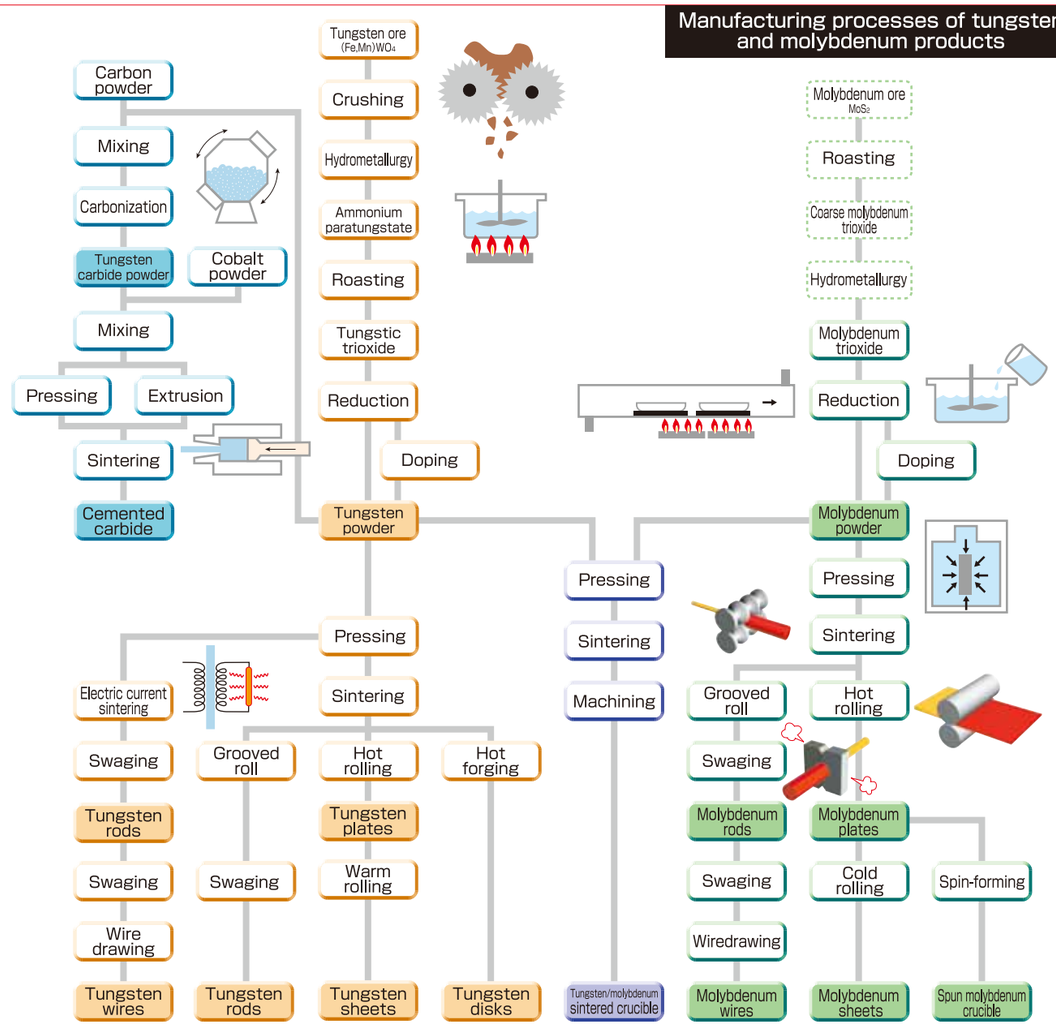


25 CuW electrode for EDM NEL 150

High quality electrode enabling to achieve higher speed, lower wear, and higher precision.

	LSI computers	Information communications	Electrical machinery electron tube lighting	Automobiles electric trains	Electric power furnace materials structural materials	Tools molds machines	Medical
17 Tungsten and molybdenum crucibles	●	●	●		●		
18 Molybdenum trays	●	●	●		●		
19 Molybdenum meshes	●	●	●		●		
20 High-temperature furnace parts, electrodes, ion implantation and vacuum parts			●	●	●		
21 Parts for CT scans							●
22 High performance heatspreader materials	●	●		●			
23 High-density tungsten heavy metal alloys				●	●	●	●
24 Electric contacts, ELCON				●	●		
25 CuW electrode for EDM NEL 150						●	

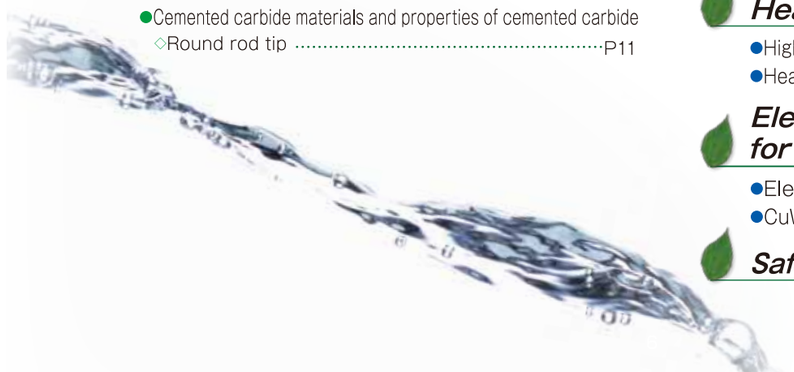
Manufacturing processes of tungsten and molybdenum products



Characteristics of W and Mo	Tungsten(W)	Molybdenum(Mo)
Physical properties		
Atomic number	74	42
Atomic weight	183.85	95.94
Crystal structure	Body-centered cubic lattice	Body-centered cubic lattice
Lattice constant (Å)	3.1647(20℃)	3.146(21℃)
Melting point (℃)	3410±10	2620±10
Boiling point (℃)	Approx. 5900	4827
Density (g/cm³)	19.3	10.2
Electrical resistance(μΩ·cm)	5.5 (20℃)	5.78(27℃)
Coefficient of linear expansion(10^{-6}/℃)	4.44(27℃)	5.1 (27℃)
Chemical properties	(1)Appreciably stable at ordinary temperatures, but oxidizes to such an extent that the surface gloss is lost. Reacts mainly with O_2, CO, N_2, H_2O and hydrocarbon at high temperatures, but does not react with mercury vapor and hydrogen. (2)Makes higher oxide (WO_3) through lower oxide, such as W_3O, WO_2 and $W_{20}O_{58}$, with increasing temperatures when reacting with oxygen or air. (3)Unaffected by water, but affected by water vapor in a red-hot state to make WO_3. (4)Drastically reacts with a mixed solution of nitric acid and hydrofluoric acid. (5)Has reducibility at searing temperatures. Makes compound (WS_2) upon ignition with sulfur, and forms compound (W_3P_4) when passed through phosphorus vapor.	(1)Does not react with dry oxygen at ordinary temperatures, but rapidly oxidizes at 500℃ or above.Becomes white-mouse-gray volatile MoO_3 at 650℃ or above. (2)Easily combines with sulfur, carbon or silicon at high temperatures to make MoS_2, Mo_2C and $MoSi_2$, etc. (3)Has a strong affinity to arsenic. (4)Hardly affected by hydrofluoric acid, hydrochloric acid and sulfuric acid at 20℃, but severely affected by nitric acid, mixed solutions of high-concentration sulfuric acid and aqua regia.

Full lineup of functional materials and products by mixing up the technology of powder metallurgy and metal fabrication.

C O N T E N T S

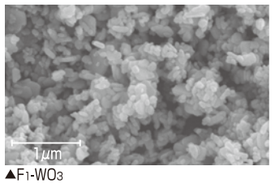


powder

Tungsten/molybdenum metal powders and compound powders are used as raw materials of various electronic parts and tools, taking advantage of such features as resistance to high temperatures, high hardness and high density.Our integrated production system from raw materials to final products realizes manufacturing and sales of a variety of high quality and highly reliable products assured by our advanced evaluation and analysis technology.We also offer such services as proposals of products that are best suited for purposes of use and flexible product design according to needs of customers, and promote aggressive development of new materials in pursuit of new functions.

Tungsten powder

Tungsten powder is manufactured under strict quality control as raw materials of high density composites, diamond tools, metallizing paste, sintered parts of tungsten, etc.



▲B30

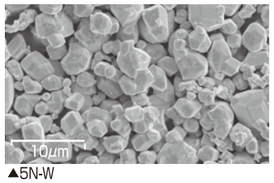
■Standard W powder

Type	Particle size(μm)	W(%)	O(%)	Fe(%)	Mo(%)	NVR*(%)
A 20	0.5~0.6	≧99.9	≦0.60	≦0.02	≦0.02	≦0.01
A 30	0.6~0.8	≧99.9	≦0.60	≦0.02	≦0.02	≦0.01
B 10	1.0~1.3	≧99.9	≦0.40	≦0.02	≦0.02	≦0.01
B 20	1.0~1.5	≧99.9	≦0.20	≦0.02	≦0.02	≦0.01
B 30	1.4~1.7	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
C 10	1.7~2.0	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
C 20	1.9~2.2	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
C 30	2.1~2.5	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
C 40	2.3~2.8	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
C 50	2.8~3.4	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
C 60	3.1~3.6	≧99.9	≦0.15	≦0.02	≦0.02	≦0.01
D 10	3.6~4.4	≧99.9	≦0.10	≦0.02	≦0.02	≦0.01
D 20	4.5~7.5	≧99.9	≦0.10	≦0.02	≦0.02	≦0.01
D100	7.6~12	≧99.9	≦0.10	≦0.02	≦0.02	≦0.01

"Particle size" is the average particle diameter according to the fischer method. "NVR" is the part remaining after heating in hydrogen chloride air current."W" is the part remaining after subtracting Fe, Mo and NVR from 100.
※In addition to the above, up to 30μm particle sizes are available upon request. *NVR: Non Volatile Residue by Chlorination

High-purity tungsten powder

High-purity tungsten powder that is extremely low in radioactive elements and alkali metals is manufactured by our excellent purifying technology and strict environmental controls.



▲5N-W

■4N-W

Type	W(%)	Na(ppm)	K(ppm)
4N-W	≧99.99	≦10	≦10
Typical	≧99.99	5	3

※Particle sizes in a range of 1.0 - 5.0μm are available upon request.

■5N-W

Type	W(%)	Na(ppm)	K(ppm)	U(ppb)	Th(ppb)
5N-W	≧99.999	≦1	≦1	≦1	≦1
Typical	≧99.999	0.08	0.04	0.2	0.5

※Particle sizes in a range of 1.0 - 5.0μm are available upon request.

Tungsten trioxide powder

High-purity tungsten trioxide powder is manufactured by chemical refinement of tungsten material. It is used for optical applications, high dielectric constant ceramics and other new industrial materials.

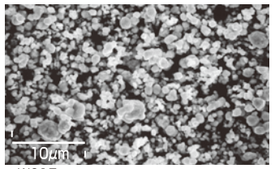
▲F_1-WO_3

■High-purity WO_3 powder

Type	Particle size(μm)	WO_3(%)	NVR(%)	Fe(%)	Mo(%)
A_2-WO_3	7~12	≧99.9	≦0.010	≦0.001	≦0.010
C_3-WO_3	15~20	≧99.9	≦0.010	≦0.001	≦0.010
F_1-WO_3	0.5~1.2	≧99.9	≦0.010	≦0.002	≦0.010

Tungsten carbide powder

Tungsten carbide powder that is used for cemented carbide, cermet diamond tools, electric contacts, etc., is manufactured under thorough quality control.



▲WC15

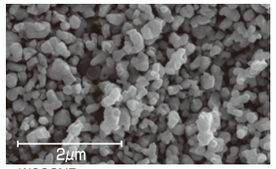
■Standard WC powder

Type	Particle size (μm)	WC(%)	T.C(%)	F.C(%)	Fe(%)	Mo(%)	NVR*(%)
WC 10	0.9~1.1	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 12	1.1~1.3	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 15	1.3~1.8	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 20	1.8~2.2	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 25	2.2~2.8	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 30	2.8~3.3	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 35	3.3~3.8	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 40	3.7~4.4	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 45	4.2~5.0	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01
WC 60	5.0~7.1	≧99.8	6.13±0.05	≦0.10	≦0.05	≦0.02	≦0.01

"Particle size" is the average particle diameter according to the fischer method.
"T.C" other than the above is also available upon request."W" is the part remaining after subtracting F.C, Fe and Mo from 100.
*NVR: Non Volatile Residue by Chlorination

Ultrafine tungsten carbide powder

High-hardness and high-strength ultrafine tungsten carbide powder for cemented carbide is manufactured by direct carburization reaction of tungsten oxide and carbon powder.
In particular, we have developed the WCP Series (low volume powder) that has the reduced number of agglomerates and increased apparent density with the particle size unchanged. This feature contributes to reduction of the alloy shrinkage during cemented carbide sintering to make this material ideal for such tools as micro drills and endmills that require higher hardness and higher strength.



▲WC02NP

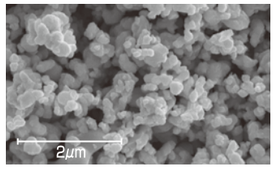
■Ultrafine WC powder

	Type	Particle size(μm)	T.C(%)	F.C(%)	Fe(%)	Mo(%)	Additive
Standard powder	WC02N	※0.10~0.13	6.20±0.05	≦0.20	≦0.02	≦0.02	Grain growth inhibitor
	WC04N	0.45~0.49	6.20±0.05	≦0.15	≦0.02	≦0.02	Grain growth inhibitor
	WC05N	0.50~0.55	6.20±0.05	≦0.15	≦0.02	≦0.02	Grain growth inhibitor
	WC02NR	※0.10~0.14	6.10~6.25	≦0.25	≦0.02	≦0.02	–
	WC04NR	0.45~0.49	6.15±0.05	≦0.15	≦0.02	≦0.02	–
	WC05NR	0.50~0.55	6.15±0.05	≦0.15	≦0.02	≦0.02	–
	WC06NR	0.56~0.65	6.15±0.05	≦0.15	≦0.02	≦0.02	–
	WC07NR	0.55~0.70	6.15±0.05	≦0.15	≦0.02	≦0.02	–
Low volume powder	WC02NP	※0.10~0.13	6.20±0.05	≦0.20	≦0.02	≦0.02	Grain growth inhibitor
	WC04NP	0.45~0.49	6.20±0.05	≦0.15	≦0.02	≦0.02	Grain growth inhibitor
	WC05NP	0.50~0.55	6.20±0.05	≦0.15	≦0.02	≦0.02	Grain growth inhibitor
	WC02NRP	※0.10~0.14	6.10~6.25	≦0.25	≦0.02	≦0.02	–
	WC04NRP	0.45~0.49	6.15±0.05	≦0.15	≦0.02	≦0.02	–
	WC05NRP	0.50~0.55	6.15±0.05	≦0.15	≦0.02	≦0.02	–

"Particle size" is the average particle diameter according to the fischer method.
The ※ mark shows the particle diameter converted by the BET method.

Low volume and Ultrafine tungsten carbide powder

Low volume ultrafine tungsten carbide powder has been realized by secondary particles that are primary particles made finer as Cr dissolved and diffused in the tungsten phase loses its solubility and precipitates during carburization reaction.
In particular, we have developed WCR06J that has the reduced number of agglomerates and increased apparent density with the particle size unchanged, which enables it to further reduce the alloy shrinkage during cemented carbide sintering.



▲WCR06J

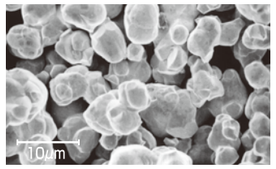
■Low volume and Ultrafine WC powder

Type	Particle size(μm)	T.C(%)	F.C(%)	Fe(%)	Mo(%)	Cr(%)
WCR07	0.65~0.95	6.10~6.20	≦0.10	≦0.05	≦0.02	0.80~0.90
WCR15	1.2 ~1.8	6.10~6.20	≦0.10	≦0.05	≦0.02	0.80~0.90
WCR06J	0.55~0.65	6.10~6.20	≦0.10	≦0.05	≦0.02	0.80~0.90

"Particle size" is the average particle diameter according to the fischer method.
*Consult with us about particle size and volume of grain growth inhibitor.

For shock resistant tools Uniform tungsten carbide powder

Uniform tungsten carbide powder with narrow particle-size distribution and advanced single-crystallization is manufactured by carbonizing tungsten powder at higher temperatures.



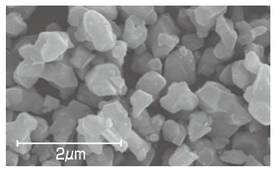
▲WC60S

■Uniform WC powder

Type	Particle size(μm)	WC(%)	T.C(%)	F.C(%)	Fe(%)	Mo(%)	NVR*(%)
WC 25U	2.4~3.2	≧99.8	6.13±0.05	≦0.10	≦0.02	≦0.02	≦0.01
WC 30S	2.5~3.5	≧99.8	6.15±0.03	≦0.05	≦0.02	≦0.02	≦0.01
WC 35U	3.2~3.8	≧99.8	6.13±0.05	≦0.10	≦0.02	≦0.02	≦0.01
WC 40S	4.0~5.0	≧99.8	6.15±0.03	≦0.05	≦0.02	≦0.02	≦0.01
WC 45S	4.5~5.5	≧99.8	6.13±0.05	≦0.10	≦0.02	≦0.02	≦0.01
WC 60S	6.0~7.0	≧99.8	6.15±0.03	≦0.05	≦0.02	≦0.02	≦0.01
WC 70S	7.0~8.0	≧99.8	6.13±0.05	≦0.10	≦0.02	≦0.02	≦0.01
WC 80S	8.0~10.0	≧99.8	6.15±0.03	≦0.05	≦0.02	≦0.02	≦0.01
WC 100S	14~16	≧99.8	6.15±0.03	≦0.05	≦0.02	≦0.02	≦0.01

*NVR: Non Volatile Residue by Chlorination

Various kinds of carbide powders



▲OR10

■TiC,ZrC,Cr_3C_2,VC,(W,Ti) C powders

Description	Composition	Type	Particle size (μm)	T.C(%)	F.C(%)	N(%)	O(%)	Fe(%)
Titanium carbide powder	TiC	OR06	0.60~1.1	18.00~19.50	≦0.30	≦0.30	≦2.00	≦0.02
Zirconium carbide powder	ZrC	OV25	2.1 ~3.0	10.90~11.50	≦0.40	≦1.00	≦0.50	≦0.10
Chromium carbide powder	Cr_3C_2	OR15	1.0 ~2.0	13.00~13.50	–	≦0.10	≦0.80	–
Vanadium carbide powder	VC	OR10	≦1.2	≧16.50	≦0.50	≦0.50	≦0.70	≦0.10
Double carbide powder	(W,Ti)C(70/30)	DC30	2.5 ~3.5	9.70~10.00	≦0.10	≦0.10	≦0.20	≦0.10

Consult with us about composition, particle size, carbon value and nitrogen value.

Various kinds of carbonitride powders

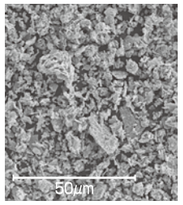
■TiCN,ZrCN powders

Description	Composition	Type	Particle size (μm)	T.C(%)	F.C(%)	N(%)	O(%)	Fe(%)
Titanium carbonitride powders	$TiC_{0.5}N_{0.5}$	5OR08	0.70~1.0	9.70~10.00	≦0.40	10.20~11.60	≦1.00	≦0.10
		5MP15	1.1 ~1.5	9.70~10.00	≦0.30	10.20~11.00	≦1.00	≦0.10
		5MP30	2.6 ~3.5	9.70~10.00	≦0.30	10.20~11.00	≦1.00	≦0.10
Zirconium carbonitride powders	$ZrC_{0.5}N_{0.5}$	5OV25	2.0 ~3.0	5.30 ~ 5.80	≦0.20	6.30~ 6.90	≦0.50	≦0.10

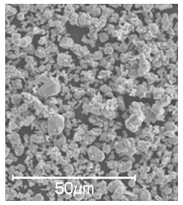
Consult with us about composition, particle size, carbon value and nitrogen value.

Molybdenum powders

3N-Mo powder is high purity powder with a particle size of 0.8μm to 6.0μm manufactured by using high-grade Mo materials and controlling the manufacturing conditions.



▲TMO-10



▲TMO-30

■3N-Mo powder

Type	Particle size(μm)	RL(%)	Fe(%)	NVR(%)	Mo(%)
TMO-10	0.8~1.7	≦1.0	≦0.01	≦0.1	≧99.9
TMO-20	1.8~2.7	≦1.0	≦0.01	≦0.1	≧99.9
TMO-30	2.8~3.7	≦0.1	≦0.01	≦0.1	≧99.9
TMO-40	3.8~4.7	≦0.1	≦0.01	≦0.1	≧99.9
TMO-50	4.8~6.0	≦0.1	≦0.01	≦0.1	≧99.9

"Mo" is the part remaining after subtracting Fe and NVR from 100.

4N-Mo powder is manufactured by using four nines of Mo materials and preventing contamination of metal impurities of Fe, Ni, etc. under strict manufacturing process control.

■4N-Mo powder

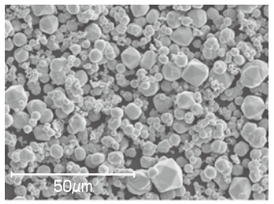
Type	Particle size(μm)	RL(%)	Mo(%)
4N-Mo	3.5~5.5	≦0.15	≧99.99

"Mo" is the part remaining after subtracting the 13 elements in the table on the under side from 100.

Element	Al (ppm)	Ca (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Mg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	Si (ppm)	Sn (ppm)	Na (ppm)	K (ppm)
Typical	<5	<1	2	1	8	<1	<1	5	<5	<10	<3	5	35

High-density molybdenum powder

This is used as molybdenum powder most suitable for ceramic packages, metallizing paste and sputtering targets due to characteristics such as high green density, lower shrinkage during pressing and low gas elements.



▲HDM

	Spec value	Typical
Particle size(μm)	≧4.0	5.0
Purity (%)	≧99.95	≧99.95
Oxygen(%)	≦0.15	0.05
Fe (%)	≦0.015	0.006
NVR (%)	≦0.10	0.003
FV(cm^3/100g)	≦47	39
TV(cm^3/100g)	≦22	19.4

"Mo" is the part remaining after subtracting Fe and NVR from 100.

Molybdenum trioxide powder

Molybdenum oxide used for pigments, coloring and catalysts.

■High-purity MoO_3 trioxide powder

Type	Al (ppm)	Ca (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Mg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	Si (ppm)	Sn (ppm)	Particle size (μm)	IL (%)
MoO_3-1	≦15	≦15	≦15	≦15	≦15	≦15	≦15	≦15	≦15	≦15	≦15	10~20	≦0.3
MoO_3-2	≦20	≦20	≦20	≦20	≦50	≦20	≦20	≦20	≦30	≦150	≦60	1~5	≦0.6

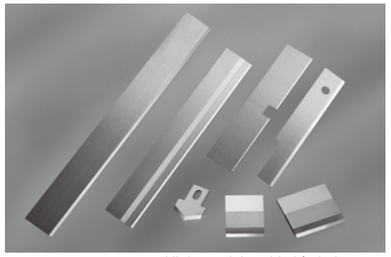
In addition to the above, consult with us about manufacturing of intermediate (low-grade) oxides.

Cemented carbides

We offer total manufacturing from tungsten carbide powder up to cemented carbide. Our carbide manufactured by technology accumulated over many years, high-level quality controls, and manufacturing methods suitable for various applications will assist you in productivity improvements.

Precision knife

■Square type


High-precision thin-bladed cutter

(Unit:mm)

T	0.05~
H	18~27
L	30~250
θ	10°~90°
Edge shape	Single-edged , Double-edged, Stepped, 2-stage, 3-stage

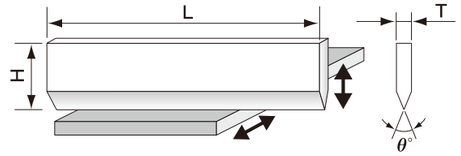
※Contact us for dimensions other than the above.

(Features of the products)

- Maintains sharp edges over long-time cutting.
- Realizes chipping "submicron" by the micropolishing technology.
- Realizes a minimum thickness of 0.05 mm and high straightness by the ultra-high-precision machining technology.
- 150 to 300 times longer life than SUS materials.
- Cutter replacement intervals extended substantially.

(Examples of application of products)

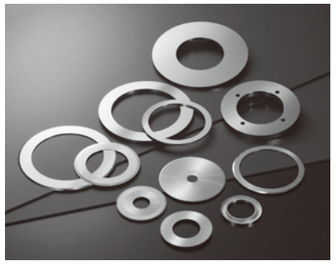
☆Ceramic capacitors (green sheets)
☆For tape
☆For film
☆Fibers



■Round type

Our cemented carbide slitters are excellent cutters for magnetic tape, capacitors, paper, plastics and metals and offer good durability 10 times greater than that of steel.
Cemented carbide slitter knife units are also manufactured.
Metal-slitting saws are used for metal-slitting of magnetic heads, frames of glasses, etc.

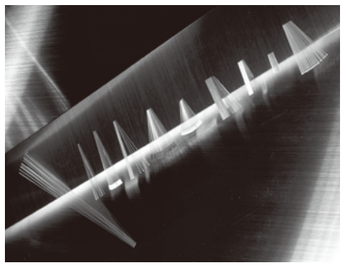
※Designed and manufactured according to your requirements.


Slitter / metal-slitting saws

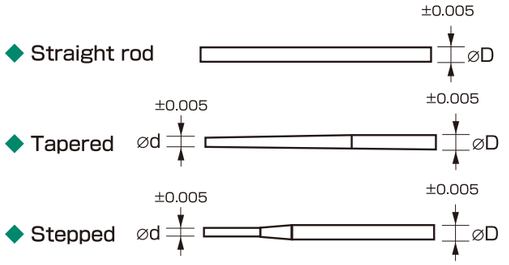
Precision rod

■Pins

Not only small-diameter pins for ultra-high-precision jigs and tools for manufacturing semiconductor-related products, but also dot pins for dot printers, punch pins and so on are widely manufactured by using high-hardness and high-strength materials.

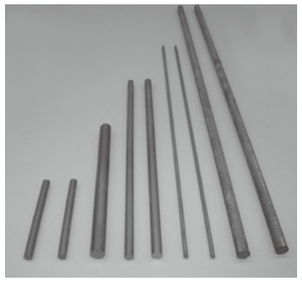

Cemented carbide wires

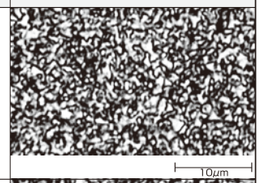
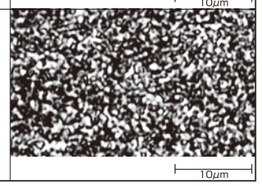
Material	Transverse rupture strength/GPa	Hardness/HRA	Application
FM10K	3.3	91.5	For mold pin
FM70S	4.0	88.5	For dot pin



Cemented carbide materials and Properties of cemented carbide

■Round rod tip



Type	Hardness/HRA	Transverse rupture strength/GPa	Application	Microstructure
H10	92.5	2.1	Cutting tools for cast iron Cutting tools for nonferrous metals	
FM10K	91.5	3.3	●For microtools such as end mills, taps, and drills ●For cutting edges for ceramic capacitors, metal foils, magnetic tapes, paper, resin films, etc. ●Punch pin, Dot pin	
FM20K	90.0	3.4		
FM21K	89.0	2.9		
FM70S	88.5	4.0		

Tungsten& Molybdenum Materials

Tungsten and molybdenum have a high melting point, low thermal expansion rate and are extremely stable materials in a vacuum. They are used widely in many fields of electronics such as electrodes, heat and radiation shielding and in lighting filaments. Our tungsten and molybdenum products are made directly from raw materials into the processed products - which are subject to strict quality control using high quality analytical instruments and rigorous evaluation of the production process. In addition we have different sizes and types of powder, and variations on finishing and processing so the performance is optimized and best suited to the product at hand.

Tungsten wires and rods

◎Most suitable ○Suitable △Unsuitable

■Product selection guide

		Application	Non-sag	Shock resistance	Machinability	Discharge ability	Discharge consumption resistance	Wear resistance	Corrosion resistance (VM)
W	AW	Filaments for halogen lamps (thinner), Grids, Supports, Heaters and Corona wires	◎	○	○	△	○	○	△
	AX	Filaments for ultrahigh temperature halogen lamps (thicker)	◎	◎	◎	△	○	○	△
	EX	Vacuum evaporation, Heaters for high-temperature furnaces, Print wires for printers, Supports, Discharge electrodes and Probe pins	○	○	◎	△	◎	◎	◎
	DW	Electrodes, EDM wires and Filaments for thermionic emission	○	◎	◎	◎	◎	○	△
	CY (PFW)	Structural materials and Heaters for furnaces	△	△	◎	△	△	○	◎
	EP	Discharge electrodes, Structural materials and Pressure welded electrodes	○	△	◎	△	◎	◎	△
	KT	Discharge electrodes and Structural materials	○	△	◎	△	◎	◎	△
	4N-W 5N-W	Electrodes and Heaters	△	△	◎	△	○	◎	○

■Product lines

●AW

AW is a non-sag tungsten material that has been developed for various kinds of lamps including halogen lamps and is widely used not only throughout the domestic market but also in overseas markets. This material is highly resistant to high-temperature deformation, blackening and shocks, has a long life, contains little impure gas and has excellent coiling ability at room temperature. Besides filaments, AW can be used for supports, grids, heaters, etc.

●AX

AX is a high-quality tungsten material having been developed as a filament for ultrahigh temperature halogen lamps. Compared with conventional materials, the recrystallization temperature is 50 to 200℃ higher, and the dope holes are smaller. Moreover, the length of the crystal structure after recrystallization is 3 to 4 times longer, and the non-sag property has been substantially improved. Also, the tensile strength can be adjusted for each size, and coiling ability is considerably superior. In particular, the brittleness of the thicker sizes has been greatly improved, and sizes no larger than D 1.0mm can be processed at room temperature, and can be used for heaters for high-temperature furnaces.

●EX

EX has been developed as a filament material for vacuum evaporation of metal materials. It is the world's top-class long-life filament material, contains little impure gas, excels in high-temperature deformation resistance and is corrosion resistant to evaporated metals such as Al, Ni and Cr. While it is also suitable for furnace heaters and electrodes, the EX is widely used in probe pins because of its high hardness and tensile strength, excellent wear resistance and heat resistance (brazing ability), smooth surface, and minimal wear.

●DW

DW is a material that has developed as a filament for thermionic emission. It is long-life tungsten material that facilitates thermionic generation by using a technology which introduces special additives evenly and prevents grain growth and intergranular fracture at thermionic emission temperatures. It is used for EDM wires, and hot -cathode mass spectrometers, vacuum gauges, X-ray tubes, discharge tubes, copiers, air cleaner corona wires, etc. Coil processing, end processing and assembly processing are also available upon request.

●CY (PFW)

CY is the most common pure tungsten material and has been widely adopted for use in heaters for furnaces and structural materials, taking advantage of such features as being highly machinable, excelling in corrosion resistance and containing little impure gas.

●EP、KT

EP and KT are materials that has been developed for electrodes used at ultrahigh temperatures. The resistance to loss of current, through electrical discharge, can substantially be increased by fine dispersion of grains. It is also suitable for structural materials at high temperatures, due to its excellent high-temperature characteristics. The fine crystals are resistant to shocks, and highly suitable for pressure welded electrodes.

●4N-W、5N-W

4N-W and 5N-W are made to have a high degree of purity. Especially, 5N-W reduces the impurities to an extremely low level, realizing tungsten of highest purity attainable in the world. This is best suited for products where even small amounts of impurities are undesired, for example in advanced technical use such as electrodes for discharge lamps and ultrahigh pressure mercury lamps.

Standard specifications of tungsten wires and rods

Diameter range	Rods											wires								
	Material					Representative spec						Material			Representative spec					
	AW AX	CY PFW	4N-W 5N-W	EX	EP KT	Finish Black	Finish Electrolytic	Finish CC	Tolerance diameter	Finish grinding ※1	Tolerance diameter	AW AX	CY EX	4N-W 5N-W	Finish Black	Finish CC	Finish Electrolytic	Finish Straight	Tolerance diameter	Tolerance MG
~0.0129												○					○		±0.005mm	±4%
0.013~0.029												○			○		○		±0.005mm	±3%
0.03~0.19	○					○	○		±0.005mm			○	○	○	○		○	○	±0.005mm	±2%
0.20~0.39	○		○	○		○	○		±0.005mm			○	○	○	○		○	○	±0.005mm	±2%
0.40~0.49	○		○	○		○	○		±0.01mm			○	○	○	○		○	○	±0.01mm	±2%
0.50~0.59	○		○	○		○	○		±0.02mm			○	○	○	○		○	○	±0.02mm	
0.60~0.79	○		○	○		○	○	○	±0.03mm			○	○	○	○	○	○	○	±0.03mm	
0.80~0.99	○	○	○	○		○		○		○	±0.03mm	○	○	○	○	○	○			
1.0~2.9		○	○	○		○		○	±0.05mm	○			○	○	○	○			±0.05mm	
3.0~3.9		○	○	○		○		○	±0.15mm	○					○	○			±0.1mm	
4.0~4.9		○	○	○		○		○	±0.15mm	○										
5.0~6.3		○	○	○		○		○	±0.2mm	○	±0.05mm									
6.4~11.9		○	○	○		○		○	±0.3mm	○	±0.1mm									
12.0~14.9		○	○	○				○	±0.4mm	○										
15.0~20.9		○	○		○			○	±0.5mm	○	±0.15mm									
21.0~40.0		○	○		○					○	±0.2mm									

※1 Finish grinding: Centerless grinding for wires and rods of 20 mm or less in diameter and belt grinding for wires and rods larger than 20 mm in diameter.

Manufacturing range of length of standard tungsten rods

Diameter (mm)	Length	
	MAX	Standard
50	450	230
45	600	300
41	800	400
36	1000	500
31	1400	700
25	1500	850
21	1500	1100
16	2000	1200
11	3300	1000
8	8000	1100
6	12000	1000
5	17000	1000

Finish and thickness range of tungsten wires and rods

Code	Finish
D	DRAWN
DS	DRAWN AND STRAIGHTENED
CC	CHEMICAL CLEANED
EE	ELECTROLYTIC ETCHED
EES	ELECTROLYTIC ETCHED AND STRAIGHTENED
EP	ELECTROLYTIC POLISHED
EPS	ELECTROLYTIC POLISHED AND STRAIGHTENED
EPSC	ELECTROLYTIC POLISHED, STRAIGHTENED AND CUT
G	GROUND
S	SWAGED

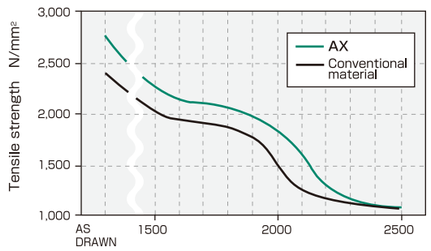
Standard tolerance of length of tungsten rods

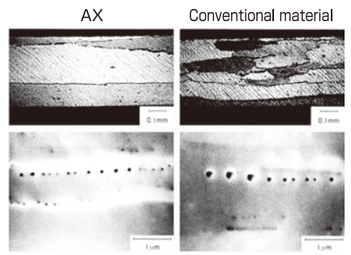
(Unit:mm) Target : D16 max.	
From 50 incl. to 100 excl.	±1.0
100~300	+3−0
300~500	+4−0
500~1000	+5−0
1000~2000	+10−0
2000~	±50

Purity of tungsten wires and rods

Type	W %
AW, AX, EX, CY, EP, KT	99.95min.
DW	99.20min.
4N-W	99.99min.
5N-W	99.999min.

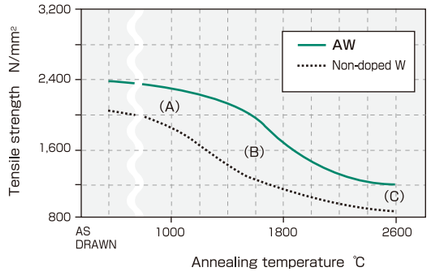
Tensile strength of AX (D0.39mm)

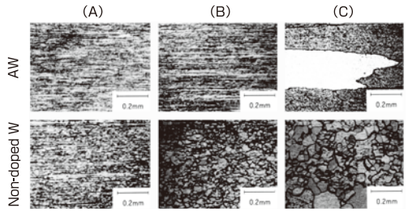




Recrystallization structure and dope holes of AX and conventional material (D0.39mm)

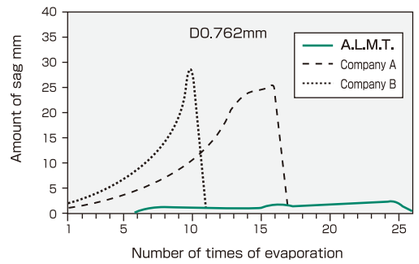
Tensile strength of AW (D0.39mm)

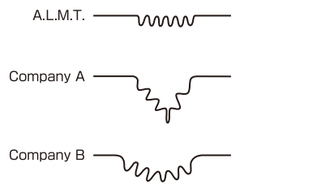




Tensile strength of AW and non-doped W (D0.39mm)

Amount of sag of EX after Al evaporation test





Sagging state upon the 9th time of Al evaporation

Tensile strength of tungsten wires

Thickness		D.C.E of VWW 1,2 (non-heat-treated)	D.C.E of VWW 1,2 (heat-treated)
Wires diameter(μm)	M G	Tensile strength N/mm²(gf/MG)	Tensile strength N/mm²(gf/MG)
Under 25	Under 1.9	3,000~4,500(80~120)	1,700~3,600(45~95)
From 25 incl. to 50 excl.	From 1.9incl. to 7.5excl.	2,400~4,000(65~105)	1,500~3,400(40~90)
From 50 incl. to 70 excl.	From 7.5incl. to 14.8excl.	2,300~3,800(60~100)	1,100~3,000(30~80)
From 70 incl. to 130 excl.	From 14.8incl. to 51.0excl.	2,100~3,600(50~ 95)	1,100~3,000(30~80)
From 130 incl. to 180 excl.	From 51.0incl. to 97.7excl.	1,900~3,400(50~ 90)	1,100~3,000(30~80)
From 180 incl. to 260 excl.	From 97.7incl. to 204.0excl.	1,900~3,400(50~ 90)	—

※Separately consult with us about a 260μm (204.0MG) or thicker diameter.

Straightness of tungsten wires and rods

①Straightness-required wires satisfy the following requirements.
a) Natural hanging method: Wires under 100μm (MG30.16) in diameter shall be 450mm or more in natural hanging length for a length of 500mm.
b) Circular chord method: Wires 100μm or more in diameter shall be 10mm or less in height of arc with respect to 100mm in chord length when cut to a length of 200mm.

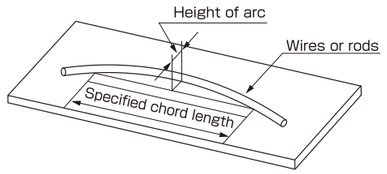
②Straightness-required rods shall be 1mm or less in height of arc with respect to 100mm in chord length throughout the overall length of the rods.

■Straightness test

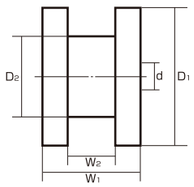
Natural hanging method:
Wires shall be cut to the length specified by each standard, and its natural hanging length shall be measured.

Circular chord method:
Wires or rods shall be cut to the length specified by each standard, and placed on a smooth plane, and the height of arc with respect to the specified chord length shall be measured as shown in the illustration below.

How to measure the height of arc



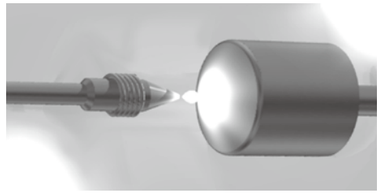
Standard spools for tungsten wire



Spool type	Drawing No.	Material	Flange dia. D1(mm)	Barrel dia. D2(mm)	Width W1(mm)	Traverse width W2(mm)	Hole dia. d(mm)	Spool mass(g)	Max.coiling wire mass max(g)	Wire dia. range and applicable finish cord
Aluminum spool A	F-1565	Aluminum	106	75	32	26	10.1	104	1,400	0.1mm~0.5mm D,EE,EP
Aluminum spool B	F-1590	Aluminum	109	90	23	18	10	80	600	0.1mm~0.24mm D,EE,EP
Resin spool 106	F-1575	SAN resin added with E glass	106	75	34	26	10	105	900	0.02mm~0.24mm D,EE,EP
Resin spool D	F-1581	SAN resin added with E glass	106	90	34	26	10	107	600	0.04mm~0.25mm For gold-plated wires
Resin spool C	F-1568	SAN resin added with E glass	55	40	30	24	10	28	250	0.01mm~0.10mm D 0.01mm~0.02mm EE,EP
Resin spool E	F-1579	Styrene	50	34	10	7	13	6.3	—	0.05mm~0.1mm For 20m and 50m
Spool L	F-1569	Synthetic resin	277	221	60	44	215	310	2,800	0.2mm~1.0mm EE,EP
Bundle 10 inch	Inner dia. 254mm(10inch)								4,800	0.6mm~1.50mm CC
Bundle 12 inch	Inner dia. 305mm(12inch)								4,800	0.64mm~1.50mm D
Bundle 17 inch	Inner dia. 431mm(17inch)								4,800	1.5mm~1.90mm D,CC
Bundle 25 inch	Inner dia. 635mm(25inch)								4,800	1.91mm~2.0mm D,CC

SMD-W(Electrode materials for discharge lamps)

Tungsten, which has the highest melting point among all metals, is used for electrodes for discharge lamps. SMD-W (tungsten) having a high density to meet high-powering and up sizing requirements of recent discharge lamps provides excellent characteristics for discharge lamps.



SMD-PFW	Standard grade	For all discharge lamps
SMD-EP	High-performance grade	Improved flushing-resistant performance with grains controlled
SMD-KT	Ultraperformance grade	Further advanced EP specifically intended for electrodes
SMD-4N	Lower impurities grade	Used for the types sensitive to impurities (W purity:99.99% min.)
SMD-5N	Ultralow impure content grade	Suitable for highest purity requirement (W purity:99.999% min.)

Electrode for ultra high pressure mercury and metal halide lamps

Tungsten electrode assembled with pin and coil.
Melted type and point on the sdge are available.

CY	Standard pure tungsten
EX	Doped tungsten by controlled crystal grains and resistance to deformation
4N-W	Purity of tungsten 99.99% min.
5N-W	Purity of tungsten 99.999% min.

Molybdenum wires and rods

◎ Most suitable
○ Suitable
△ Unsuitable

■Product selection guide

		Application	Non-sag	Shock resistance/ Quakeproof	Machinability	Wear resistance
Mo	MOP	Structural materials,Heaters,Bolts,Nuts	△	○	◎	◎
	MOS	Grids,Mandrels,Anchors	○	○	◎	○
	TEM	Supports,Heaters,Bolts,Nuts,Supporting shafts for X-ray tubes	◎	◎	◎	○

■Product lines

●MOP

MOP is the most common pure molybdenum material and is widely for heaters for furnaces, bolts, nuts, lighting, anchors for electron tubes, mandrels, supports, semiconductor support materials and magnetron parts, taking advantage of such features a high melting point, high strength at high temperatures, good heat conduction, small thermal expansion coefficient and excellent machinability.

●MOS

Conventional molybdenum materials could cause pitch irregularities when grids are formed with high-speed coil winders. This problem can be solved by using materials with a large working range, and the coiling ability and working range of MOS have been improved by composition control at the raw material stage.

●TT-TEM

TEM is a high-quality molybdenum material that has overcome the weak points of brittleness and deformation at high temperatures of conventional molybdenum. It features excellent high-temperature deformation resistance, high recrystallization temperatures and interlocked recrystallization structures. Even after it has been used at high temperatures, it excels in shock resistance, and allows deformation processing at ordinary temperatures. It also features higher bending ability than pure molybdenum. TEM is used for heaters for high-temperature furnaces, supports for halogen lamps, high-temperature structural materials (pins, nuts, bolts, hooks for heaters), anode supporting shafts for X-ray tubes, etc.

Standard specifications of molybdenum wires and rods

Diameter range	Rods									wires							
	Material			Representative spec						Material			Representative spec				
	MOP	MOS	TEM	Finish			Tolerance Diameter	Finish grinding ※1	Tolerance Diameter	MOP	MOS	TEM	Finish			Tolerance Diameter	Tolerance MG
				Black	Electrolytic	Acid cleaning							Black	Annealing	Electrolytic		
0.02~0.19				○	○		±0.005mm			○	○		○	○	○	±0.005mm	±3%
0.20~0.39	○	○	○	○	○		±0.005mm			○	○	○	○	○	○	±0.005mm	±2%
0.40~0.49	○	○	○	○	○		±0.01mm			○	○	○	○	○	○	±0.01mm	±2%
0.50~0.59	○	○	○	○	○		±0.02mm			○	○	○	○	○	○	±0.02mm	
0.60~0.79	○	○	○	○	○		±0.03mm			○	○	○	○	○	○	±0.03mm	
0.80~0.99	○	○	○	○	○			○	±0.02mm	○	○	○	○	○	○		
1.0~1.4	○	○	○	○	○			○		○	○	○	○	○	○		
1.5~1.9	○	○	○	○		○	±0.05mm	○		○	○	○	○	○		±0.05mm	
2.0~2.9	○	○	○	○		○		○		○	○	○	○	○			
3.0~3.9	○	○	○	○		○	±0.15mm	○	±0.03mm	○	○	○	○			±0.1mm	
4.0~4.9	○	○	○	○		○	±0.15mm	○									
5.0~6.3	○		○	○		○	±0.2mm	○	±0.05mm								
6.4~11.9	○		○	○		○	±0.3mm	○									
12.0~14.9	○		○			○	±0.4mm	○	±0.1mm								
15.0~20.9	○		○			○	±0.5mm	○	±0.15mm								
21.0~25.9	○		○			○	±0.7mm	○									
26.0~35.9	○		○			○	±1.0mm	○	±0.2mm								
36.0~50.0	○					○		○									

※1 Finish grinding: Centerless grinding for wires and rods of 25 mm or less in diameter and belt grinding for wires and rods larger than 25 mm in diameter.

Standard tolerance of length of molybdenum rods

(Unit : mm) Target : D16 max.	
From 50 incl. to 100 excl.	±1.0
100~300	+3−0
300~500	+4−0
500~1000	+5−0
1000~2000	+10−0
2000~	±50

Purity of molybdenum wires and rods

TYPE	Mo %
MOP, MOS	99.95min.
TEM	99.00min.

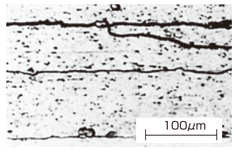
Finish and thickness range of molybdenum wires and rods

Code	Finish
D	DRAWN
DS	DRAWN AND STRAIGHTENED
CC	CHEMICAL CLEANED
CCA	CHEMICAL CLEANED AND ANNEALED
CCS	CHEMICAL CLEANED AND STRAIGHTENED
EE	ELECTROLYTIC ETCHED
EES	ELECTROLYTIC ETCHED AND STRAIGHTENED
EP	ELECTROLYTIC POLISHED
EPS	ELECTROLYTIC POLISHED AND STRAIGHTENED
EPSC	ELECTROLYTIC POLISHED, STRAIGHTENED AND CUT
G	GROUND
S	SWAGED
B	BELT GROUND

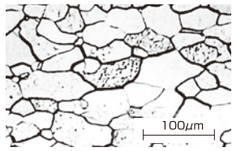
Recrystallization temperatures and structure of pure molybdenum wires and rods

Type	Recrystallization temperature ℃	Recrystallization structure
Pure molybdenum	1000~1200	Equiaxed grain
TEM	1200~1900	Long,large grain
TZM(other company's)	1300~1400	Equiaxed grain

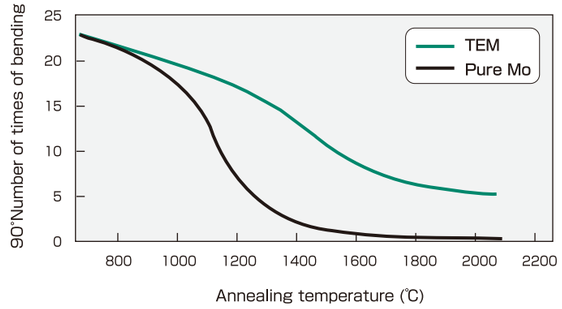
TEM



Pure Mo



Bending ability of TEM rods

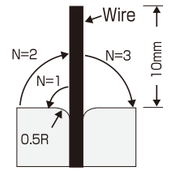


■ Test conditions

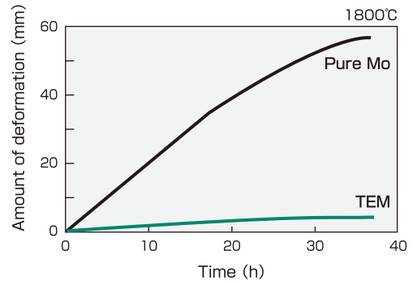
(1)Test piece D 0.6mm

(2)Heat treatment time 10 min.each

(3)Testing method



Excellent high-temperature deformation resistance of TEM rods, and examples of heater use



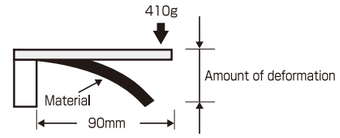
■ Test conditions

(1)Test piece D5.2mm rods

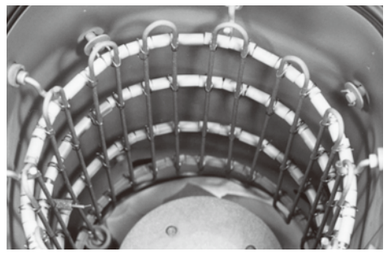
(2)Temperature 1800℃

(3)Load 410g

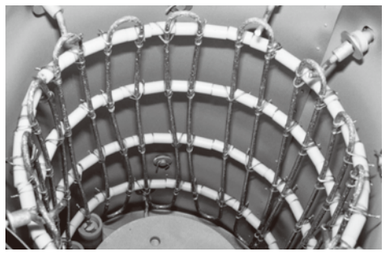
(4)Testing method



Examples of use in vacuum (1x10^{-3}Pa) at 1500℃

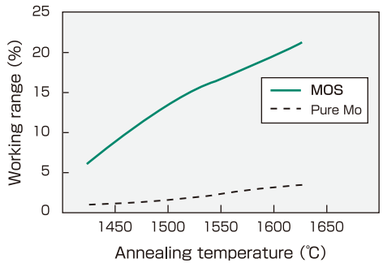


TEM heater used for 3 years



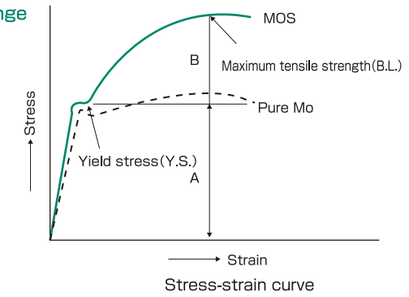
Pure Mo heater used for 1.5 years

Working range of MOS (D0.1mm)



■Definition of working range

$$\text{Working range}(\%) = \frac{\text{B.L.}-\text{Y.S.}}{\text{B.L.}} \times 100$$



Stress-strain curve

Tensile strength, elongation, and working range of molybdenum wires

Thickness		D,C,E of VMW 1,2,3(Non-heat-treated)		H of VMW 1,2,3 (Heat-treated)		
Wire diameter (μm)	MG	Tensile strength N/mm² {gf/MG}	Elongation %	Tensile strength N/mm² {gf/MG}	Elongation %	Working range (%)
35 excl.	2.0 excl.	1,300{65}min.	5max.	800{40}min.	8min.	—
From 35 incl. to 40 excl.	From 2.0 incl. to 2.6 excl.	1,200{60}min.	5max.	800{40}min.	10min.	—
From 40 incl. to 60 excl.	From 2.6 incl. to 5.8 excl.	1,200{60}min.	5max.	740{37}min.	10min.	8min.
From 60 incl. to 100 excl.	From 5.8 incl. to 16.0 excl.	1,100{55}min.	5max.	740{37}min.	12min.	10min.
From 100 incl. to 150 excl.	From 16.0 incl. to 36.0 excl.	1,000{50}min.	5max.	700{35}min.	14min.	12min.
From 150 incl. to 300 excl.	From 36.0 incl. to 144.0 excl.	1,000{50}min.	5max.	700{35}min.	14min.	—
80 excl.	10.2 excl.	1,100{55}min.	5max.	800{40}min.	—	—
From 80 incl. to 300 excl.	From 10.2 incl. to 144.0 excl.	1,000{50}min.	5max.	700{35}min.	—	—

※Separately consult with us about a 300μm (144.0MG) or thicker diameter.

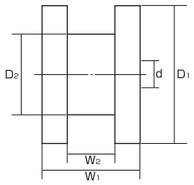
Straightness of molybdenum wires and rods

The wires to be heat treated shall be tested for a wire length of 500mm by the suspension method, and for a chord length of 100mm when the wire is cut to 200mm by the circular chord method, and shall satisfy the following requirements.

Thickness		Straightness(mm)	
Diameter(μm)	M G	Natural hanging method	Circular chord method
100 excl.	16.0 excl.	400min.	—
From 100 incl. to 150 excl.	From 16.0 incl. to 36.0 excl.	—	10max.
From 150 incl. to 300 excl.	From 36.0 incl. to 144 excl.	—	15max.

※Straightness-required rods shall be 1mm or less in height of arc with respect to 100mm in chord length throughout the overall length of the rods.

Standard spools for molybdenum wire



Spool type	Drawing No.	Material	Flange dia. D1(mm)	Barrel dia. D2(mm)	Width W1(mm)	Traverse width W2(mm)	Hole dia. d(mm)	Spool mass (g)	Max.coiling wire mass max(g)	Wire dia. range and applicable finish cord
Aluminum spool A	F-1565	Aluminum	106	75	32	26	10.1	104	690	0.1mm~0.6mm D,EP,EE ※ Maximum winded weight per spool : 500g
Aluminum spool B	F-1590	Aluminum	109	90	23	18	10	80	290	0.1mm~0.2mm D,EP,EE
Spool L	F-1569	Synthetic resin	277	221	60	44	215	310	2,800(MOS) 3,800(MOP)	0.25mm~1.5mm EP,EE
Bundle 48inch	Inner dia. Approx. 1,250mm								2,800(MOS) 3,800(MOP)	2.9mm~4.0mm D
Bundle	Inner dia. Approx. 260mm								2,800(MOS) 3,800(MOP)	0.9mm~1.5mm D
Bundle	Inner dia. Approx. 230mm								2,800(MOS) 3,800(MOP)	1.5mm~2.8mm D
Bundle	Inner dia. Approx. 230mm								2,800(MOS) 3,800(MOP)	1.5mm~4.0mm C,C

※ Maximum winded weight of DM & TEM per spool : 1,800g

Tungsten sheets / plates

◎ Most suitable
○ Suitable
△ Unsuitable

■Product selection guide

	Application		Type	Cutting ability	Bending ability	Shock resistance	Sputtering ability	Density
W	3N-W	Base plates for sintering, boats, Heaters, Reflectors, Heatspreader, Weights, Spacers, Various kinds of jigs and tools	Rolled products	◎	◎	○	◎	◎
			Sintered products	△	△	△	△	△
	4N-W	Sputtering targets, Molds for hot pressing	Rolled products	◎	◎	○	◎	◎
			Sintered products	△	△	△	△	△
	5N-W	Sputtering targets	Rolled products	◎	◎	○	◎	◎
			Sintered products	△	△	△	△	△

■Product lines

Rolled products

The most common tungsten sheets / plates are made by rolling, which can be bent or pressed while heating if the thickness is 3mm or less. To facilitate cutting and polishing, we provide fully annealed tungsten sheets / plates.

Sintered products

Sintered products are used for parts requiring moderate mechanical strength, such as discrete semiconductors, weights and spacers. This is intended to reduce costs by sintering after powder molding in plate form through control of powder particle size and establishment of press forming technology.

※Rolled products and sintered products are available in 3N, 4N and 5N grades of purity.

3N-W (General material)

3N-W is the most common tungsten sheets /plates manufactured by using tungsten powder with a purity of 3N5 (99.95%) or more by powder metallurgy. This is used for heat-resistant structural materials, electrode materials, and so on, taking advantage of such features as excellent in high-temperature deformation resistance and corrosion resistance, and containing less impure gas. It is also used for semiconductor parts since the coefficient of thermal expansion is the lowest among metals.

4N-W (High-purity material)

4N-W is tungsten sheets /plates manufactured by using tungsten powder with a purity of 4N (99.99%) or more by powder metallurgy. It is generally used for sputtering target materials, jigs and tools.

5N-W (Ultrahigh-purity material)

5N-W is tungsten sheets /plates manufactured by using high-purity tungsten powder with a purity of 5N (99.999%) or more by powder metallurgy. This is used for sputtering target materials, and various jigs and tools for manufacturing high-purity tungsten powder.

Standard dimensions of tungsten sheets / plates

(Unit: mm)

Thickness General tolerance ±10%	Finished surface			Dimensions	
	Chemical cleaned	Ground/polished	Honed	Max.width	Max.length
1.0 ～ 1.9	○	○	○	300	500
2.0 ～ 4.9	○	○	○	300	500
5.0 ～10.0	○	○	○	300	300

※ Please contact us for sheets/plates thicker than 10mm.

Tolerance of width and length of tungsten sheets/plates

(Unit: mm)

Tolerance	Thickness from 1 to 1.5mm excl.	Thickness from 1.5 to 10mm excl.
Width/length	±2.0	±3.0

※Separately consult with us about tolerances according to processing methods.

Types of tungsten sheets / plates

Material	Purity
3N-W(General material)	99.95 %min.
4N-W(High-purity material)	99.99 %min.
5N-W(Ultrahigh-purity material)	99.999%min.

Type	Density(g/cm^3)	Relative density(%)
Rolled products	18.6～19.3	96.3～100.0
Sintered products	17.0～17.9	88.1～92.7

Molybdenum sheets / plates

◎ Most suitable
○ Suitable
△ Unsuitable

■Product selection guide

	Application		Type	High-temperature deformation resistance	Shock resistance	Bending ability	Drawing ability	Cutting ability
Mo	MOP	Heatspreader, Boats for evaporation, Electron tubes, Furnace pars, Crucibles	Standard products	△	○	○	○	◎
		Deep drawing materials, Boats for evaporation	Cross-rolled products	△	○	◎	◎	◎
	TEM	Reflectors	Standard products	○	◎	○	○	○
	DMB	Reflectors,Sintering plates,Boat	Honed surface, Coated surface	◎	△	△	△	○
	TEM-B			◎	○	◎	○	△
	TEM		Acid-cleaned and mirror finish	○	◎	○	△	○

■Product lines

●MOP

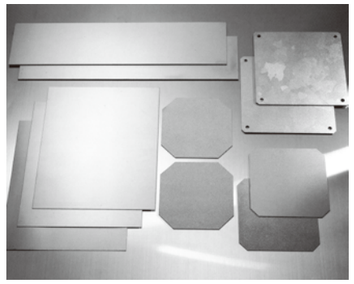
MOP is the most common pure molybdenum sheets/plates. This is widely used for heatspreader, reflectors, and boats for evaporation, taking advantage of features a high melting point, high strength at high temperatures, high thermal conductivity, low coefficient of thermal expansion and excellent machinability.

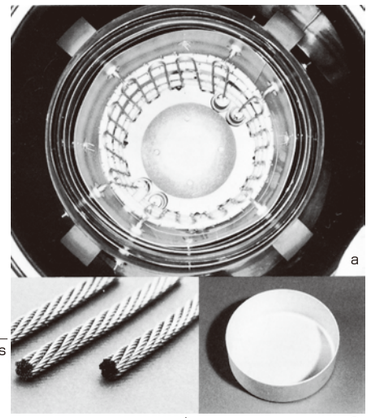
●TT-DMB

DMB is a molybdenum sheets/plates that is most suitable for setters for sintering ceramics and rare-earth magnets. This features excellent creep (deformation) resistance at high temperatures, a low coefficient of thermal expansion and excellent characteristics in vacuum or reduction atmosphere. Use of DMB sheets /plates in place of conventional bulky and heavy ceramic sheets/ plates ensures thickness reduction to approximately 1/5 or less, and remarkably improves the furnace operating efficiency and the lifetime of setters for sintering.

●TT-TEM

TEM is molybdenum sheets/plates by adding small amounts of special elements and combining plastic working. In particular, the TEM-B sheets/plates has a laminated structure of long, large grains, and excels at high-temperature deformation resistance, and shock resistance at room temperature and also allows plastic working at room temperature. It also features higher high-temperature strength than pure molybdenum. This is used for reflectors for high-temperature furnaces, parts for furnaces, setters, boats, etc.





TEM products
(examples of application)

a.Heating elements and reflectors
b.Stranded wires
c.Crucibles

Standard specifications of molybdenum sheets/plates

(Unit : mm)

Thickness General tolerance ±10%	Material		Finished surface		Dimensions		Material		Finished surface			Dimensions	
	MOP	TEM	Mirror	Chemically cleaned	Max. width	Max. length	DMB	TEM-B	Mirror	Chemically cleaned	Sand blasted	Max. width	Max. length
0.015～0.099	○		○		110	500							
0.10～0.15	○		○		300	1000							
0.16～0.19	○		○	○	300	1500							
0.20～0.49	○	○	○	○									
0.50～1.4	○	○	○	○	600	2000		○	○	○	○	300	600
1.5～2.9	○	○	○	○			○	○	○	○	○	500	600
3.0～6.9	○	○		○			○	○		○	○	600	600
7.0～14.9	○	○		○	600	1000	○			○	○	600	600
15.0～25.0	○	○		○									

※ The tolerances in the above table may vary depending on finishing. Please contact us if you require different specifications.

Standard specifications of cross-rolled molybdenum sheets/plates

(Unit : mm)

Thickness General tolerance ±10%	Material MOP	Finished surface	Dimensions	
		Mirror	Max. width	Max. length
0.10～1.00	○	○	300	1000

※ The thickness tolerance may vary depending on the finish.

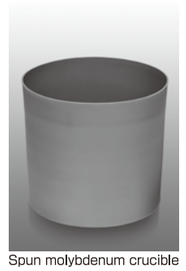
Tungsten and molybdenum crucibles

High-performance crucibles developed in pursuit of upsizing and a long life by various manufacturing methods. In particular, molybdenum crucibles have been well-received as long-life crucibles due to such features as high density and uniform microstructure. These are widely used for growing single-crystal sapphire. where productivity has remarkably improved.

(Unit : mm)

	Material	Size	
		Outside diameter × height	Thickness
Sintered products	Molybdenum	(max)D400×H400	–
	Tungsten-molybdenum alloy	(max)D300×H300	–
	Tungsten	(max)D200×H200	–
Spinning product	Molybdenum	(max)D600×H600	(max)15.0、(min)1.0

※Consult with us about sizes exceeding the above and for special processing.



Spun molybdenum crucible

Ceramic-coated molybdenum sheets/plates

The furnace operating efficiency is remarkably improved by using ceramic-coated molybdenum sheets /plates having anti-adhesion and anti-reacting functions with thickness further reduced to approx. 1/5 or less to replace conventional bulky ceramic sheets/plates with poor thermal efficiency.

Application	Coating type	Example of composition	Example of operating temperature (in hydrogen atmosphere or in vacuum)	Coating thickness
Sintering MIM products (SUS,Fe-Ni Ti, Alloys parts)	Alumina	Al_2O_3 99.0%	1400℃	30～150μm
	Alumina-Titania	Al_2O_3 –2.5%TiO_2	1400℃	
	Alumina-Zirconia	Al_2O_3 –25%ZrO_2	1700℃	
	Zirconia-Yttria	ZrO_2 –8%Y_2O_3	1400℃	
	Zirconia-Silica	ZrO_2 –33%SiO_2	1400℃	

Molybdenum mesh

Width × length (mm)	Wire diameter (mm)	Mesh(approx.)	Porosity(approx.)%
1000×1000	0.35	24	44

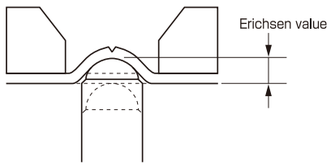
※Consult with us for specifications other than the above.

Erichsen value of MOP thin sheet

(Unit : mm)

Thickness	Standard
From 0.10 incl. to 0.15 excl.	3.0min.
From 0.15 incl. to 0.20 excl.	3.7min.
From 0.20 incl. to 0.25 excl.	4.0min.
From 0.25 incl. to 0.30 excl.	4.4min.
From 0.30 incl. to 0.40 excl.	4.9min.
From 0.40 incl. to 0.50 excl.	5.3min.
From 0.50 incl. to 0.60 excl.	5.6min.
From 0.60 incl. to 0.70 excl.	5.7min.

Erichsen value measuring method (JIS Z2247A)
Amount of travel of the ball head punch between the instant it comes in contact with the sheet surface and the instant a crack reaching the back surface occurs.



Flatness of MOP and TEM sheets/plates

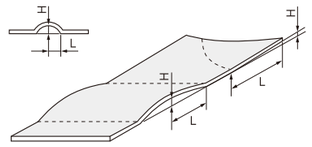
The flatness measuring method is based on TMIAS0301.4.4 (Mo flatness measuring method) as shown in the table below.

$$\text{Flatness}(\%)=\frac{H}{L}\times 100$$

Thickness (mm)	Range
0.5min.	3.5%max.
less than 0.5	4.5%max.

Flatness measuring method

H:The maximum spacing between the bottom surface and flat surface of a sheet.
L:The minimum distance between the tangent of the flat surface and maximum height of sheets/plates.

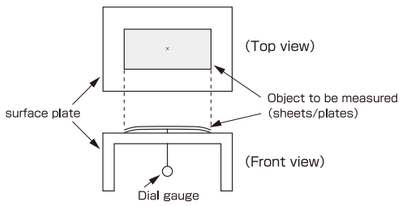


Flatness measuring method and tolerance of DMB and TEM-B sheets/plates

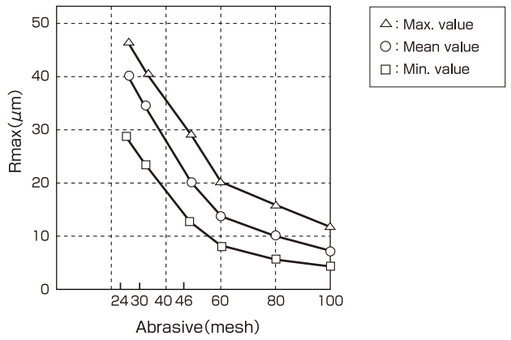
(Unit : mm)

Length of sheets/plates	Tolerance of flatness
100max.	0.25max.
200max.	0.30max.
300max.	0.50max.

Flatness measuring method

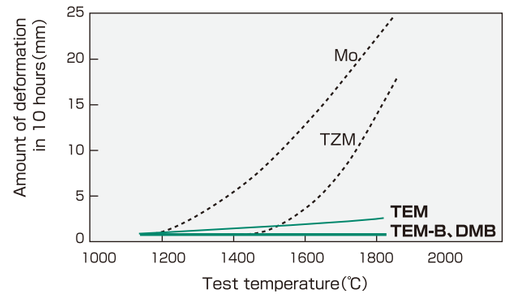


Sand blasted surface roughness of DMB and TEM-B sheets / plates



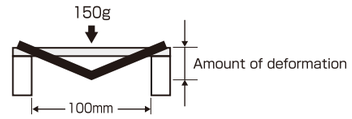
High-temperature deformation resistance of various kinds of molybdenum sheets/plates

①Temperature dependence of the amount of deformation at each temperature under a fixed load

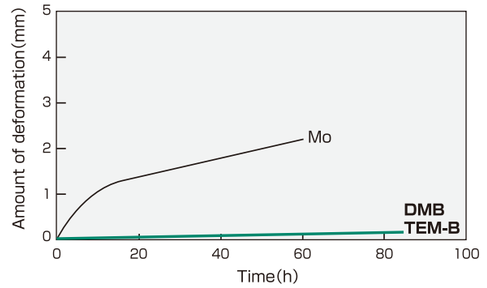


■ Test conditions

(1)Test piece T1×B20×L120mm
(2)Time 10 hours
(3)Load 150g
(4)Testing method

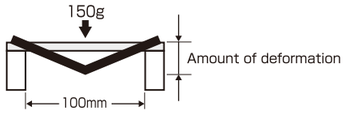


②Time dependence of the amount of deformation at 1200℃ under a fixed load

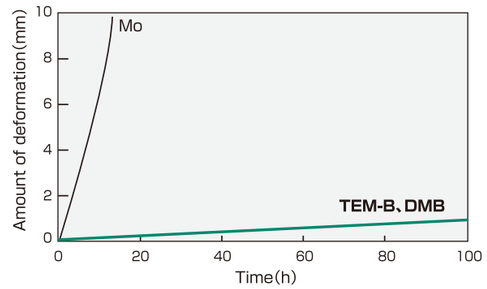


■ Test conditions

(1)Test piece T1×B20×L120mm
(2)Temperature 1200℃
(3)Load 150g
(4)Testing method

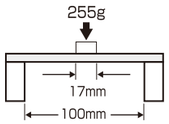


③Time dependence of the amount of deformation at 1800℃ under a fixed load

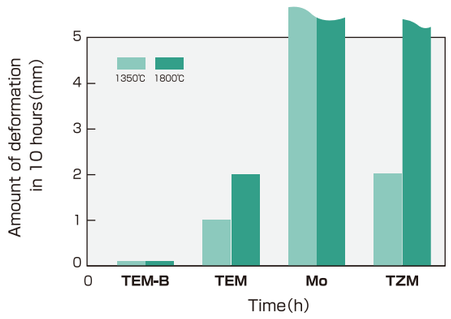


■ Test conditions

(1)Test piece T 1.5×B20×L120mm
(2)Temperature 1800℃
(3)Load 255g
(4) Testing method

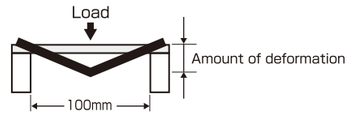


High-temperature deformation resistance of TEM-B sheets/plates

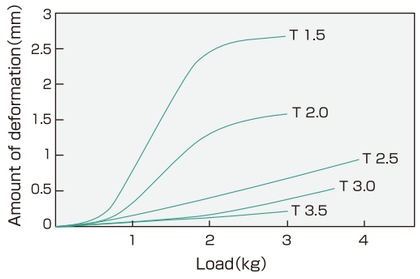


■ Test conditions

(1)Test piece T1.5×B20×L120mm
(2)Temperature 1350℃, 1800℃
(3)Time 10 hours
(4)Load 300g(1350℃)
340g(1800℃)
(5)Testing method

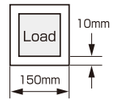


High-temperature deformation resistance of DMB and TEM-B sheets/plates

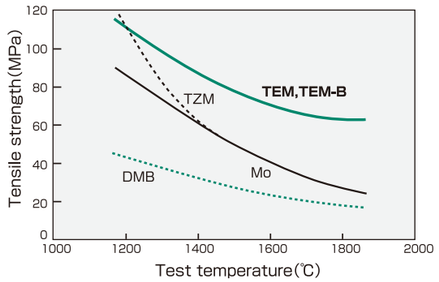


■ Test conditions

(1)Test piece T×□150mm
(2)Temperature 1200℃
(3)Time 0.5 hours
(4)Load Uniform load(~4kg)
(5)Testing method



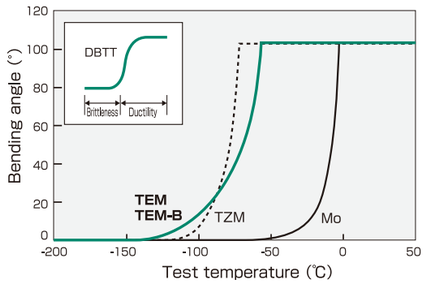
High-temperature strength of various kinds of molybdenum sheets/plates after use at high temperature (1800℃)



■ Test conditions

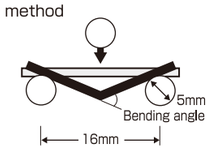
(1)Test piece T1mm (Rolling is in the direction of length.)
(2)Strain rate 8.3×10^{-5} s^{-1}

Ductile-to-Brittle Transition Temperature (DBTT) of various kinds of molybdenum sheets/plates after use at high temperature (1800℃) (Toughness and processing ease at low temperature)

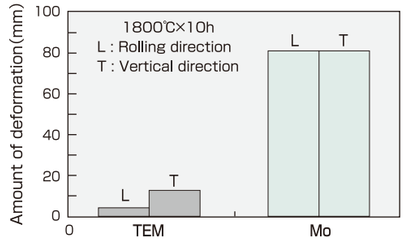


■ Test conditions

(1)Test piece T1×B3×L25mm
(Rolling is in the direction of length.)
(2)Speed 1mm/min
(3)Testing method

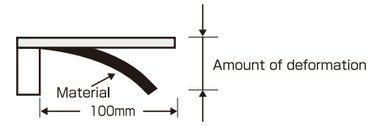


Excellent high-temperature deformation resistance of TEM sheets/plates, and examples of reflector use



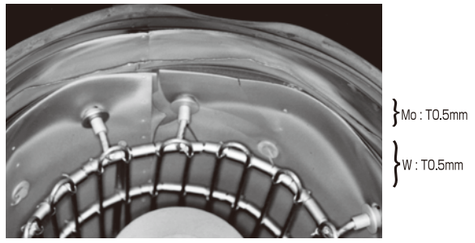
■ Test conditions

(1) Material T0.5mm (W10×L120)
(2) Temperature 1800℃
(3) Time 10hours
(4) Load Own weight
(5) Loading method



Examples of 100h use in vacuum (1 x 10^{-3}Pa) at 1500℃

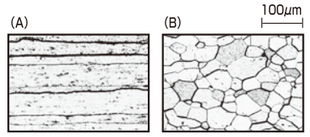
TEM reflector



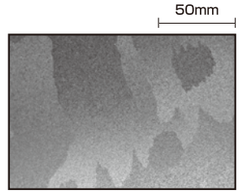
W-Mo reflector

Recrystallization temperature and structure of various kinds of molybdenum sheets/plates

Material	Recrystallization temperature	Recrystallization structure
MOP(pure Mo)	1000~1100℃	Equiaxed grain(B)
DMB	—	Huge grain
TEM	1200~1800℃	Long, large grain(A)
TEM-B	—	Long, large grain(A)
TZM	1300~1400℃	Equiaxed grain



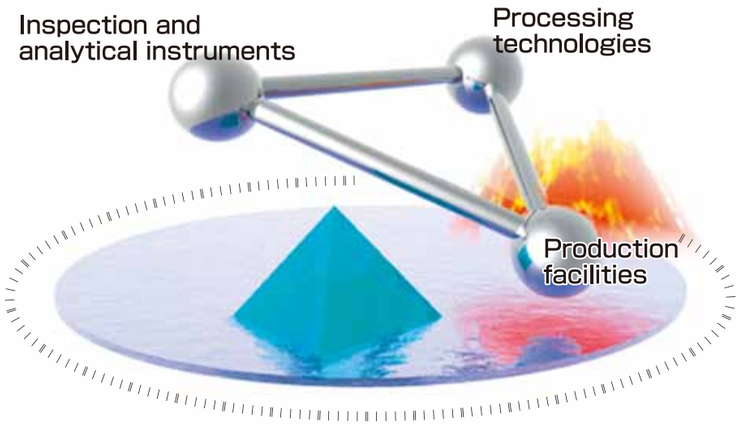
Cross-sectional structure in parallel with the rolling direction



Appearance of DMB

An abundance of processing technologies compatible of handling any request

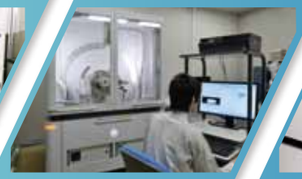
Our company is a top manufacturer having processing technologies of tungsten and molybdenum metal products. We can handle every processing request with our special materials and full lineup of products. We can provide information on use and also cooperation in design and processing not only for special processing that meets each customer's needs, but also based on the considerable experience we have accumulated in tungsten and molybdenum processing. Additionally, we supply high quality with substantial evaluation and analytical instruments, and know-how.



We deliver peace of mind with reliable quality controls.


Ultrasonic flaw detectors


ICP plasma emission spectrophotometers


X-ray diffraction instruments


Frameless atomic absorption-photometers


Field-emission type scanning electron microscopes


Electron-beam micro-analyzers

Rolling and cladding

- Rolling (Cold, Warm, Hot)

Cutting-off

- Shearing
- Wheel cutting
- Pressing
- Countering (Contour machining)
- Electric discharge machining

Punching and bending

- Pressing
- Punching
- Roller bending
- Drawing

Cutting and grinding

- Lathe
- Milling machine
- Drilling machine
- Machining center
- Electric discharge machining
- Surface grinding
- Rotary grinding
- Centerless grinding

Surface machining

- Lapping
- Polishing
- Barreling
- Surface cleaning
- Blasting

Special processing

- Plating
- Bonding
- Photo-etching
- Heat treatment (Destraining, Degassing, Cleaning)

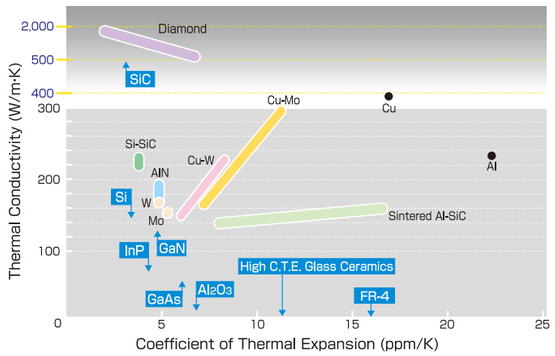
Line processing

- Wiredrawing
- Electrolytic polishing
- Rewinding
- Straight-lining
- Meshing
- Cutting-off
- Deburring
- Coiling
- Bending
- Plating
- Heat treatment

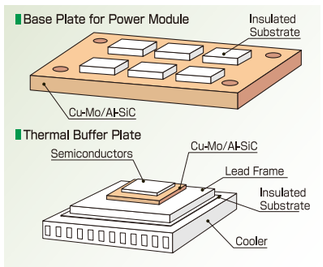
Comparison of physical and mechanical properties of Heatspreader Materials

	Category	Material	Trade Name	Composition	Coefficient of Thermal Expansion [ppm/K]	Thermal Conductivity [W/(m·K)] 25℃	Thermal Conductivity [W/(m·K)] 100℃	Specific Heat [kJ/(kg·K)]	Specific Gravity	Hardness [Hv]	Transverse Rupture Strength [MPa]	Tensile Strength [MPa]	Young's Modulus [GPa]	Poisson's Ratio	Electric Resistivity [Ωm]	Dielectric Constant [at 1MHz]	Application: Automobile and industrial machinery	Application: LSI	Application: Wireless communication	Application: Opto Electronics	Application: LD·LED	Characteristics
Heatspreader	Metals	W			4.5	167	159	0.13	19.3	370	—	—	380	0.284	5.5×10^{-8}	—	●		●		●	Low coefficient of thermal expansion Machine processing is available
		Mo			5.1	159	138	0.25	10.2	240	—	—	320	0.324	5.7×10^{-8}	—						
	Metal Composites, Alloy	Cu-W	W-6	94W-6Cu	6.0	150	—	0.15	17.6	330	1,000	590	350	—	—	—		●	●	●	●	C.T.E. is variable Good machinability
			W-10	89W-11Cu	6.5	180	176	0.16	17	300	1,100	560	330	0.295	5.3×10^{-8}	—						
			W-15	85W-15Cu	7.2	190	183	0.17	16.4	280	1,200	530	310	0.3	4.6×10^{-8}	—						
			W-20	80W-20Cu	8.3	200	197	0.18	15.65	260	1,300	490	280	0.305	4.0×10^{-8}	—						
			W-10N	89W-11Cu	6.5	200	—	0.16	17	300	1,100	560	330	—	5.3×10^{-8}	—						
			W-10T	89W-11Cu	6.5	205	—	0.16	17	300	1,100	560	330	—	—	—						
		Cu-Mo	CM-15	85Mo-15Cu	7.0	160	156	0.28	10.01	150	1,200	540	280	—	5.3×10^{-8}	—	●		●	●	●	Good machinability
			PCM30	70Mo-30Cu	x7.0-y8.3(7.3)	200	196	0.29	9.8	180	—	600	230	0.315	4.0×10^{-8}	—						Suitable for rolling and pressing process
			PCM35	65Mo-35Cu	x7.2-y9.3(7.7)	210	205	0.3	9.7	175	—	560	220	—	3.5×10^{-8}	—						
			PCM40	60Mo-40Cu	x7.5-y10.2(8.4)	222	217	0.31	9.6	170	—	530	210	0.32	3.4×10^{-8}	—						
			RCM60	40Mo-60Cu	x10.0-y13.2(11.1)	286	280	0.33	9.4	160	—	440	170	0.33	2.7×10^{-8}	—						
			CPC141(30)	Cu/PCM/Cu	x7.3-y10.0(8.5)	220	211	0.32	9.5	—	—	380	160	—	—	—						Suitable for rolling and pressing process
			CPC232(30)	Cu/PCM/Cu	x7.5-y11.0(9)	255	250	0.34	9.3	—	—	350	130	—	—	—						
			CPC111(30)	Cu/PCM/Cu	9.5	260	—	0.35	9.2	—	—	310	125	—	—	—						Good heat dissipation by Cu surface layer
			CPC212(30)	Cu/PCM/Cu	11.5	300	—	0.36	9.1	—	—	230	120	—	—	—						
	Ceramics	AlN	SALN-20 White		4.5	>200	>180	0.67	3.26	1,200	300	—	270	—	10^{11}	8.5	●	●		●	●	High T.C. and Insulator
			SALN-17 White			>170	>150															
	Ceramics -Metal	Al-SiC	β8	70SiC-30Al	8	140	—	0.73	2.60	—	240	—	130	0.26	—	—	●	●	●			1/3 the density of copper C.T.E. is variable Available for an aluminum skin
			β10	60SiC-40Al	10	145	—	0.75	2.70	—	240	—	130	—	—	—						
			β12	50SiC-50Al	12	150	—	0.77	2.70	—	280	—	120	—	—	—						
			β14	45SiC-55Al	14	160	—	0.78	2.60	—	280	—	100	—	—	—						
			β16	25SiC-75Al	16.5	160	—	0.83	2.80	—	250	260	100	0.29	—	—						
		Si-SiC	Invader	SSC200 18Si-SiC	3	>200	—	0.67	3	—	350	—	400	—	4.7	—	●	●				Same low C.T.E. as Si and high T.C.
	Diamond	DMCH Diamond-Cu	DC60	Diamond-Cu	6.0	550	—	0.45	5.0	—	—	—	410	0.15	2.6×10^{-4}	—			●	●	●	High T.C.
			DC70		6.5	500	—	0.44	5.5	—	—	—	—	—	—	—						
		Sumicrystal			2.3	2,000	1,400	0.51	3.52	9,000~10,000	3,900	—	1,050	—	10^{14}	5.7						
		CVD-Diamond			2.3	>1,000	—	0.51	3.52	9,000~10,000	1,000	—	1,050	—	5×10^{7}	5.8				●	●	High T.C. and Insulator
Reference data	Semiconductor	Si			3	151	—	0.75	2.3	—	200	—	170	—	2.3×10^{-3}	11.7						
		GaAs			5.9	46	34	0.33	5.32	—	—	290	90	—	3.8×10^{-6}	11.1						
		InP			4.5	70	—	0.32	4.79	—	—	—	60	—	8.2×10^{-7}	12						
		GaN			a5.6-c3.2	130	—	0.49	6.15	—	—	—	—	—	—	—						
		SiC			3.1	490	—	0.69	3.2	—	—	—	221	—	—	10						
	Ceramics	Al_2O_3			6.7	17	17	0.8	3.6	1,900	300	—	370	—	10^{12}	8.9						
		BeO			7.6	251	180	0.96	2.9	1,200	200	—	330	—	10^{13}	6.7						
		SiO_2			3	1.4	—	—	0.7	—	—	—	—	—	—	—						
		High C.T.E. Glass Ceramics			11.5	0.2	—	—	1	—	—	—	—	—	—	—						
	Metals	Cu			17	393	393	0.38	8.93	80	—	250	120	—	1.7×10^{-8}	—						
		Al			23	238	—	0.27	2.7	—	—	—	80	—	—	—						
		Kovar			5.3	17	17	0.44	8.36	160	—	540	140	—	4.9×10^{-7}	—						
	Organic	FR-4			x15-y17	0.2	—	—	—	—	—	—	—	—	—	—						
		Polyimide			25	0.2	—	—	—	—	—	—	—	—	—	—						

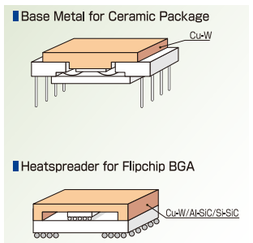
Thermal properties of Heatspreader Materials



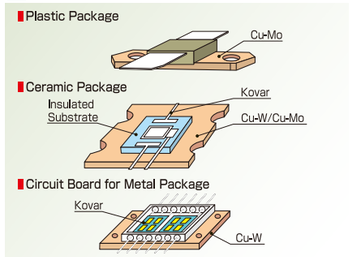
For Automobile and Industrial Machinery



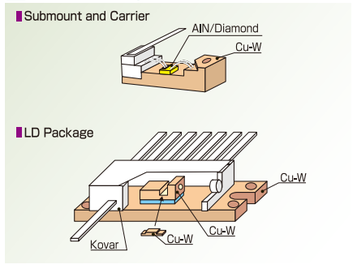
Parts for LSI



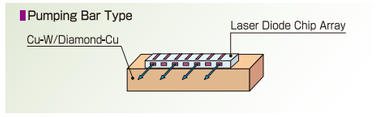
Parts for Wireless Devices



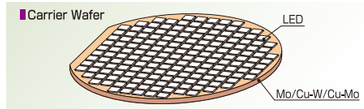
Parts for Optical Communication



Parts for LD



Parts for LED



1. Metals Category

Pure Mo, Pure W

These have low thermal expansion close to Si chips, and superior mechanical properties. These are most suitable for high-power / high-reliability heatspreader. Various machining processes including pressing can be done on these materials.

■Application: For diode and thyristor, Power transistor substrate, LED substrate, etc.

2. Metal Composites, Alloy Category

Cu-W

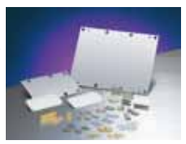
Cu-W is a combination of W which has low thermal expansion and Cu which has high thermal conductivity. Thermal expansion can be adjusted to those of Alumina and Kovar materials. Also, with good machinability, it's possible to manufacture the parts with small-complicated shapes.

■Application: Wireless communication, Opto electronics, LED substrate, MPU, etc.

Cu-Mo

Cu-Mo is suitable for rolling and pressing processes. Thermal expansion and thermal conductivity are adjustable with this material. Since the "Clad" material's surface is pure Cu, the heat dissipation on surface layer is larger.

■Application: Wireless communication, Plastic package, Power transistor substrate, LED substrate, etc.

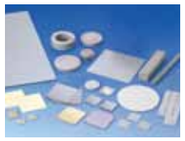


3. Ceramics Category

AlN

AlN has a high electric insulation and low dielectric constant. Various metallizing processing is possible with this material.

■Application: Semiconductor laser submount, LED substrate, etc.

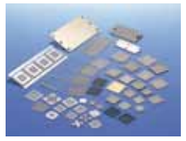


4. Ceramics-Metal Category

Sintered Al-SiC

Al-SiC is a heatspreader easily applied for low volume demand and relatively complex shaped parts production. Specific gravity is 1/3 of Cu. By adjusting the composite ratio of Al and SiC, it is possible to customize the thermal expansion to required specification. Moreover, as an option it is possible to laminate an aluminum layer on the surface.

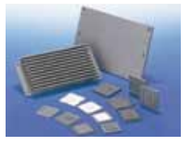
■Application: MPU, DSP, System LSI, Router LSI, etc.



Invader (Si-SiC)

Si-SiC is a heatspreader which has similar low thermal expansion to Si chips and also has high thermal conductivity. Available for a near net shape.

■Application: LSI for super computer, MPU for high performance server, etc.



5. Diamonds Category

Sumicrystal

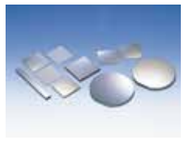
Our original ultrahigh pressure technology enables the production of synthetic single crystal diamonds which possess one of the best thermal conductivities of all known materials.

■Application: Semiconductor laser submount, etc.

CVD-Diamond

Because of its binderless polycrystalline structure, our CVD diamond exhibits a high thermal conductivity approaching that of single crystal diamond. Large diamonds can be made and can be applied in wide number of applications.

■Application: Semiconductor laser submount, power transistor substrate, etc.



DMCH Diamond-Cu

Composite material of diamond and copper with thermal expansions similar to InP or GaAs and thermal conductivity higher than copper.

■Application: Semiconductor laser submount, power transistor substrate, etc.

High-density tungsten heavy metal alloys

●Machining / processing characteristics of heavy metal

A new line of products have been developed that allow processing options beyond cutting such as forging and rolling. They can be manufactured into more complex shapes and configurations while keeping costs low. Have comparable specific gravities to lead, but environmentally friendly.

Before forging ▶ After forging

●Features of high density of heavy metal

These heavy metals are comprised primarily of tungsten, and utilizing it's high density characteristics we have developed technology to allow us to use injection molding to create 3D shapes with high accuracy and low cost.

▲ Technology of injection molding for Heavy Metal

●Application

- Balancer for aircraft
- Weight for golf club
- Roater for watch
- Balancer for meter in the automobile
- Vibrator for mobile phone
- Balancer for automobile

●Absorption properties

Heavy metals are far superior compared to other metals in terms of absorption of high-energy beams and radiation, they have extremely low gas emissions within a vacuum and are superior in mechanical strength and processing workability.

▲ Shield capsule for isotope

▲ Medical leaf-collimator

▲ Shield products for high energy

●Application

● Medical leaf-collimator ● Shield capsule for isotope
● Shield products for high energy

Shielding effect of heavy metal

Isotope	γRay energy (MeV)	Absorption coefficient(cm⁻¹)	1/2 Damping thickness (cm)	1/10 Damping thickness (cm)
^{60}Co	1.17 1.33 } Ave.1.25	0.93	0.75	2.05
^{131}I	0.364 0.638	3.69 1.74	0.188 0.40	0.64 1.32
Ra	2.20	0.72	0.97	3.20
^{24}Na	1.38 2.76	0.97 0.66	0.72 1.05	2.36 3.50
^{187}W	0.68	1.43	0.49	1.60

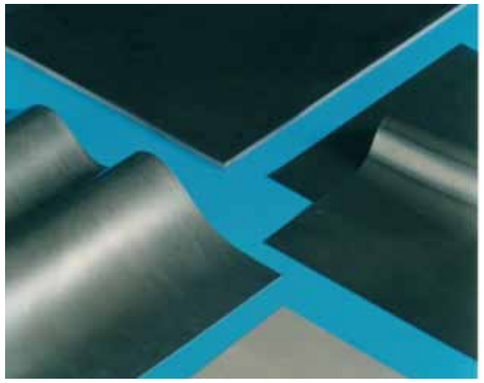
Typical properties of heavy metal

★Plastic heavy metal ☆Corrosion resistant heavy metal (ST series)

Properties \ Material			★HM-12	HM-1	HM-2	HM-5	HM-7	HM-7S	☆HM-7ST	☆HM-8ST	HM-185
Tungsten composition %			53	90	90	95	95	95	95	97	97
Density			12	17	17	18	18	18	18	18.5	18.5
Mechanical properties	Hardness	H_RC	24	26	26	28	28	28	28	29	29
	Compression strength (Warpage 0.2%)	MPa	–	690	690	780	560	560	690	690	780
	Tensile strength	MPa	880	590	600	880	780	780	780	780	880
	Yield strength (Warpage 0.2%)	MPa	650	510	510	650	560	560	650	650	650
	Elongation	%	40	0.4	0.4	25	5	5	5	5	10
	Young's modulus	GPa	–	280	–	350	300	300	350	300	370
	Transverse rupture strength	GPa	–	1.4	–	2.2	2.1	2.1	–	–	2.2
	Impact strength	J/cm²	40	2.0	–	4.9	2.9	2.9	–	–	2.9
Thermal properties	Thermal conductivity	W/(m·K)	–	88	–	84	92	92	75	–	100
	Coefficient of linear expansion	ppm/K	–	6.0	–	5.2	5.6	5.6	5.2	–	5.0
Electrical properties	Electrical conductivity	%I.A.C.S	–	15	–	–	16	–	–	–	–
	Specific resistance	Ωm	–	–	–	110	–	–	–	–	81
Magnetic properties	Magnetism		exist	none	weak	exist	weak	none	none	none	exist
	Magnetic permeability	Km	–	1.00022	–	4.723	–	1.00013	1.00028	–	4~4.5
	Magnetic susceptibility	Xm	–	0.00022	–	3.723	–	0.00013	0.00028	–	3~3.5

*The above values may vary depending on production conditions.

Heavy metal sheets for radiation shields



●Features of Heavy metal sheets

- ●Lead(Pb) free, Tungsten (W) is main composition
- ●Approximately two times X Ray radiation shielding compared to conventional Lead contained sheet
- ●Keeping the almost same elasticity and flexibility as standard rubber
- ●Various shape and size are available by easy cutting
- ●High specific gravity ($\rho \geqq 9$)

●Application

- ●Radiation shielding parts with elasticity and flexibility requirements
- ●Weight parts with elasticity and flexibility requirements
- ●Radiation shielding parts with various shape requirements
- ●Damper

Mechanical and thermal properties

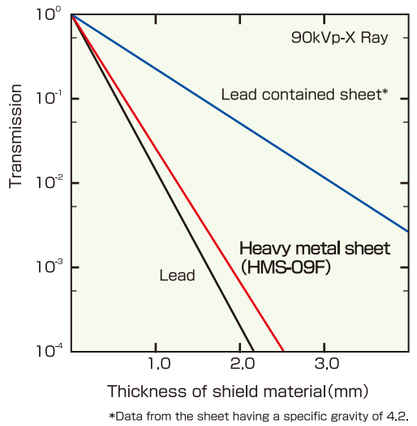
Grade \ Properties	Specific gravity	Mechanical properties: Tensile strength (MPa)	Mechanical properties: Elongation (%)	Mechanical properties: Hardness (JIS A)	Thermal properties: Specific heat (kJ/kg·K)	Thermal properties: Thermal conductivity (W/m·K)	Thermal properties: Coefficient of linear expansion (×10⁻⁵/K)
HMS-09C (General purpose)	9.0	5.0	650	82	0.24	0.7	6.8 (xy-direction) 13 (z-direction)
HMS-09F (Heat and chemical resistance use)	9.0	7.0	300	94	0.26	0.6	11 (xy-direction) 19 (z-direction)

Heat and chemical resistance

Grade \ Properties	Heat resistance	Chemical resistance
HMS-09C	Usable under 100℃	Resistant to alcohol, acid and alkali
HMS-09F	Usable under 200℃	Resistant to organic solvents, alcohol, acid and weak alkali

*The above property values are intended as a guide.
Actual values may differ from those published without notice.

X ray shielding performance



*Data from the sheet having a specific gravity of 4.2.

Resistance to radiation

(Upper section : HMS-09C, lower section : HMS-09F)

(R) Exposure dose \ Item	Appearance	Tensile strength (MPa)	Elongation (%)	Hardness (JIS A)
0	—	5.0	650	82
	—	7.0	300	94
5.0×10^5	No change	4.8	630	84
	No change	7.2	290	94
7.5×10^6	No change	3.4	200	90
	No change	8.0	70	96
1.0×10^7	No change	3.4	70	90
	No change	8.5	50	96

* Irradiation by ^{60}Co ray source

●ELCON

ELCON-Is the general term of our electric contact materials developed by combination of various compounds in addition to silver/copper having good electrical conductance and tungsten-graphite having superior heat and arcing resistance.

ELCON : Electric Contact

Tungsten contacts, material series and applications

Grade		Composition	Typical properties			Application						
			Specific gravity	Conductivity %IACS	Hardness HRB	Heavy load circuit breakers	Heavy load gas breakers	Dedicated arcing contacts	Tap changers	Electrodes for resistance welding	Electrodes for discharge machine	Electrodes for spot welding
A type (Ag-W)	A-1	35Ag-65W	15.0	48	91						○	○
	A-7	35Ag-65W	14.9	55	82	○		○			○	○
	A-9	45Ag-55W	14.0	60	62	○		○				
C type (Cu-W)	C-2B	10Cu-90W	17.2	26	100		○					○
	CX-20	20Cu-80W	15.5	43	100					○		
	C-1	30Cu-70W	14.3	26	93						○	○
	C-6	30Cu-70W	14.3	55	87		○	○	○	○	○	
	C-8	40Cu-60W	13.2	64	75		○		○			
	C-10	50Cu-50W	12.1	65	60				○			
	NEL120	30Cu-70W	14.3	52	85						○	
	NEL150	32.5Cu-67.5W	13.5	56	80						○	

Grade		Composition	Typical properties			Application				
			Specific gravity	Conductivity %IACS	Hardness Hv 5kg(HRB)	Circuit breakers	Vacuum breakers	Heavy load contacts for vehicles	Magnet switches	DC contactors
KA type (Ag-WC)	KA-7	35Ag-60WC-5Co	12.8	21	330 (108)		○	○		
	KA-12	60Ag-40WC	12.0	58	120 (67)	○				
KX･KAG type (Ag-WC-Gr)	KX-125	72Ag-WC-Gr	9.6	35	65 (17)	○				
	KX-138	77Ag-WC-Gr-α	9.6	35	60 (10)	○				
	KX-140	85Ag-WC-Gr-α	9.5	45	45 (<10)	○				
	KX-150	85Ag-WC-Gr-α	9.2	62	45 (<10)	○				
	KX-170	85Ag-WC-Gr-α	9.3	62	45 (<10)	○				
	KAG-2	57Ag-WC-Gr	9.7	30	70 (25)	○				
AN type(Ag-Ni)	AN-2	85Ag-15Ni	9.9	80	67	○			○	○
AG type(Ag-Gr)	AG-2%	98Ag-2Gr	9.2	82	35	○				
	AG-5%	95Ag-5Gr	8.5	57	35	○				

A type(Ag-W)

A type (Ag-W) is a sintered contact material produced by combining silver that has a high electrical conductivity and tungsten that has a high melting point. Its beneficial characteristics include superior arcing resistance and adhesion resistance in high current areas. Many years of application have proven its high reliability. In addition, it has superior performance as an electrode used for EDM.

C type(Cu-W)

C type (Cu-W) is an alloy based on the conductive properties of copper and arcing resistance of tungsten. It is a contact material that demonstrates high performance with low dissipation, high adhesion resistance and arcing resistance and as such is used for arcing chips in gas circuits. In addition, this material is suitable for electrode to EDM.

KA type(Ag-WC)

KA type (Ag-WC) is a contact material composed of tungsten carbide that has high resistance to oxidation, coupled with silver that has good electrical conductance. It demonstrates a high efficiency when used in low voltage/high current contacts because there is no change in the contact resistance and it has superior adhesion and electrical overload resistance.

KX･KAG type(Ag-WC-Gr)

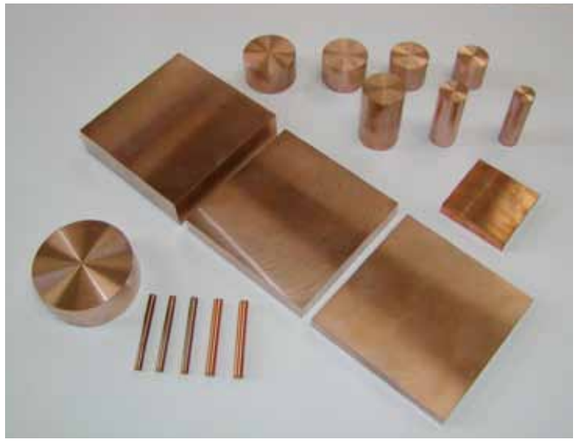
KX/KAG type (Ag-WC-Gr) Contact materials made by adding graphite to silver WC. By doing this, the low resistance contact property and adhesion resistance can be improved.

AN type(Ag-Ni)

AN type (Ag-Ni) is a alloy primarily composed of Ag and Ni. Contact material for small load equipment having less material migration with superior mechanical properties and adhesion resistance.

AG type(Ag-Gr)

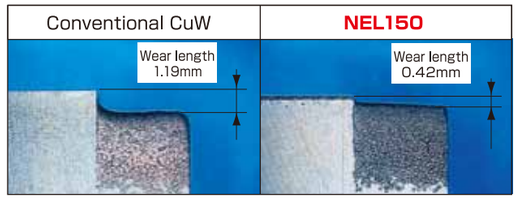
AG type (Ag-Gr) is a alloy having graphite added to silver manufactured by powder metallurgy. Its mechanical strength is not high, but the adhesion resistance and low-contact resistance are superior to make this material suitable for applications that require reliability in operation of equipment.



●Features of NEL150

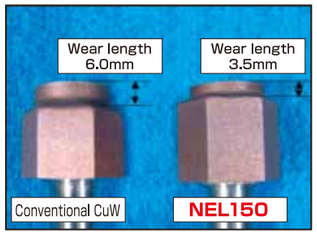
- **High speed processing…**
  The processing speed is 1.5 times faster than that of general copper-tungsten materials and it has superior arcing resistance.
- **Low consumption processing…**
  Electrode consumption is a half of consumption of general copper-tungsten materials.
- **High grade processing…**
  The processed electrical discharge surface demonstrates very little surface roughness that can be easily polished to produce excellent smoothness.

●Example 1: Tungsten carbide, machining depth 5mm, rough processing

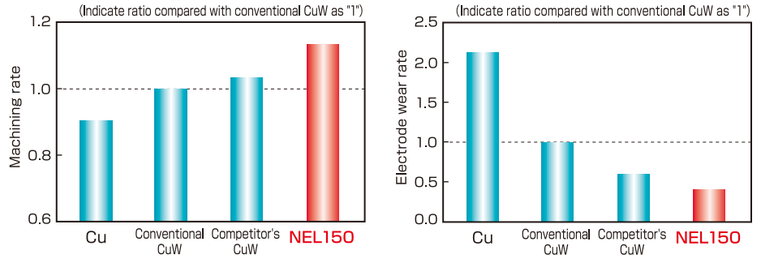


●Example 2: Tungsten carbide 28.5 mm thick, drilling through hole

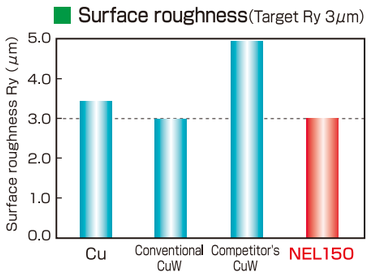
■Processing conditions
Work piece: Cemented carbide (G5)
Machine: MITSUBISHI, NC EDM EA type



Characteristics of rough processing



Characteristics of finish processing



Property

Material	Physical properties	
	Electrical conductivity (%IACS)	Hardness (HRB)
Cu	100	56
Conventional CuW	26	93
NEL150	56	80

・(Round) 3-10mm dia. and up to 100 mm long.
(Rectangle/square) Up to 150 mm × 150 mm sq. (special order)
・Please contact us for sizes and specifications of stocked products.
・Standard sizes and specifications are subject to change without notice.

Standard sizes

■ Rod/disk

Diameter	Thickness (Length)
*Ø3~10mm	50mm
Ø15~45mm	25、30、50mm
Ø50~160mm	20、25、30~45mm

*Material "NEL 120" for small diameter

■ Plate

Size	Thickness
100×100mm	10~30mm

Powder products Precautions in use and handling

1 Precautions in storage

a. If tungsten powder is heated in air, oxidation occurs, and reaction becomes more intense at high temperatures. The container should be sealed and stored away from sparks, flames and high temperature areas.
b. Fine tungsten powder (particle size under 2μm) and molybdenum powder (particle size under 3μm) are specified by the fire law as metal powder in the second category of hazardous materials. For storage or handling of the specified quantities or more, use facilities defined by the fire law. For storage and handling under the specified quantities, criteria are defined by respective municipal ordinances.

2 Precautions in handling

a. Avoid approaching sparks, flames and high-temperature elements, and heating.
b. Handle in such a manner as to generate the least possible powder dust.
c. Handle in a well ventilated area, and be careful not to inhale airborne dust.
d. Install a dust collector and/or ventilation equipment as necessary.
e. Wear protective goggles, protective mask, protective gloves and other protective equipment as necessary.

Cemented carbide tool products Precautions in use and handling

1 Precautions in handling

a. While cemented carbide materials are extremely hard, they are characterized as brittle materials. Therefore, they may break from impact, forced tightening, etc.
b. Since cemented carbide materials have large specific gravities, carefully handle as heavy lifts in the case of large products and large quantities.
c. Cemented carbide materials differ in thermal expansion coefficients from other metal materials. Therefore, shrink-fit and expansion-fit products may break if the operating temperature is extremely higher (lower) than the design value.
d. Be careful about the storage conditions of cemented carbide materials because a drop in strength is caused by corrosion with grinding fluid, lubricating fluid, moisture content , etc.

2 Precautions in processing

a. Cemented carbide tools may drop in strength depending on the surface conditions. Be sure to use a diamond grinding wheel for finishing.
b. Cemented carbide tools generate dust when ground. Since inhalation of a large amount of dust can be harmful to the body, install ventilation equipment and wear protective equipment such as protective goggles, protective mask and protective gloves. If dust has stuck to the skins or gotten in the eyes, wash it out with running water immediately.
c. Since waste includes heavy metals when cemented carbide tools or brazed products are ground, dispose of waste with reliability.
d. For regrinding cemented carbide tools, check that there is no crack after regrinding.
e. Cemented carbide materials or products may crack if marked with a laser, an electric pen, etc. Do not mark parts that are stressed.
f. If cemented carbide materials are discharge-machined, residual cracks will occur on the surface, causing a drop in strength. Therefore, completely remove cracks by grinding if necessary.
g. Exercise caution when brazing cemented carbide materials since if they are brazed at a temperature excessively lower or higher than the melting temperature of brazing, they may fall off or break.

Oxidation removing method

Methods to remove oxidation

Oxidation state	Tungsten	Molybdenum
Heavy oxidation	Dip parts in a solution of hydrofluoric acid (55%) and nitric acid (67.5%) mixed by a volume ratio of 1:1, then dip them in sodium hydroxide (6%) solution.	Dip parts in a solution of hydrofluoric acid (55%), nitric acid (67.5%) and acetic acid (90%) mixed by a volume ratio of 1.5:5:2, then dip them in hydrochloric acid (35%) solution.
Medium oxidation	Dip parts in a solution of hydrofluoric acid (55%), nitric acid (67.5%) and acetic acid (90%) mixed by a volume ratio of 1:1:1, then dip them in sodium hydroxide (6%) solution. Or, dip parts in hydrogen peroxide (35%) solution and boil them.	Dip parts in a solution of hydrofluoric acid (55%), nitric acid (67.5%), acetic acid (90%) and phosphoric acid (75%) mixed by a volume ratio of 1.5:5:2:1, then dip them in hydrochloric acid (35%) solution. Or, dip parts in a solution of hydrochloric acid (35%) and nitric acid (67.5%) mixed by a volume ratio of 3:1, then dip them in hydrochloric acid (35%) solution.
Slight oxidation	Dip parts in sodium hydroxide (10%) and boil them.	Dip parts in hydrochloric acid (35%).

Remarks: Regardless of cleaning methods, after removing oxides, wash and dry the parts fully.

Metal products Precautions in use and handling

1 Precautions for storage

(1) Fine tungsten powder of particle sizes smaller than 2μm and fine molybdenum powder of particle sizes smaller than 3μm are classified as flammable solids in Category Ⅱ in the Fire Service Act and must be stored in accordance with the Fire Service Act.
Note:Applicable to storage in Japan. Follow all the local laws & regulations for storage in your country.
(2) Fine tungsten and molybdenum powders ignite and burn when brought close to a flame or kept at high temperatures. Their containers must be sealed and stored away from sparks, flames and high temperature areas.

Range of hazardous materials

Item	Particle Size	Class of Hazardous Material	Designated Quantity
Tungsten powder	Less than 1μm	Category 1 flammable solid, hazard class Ⅱ	100kg
	1μm or over, less than 2μm	Category 2 flammable solid, hazard class Ⅲ	500kg
	2μm min.	Nonhazardous materials	—
Molybdenum powder	Less than 3μm	Category 2 flammable solid, hazard class Ⅲ	500kg
	3μm min.	Nonhazardous materials	—

Note: Applicable to storage in Japan. Follow all the local laws & regulations for storage in your country.

(3) Drawn wire (black wire) and hot finished sheets / plates (forged/hot rolled) can easily be stored because strong adhesion of oxide layer makes them durable for a relatively long-term storage even if left in the air. However, since heat-treated, chemical-treated and electrolytically polished wires easily oxidize, if such wires are to be stored for about one week, the storage environment should be such that humidity is below 60% and temperature below 28℃ and wires should be isolated from chemicals. Accordingly, wires should be stored in a desiccator or air-conditioned place (constant temperature/constant humidity) and handled with great care so as not to touch the surface with bare hands.
(4) Cold rolled and machined sheets / plates also oxide on the surface relatively easily and therefore should be stored in dry atmosphere.
(5) Ultrafine wires approximately 10μm in diameter easily stick to each other as a result of oxidation, and cannot be drawn or regenerated. Store them in a desiccator and control them with the greatest care so as not to damage the flanges of spools even while waiting between processes.
(6) Thin wires on spools will suffer winding failure or entanglement if vibration or steep change in temperature is given with the spools held horizontal.

2 Precautions for use

(1) If chemically treated wires have oxidized and discolored when left in the air, even if they are hydrogen-furnace-treated for regeneration, the surface becomes matted and therefore their ductility deteriorates. Accordingly, in order to keep the original ductility in the case of wires, regeneration of approximately 5% reduced MG by electrolytic polishing is necessary.
(2) When the surface of molybdenum or tungsten sheets / plates has oxidized slightly; for example, when blue oxide film has stuck to the mirror finished surface of cold rolled sheet, it may be removed by wiping with cloth moistened with water or hot water, though it depends on the degree of oxidation. However, if oxides have stuck firmly and are hard to remove by this method, they need to be removed by using acid or alkaline solution as described in the table at the bottom of page 37.
(3) The wire on a spool must not be rewound as a rule. Even if rewinding is necessary, straightness is impaired when straightness-emphasized wire is strongly wound on the spool for the purpose of preventing looseness. Ensure that the inverse tension does not exceed 10% of the tensile strength.
(4) Fully recrystallized wires, rods and sheets / plates are likely to be brittle due to their properties. Do not give shocks during handling.

3 Contamination embrittlement

(1) For removing the graphite layer from black wires by hydrogen, use wet hydrogen of a dew point of +10℃ or over and perform removal at 1300℃ to 1500℃. As for heat treatment of graphite-removed wires (chemically finished or annealed wires, etc.), ensure that no oils, fats or sweat stick to them or completely remove them in the preceding process.
(2) For heat treatment of molybdenum sheets / plates (removal of strain), use reducing atmosphere (preferably dry hydrogen above-40℃) and perform treatment at 850℃ to 950℃. As for sheets / plates from which oxide film has been removed (chemically finished, cold rolled, machined, etc.), ensure that no oils, fats or sweat stick to them or completely remove them in the preceding process, as with graphite-removed wires.
(3) Chemically polished, heat treated, electrolytically polished and machined materials subjected to heat treatment at above 800℃ must be kept away from contact with nickel, iron, cobalt and their alloy parts such as tweezers, guide pulleys and boats for furnaces. This is necessary to prevent occurrence of pinholes due to melting on the contact area and embrittlement . Also, similar phenomena will occur if wires to which iron rust powder has stuck are heat treated.
(4) For heat treatment of materials (wires, rods and sheets / plates), take great care in maintaining the hydrogen furnace and keep it clean.
①When replacing furnace heaters, refractories that have discolored markedly must not be reused, but must be replaced with new ones.
②After replacing furnace heaters, fully heat the furnace without contents to remove water from the materials inside the furnace so that the life of the tungsten/molybdenum heater will not be shortened.
③Do not contaminate a heat-treating furnace for molybdenum materials by placing jigs and fixtures made of other materials such as iron rods, nickel boats, carbon, stainless steel and brass.
④Do not use the same heat-treating furnace for heat treatment of nickel and copper wires to prevent contamination.
(5) Prevent sticking of getter components such as red phosphorus and zirconium used during manufacture of lamps as it may cause embrittlement.

4 Machining

(1) Wires and rods of 0.2 mm or more in diameter and sheets / plates of 0.2 mm or more in thickness can be processed (bent, punched, cut, etc.) easily when heated. A recommended temperature is 600℃ to 800℃. The optimum temperature varies depending on the history, internal strain, etc. of materials.
For example, to cut a 2-mm or thicker sheet, a hacksaw (hand saw) or grinding cutter needs to be used to cut them at normal temperature or a shear cutter to cut them after heating them fully.
(2) If cracked wires, rods or sheets / plates having a fiber structure are stressed by pressing, bending, squeezing, twisting, etc., the cracks (laminar cracks) will propagate. Therefore, when cutting or punching them, it is necessary to always control the cutter edge and clearance so that the cracks will not come to the cut ends.

5 Attention for security

Reference:Environmental index by ACGIH(American Conference of Governmental Industrial Hygienists) on the shop floor is as follows:

	Tungsten	Molybdenum
Time-weighted average based on eight-hour day (TLV-TWA)	5mg/㎥	10mg/㎥
Short term exposure limit based on 15 minutes (TVL-STEL)	10mg/㎥	—

(1) Handle products in a well-ventilated place so that you will not take in tungsten or molybdenum powder and wear a dust respirator, protective goggles, protective gloves and other protective equipment to prevent inhalation of dust. Prior to meals and smoking, wash your hands with soap.
(2) Handle products in such a manner as to generate as little powder dust as possible and prevent powder dust from coming in contact with sparks, flames and high-temperature elements.
(3) When bending and machining wires, rods, sheets / plates, wear protective goggles, protective mask, protective gloves and other necessary protective equipment. Note that wires, even if thin, are very tough and therefore never try to wind wires around your hand to pull to cut them off.
(4) Thoriated tungsten wires and rods contain a radioactive element "thorium" and release a small amount of radiation. Accordingly, to store them in a large quantity, store them in a place isolated from people. Inhaling powder dust produced during processing of their ends or fumes generated during welding may damage the health. When working on them, ensure sufficient dust collection is working and always wear protective goggles, protective mask, protective gloves and other necessary protective equipment. Prior to meals and smoking after working with them, wash your hands with soap.
(5) Arcs that are generated during welding can damage the eyes and skins. Always wear a face shield to shield your face and eyes from arcs, leather gloves and other necessary protective equipment. Touching the welding rod or electrode and the base material during welding can cause an electric shock. Never touch the electrode and live parts during welding.

6 Others

(1) For welding, such methods as TIG welding, butt welding, electron beam welding and plasma welding are used. Keep in mind, however, that the welded part will become very brittle.
(2) For polishing, various methods are available such as chemical polishing, electrolytic polishing, grinder polishing and tumbler polishing. Choose a method suitable for your purpose.