
We make the world brighter!
LUMA METALL
W
Mo
The wire of brilliance

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LUMA

Luma began the production of Tungsten Wire in 1935 for the manufacturing of filaments.

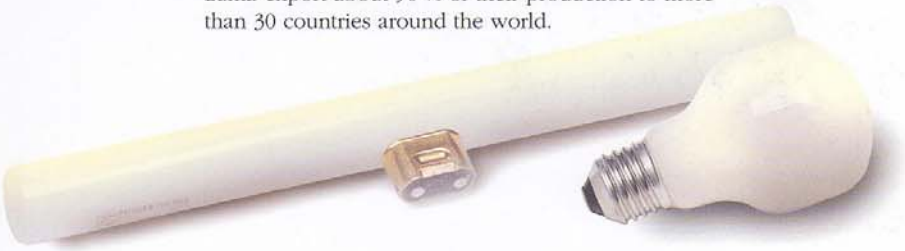
In 1943, Molybdenum Wire was added to the production programme followed by Gold Plated Grid Wire for electron tubes in 1954. Subsequently, Tungsten Rhenium Wire has also been added offering the possibility of high tensile strength twinned with the advantages of high recrystallisation temperature.

Luma has always worked closely with the industries that use their wires, ensuring constant feedback of information to maintain high quality whilst any problems that arise can be solved by drawing on our vast experience in these products.

Luma can supply wires of any dimension, although we currently specialise in fine and super fine Tungsten and Tungsten Rhenium Wires down to 3 microns' diameter. Gold Plated Wires of various dimensions are another current speciality.

In addition to manufacturing wires, Luma also produce filaments for incandescent lamps and cathodes for fluorescent tubes, all manufactured to the customers' own specifications.

Luma export about 90 % of their production to more than 30 countries around the world.



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APPLICATIONS

Tungsten and Tungsten Rhenium Wires

- Wire for manufacturing of filaments (GLS, Miniature, Halogen)
- Heating element for car windows (wind screen and rear window)
- Wire for particle detectors
- Corona wire for copy machines
- Grid wire for electronic tubes
- Wire for cathode ray tube heater coils
- Wire for medical use
- Wire for electro discharge machining tools
- Strings for musical instruments
- Wire for electrostatic filters
- Metal wire gauze
- Suspension of objects for photographing (non visible wire)

Molybdenum Wires

- Support wire for filaments in lamps
- Mandrel wire for filaments
- Grid wire in electronic tubes
- Wire for electro discharge machining tools
- Metal wire gauze

Filaments

- Standard filaments for GLS-lamps
- Specially designed filaments for candle lamps
- 15 W coiled coil instead of ordinary single coil for candle lamps
- Special filaments for Long-Life lamps
- Stick-cathodes for fluorescent lamps

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TUNGSTEN

Tungsten in nature

Tungsten is found in nature principally in one of two forms viz combined with iron and manganese oxides, which is called wolframite WO_4 or combined with calcium as calcium tungstate which is called scheelite, $CaWO_4$, the latter being the most common. The tungsten compounds seldom exeed 2 % of the orebody.

Important characteristics of tungsten

- Highest melting point of all metals
- High strength at high temperatures
- Resistance to wear
- Good conductivity for heat and electricity
- Remarkable corrosion resistance to many acids
- Good electron emission ability
- Lowest vapour pressure of all metals
- Available in very fine sizes
- High elastic modulus and hardness
- High absorbation capacity for radioactive radiation and X-rays
- Low thermal expansion

Wire qualities, tungsten

820
Standard, non-sag quality wire containing min 99,95 % W, doped with potassium, silicon and aluminium.

An all-purpose wire used for years by the lamp industries, used also as heating element, in electrostatic air cleaners, and in electro discharge machining tools.

821
Is a wire of 820 standard quality, which has passed the requisite tests to meet the demands for wire of a higher standard below Ø 50 microns i.e. virtually free from traces of cracks or splits.

Used for miniature lamps and as gold plated wire in particle detectors, copymachines and in the electronic industry.

822
Is a wire that has been modified from the standard quality (820) to give it a long grain structure and improved ductility in the recrystallized state.

Is widely used as a heater material in the electronic industry.

823
Has a low concentration of unfavourable impurities and is similar to the 822 having a long grain structure, high recrystallization temperature and increased ductility.

Wires of this quality is mainly intended for use in halogen lamps.

860
Is an alloy wire of tungsten and 3 % rhenium (Re). In comparison with the pure tungsten wire it has superior hot strength and vibration strength, a higher recrystallization temperature, greater specific resistance and greater tensile strength.

Is used in the lamp industry, e.g. for shockproof lamps.

861
Is a wire of 860 standard quality which – as in the qualities 821 and 823 – has passed the requisite tests to meet the demands for wire of a higher standard.

Used in special miniature lamps, cathode ray tube heater coils and as gold plated wire for particle detectors, copymachines and in the electronic industry.

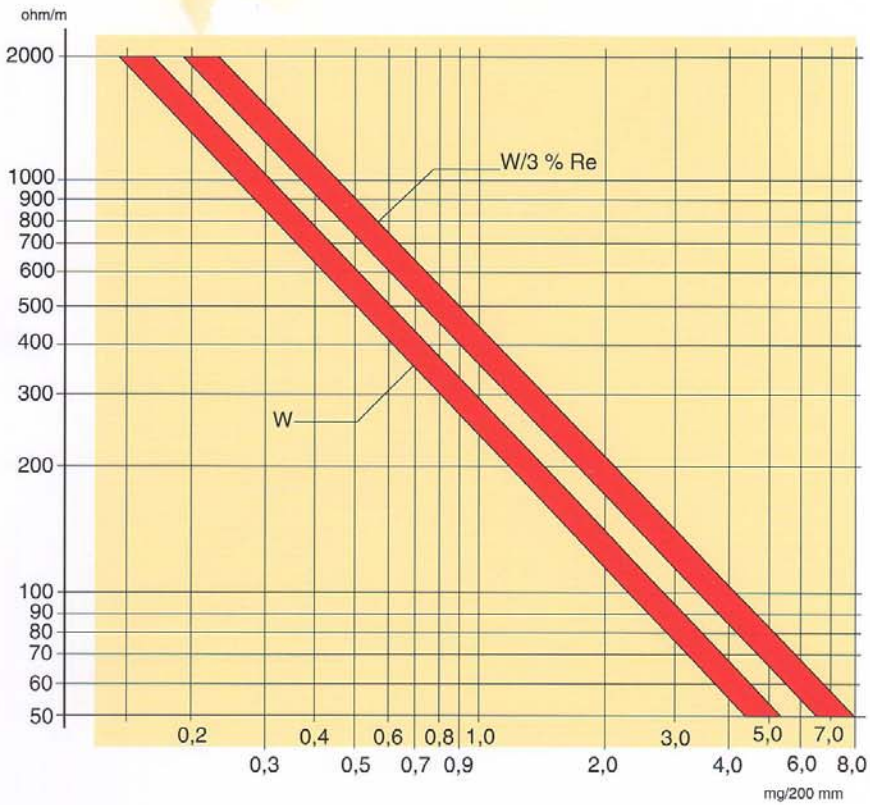
Finishes, tungsten

Quality	No	Finish	Supplied in dimensions (microns)
	20	Black drawn wire for further redrawing	> 50
	21	Black drawn wire	> 8
820	22	Black drawn wire, straightened	> 8
822	25	Black drawn wire, used as heating element	> 8
823	31	"21" wire, electrolytically cleaned	> 10
860	32	"21" wire, straightened and electrolytically cleaned	> 10
	34	"32" wire with a highly polished surface	> 10
	41	"21" wire, electrolytically etched to the final dimension	3-30
821	42	"21" wire, straightened and electrolytically etched to the final dimension	3-30
861	60	"41" and "42" wire, gold plated.	4-250
	65	Gold plated wire, for medical use	4-250

Physical properties, tungsten

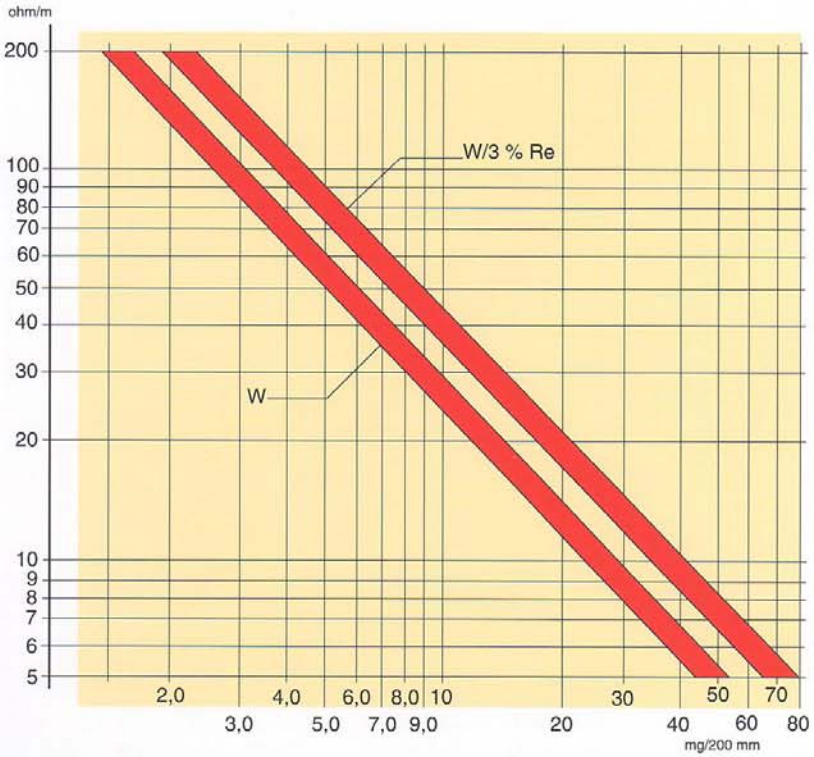
Atomic number	74
Atomic weight	183,92
Melting point	3410° C
Boiling point	5500° C (approx.)
Lattice type	body-centered cubic
Lattice constant	3,158 Å
Density	19,17 g/cm³
Work function	4,55 eV
Specific heat at 20° C, recrystallized	142 J/kg · ° C
Specific electrical resistance at 20° C	0,055 Ohm · mm²/m
Specific electrical resistance for tungsten with 3 % rhenium	0,092 Ohm · mm²/m
Modulus of elasticity at 20° C	410 kN/mm²
Modulus of rigidity at 20° C	177 kN/mm²
Vapour pressure	
2100° C	$10{,}5 \cdot 10^{-7}$ Pa
2700° C	$8{,}7 \cdot 10^{-3}$ Pa
3200° C	$6{,}3 \cdot 10^{-1}$ Pa
Linear thermal expansion coefficient:	
Worked (20° C – 500° C)	$5{,}0 \cdot 10^{-6}$ per ° C
Recrystallized (20° C – 500° C)	$4{,}5 \cdot 10^{-6}$ per ° C
Thermal conductivity	
20° C	130 W/m · ° C
900° C	116 W/m · ° C
1100° C	113 W/m · ° C
1300° C	109 W/m · ° C
1500° C	106 W/m · ° C
1700° C	103 W/m · ° C

Electrical resistance at room temperature, tungsten

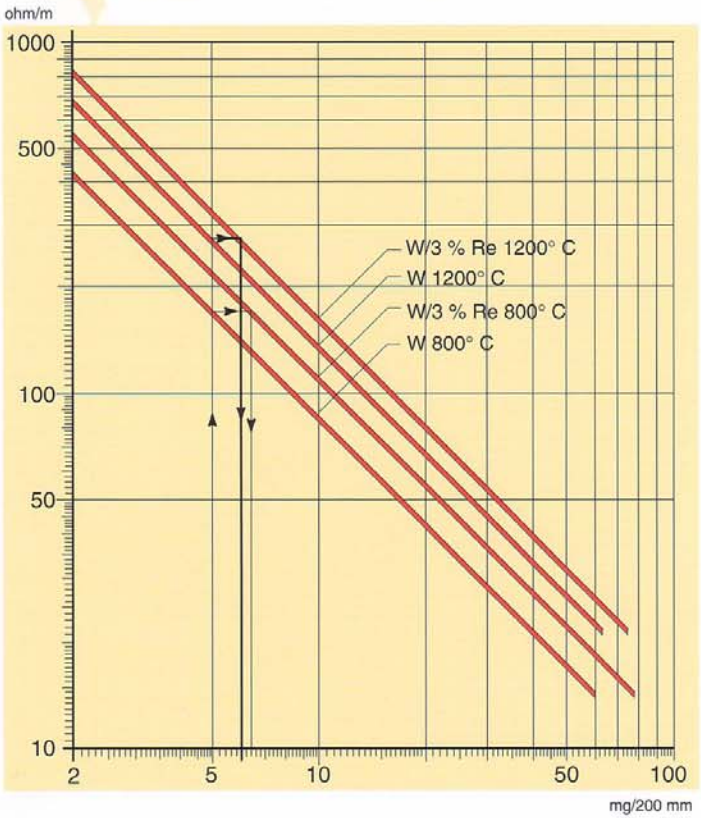


TUNGSTEN

Electrical resistance at room temperature, tungsten

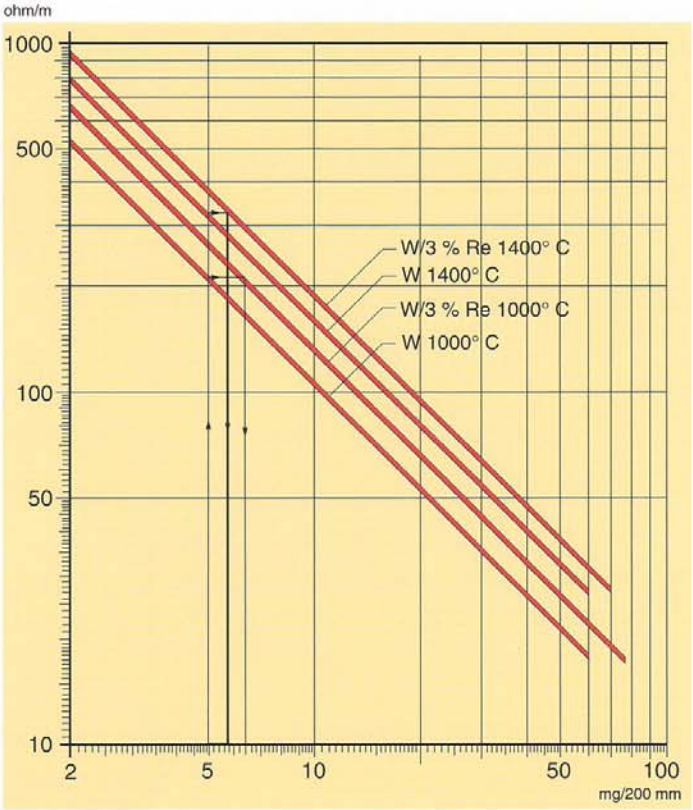


Electrical resistance at elevated temperatures, tungsten



Considering the electrical resistance at the temperature in question of a known wire weight, the corresponding approximative wire weight of a W/3 % Re wire can be obtained.

Electrical resistance at elevated temperatures, tungsten



Considering the electrical resistance at the temperature in question of a known wire weight, the corresponding approximative wire weight of a W/3 % Re wire can be obtained.

Chemical behaviour, tungsten

Substance	Tungsten reaction
Air or oxygen	Oxidation starts above 500° C
Ammonia	No reaction
Fluorine	Attacked rapidly at 20° C
Chlorine	Reaction begins above 250° C
Bromine	Reaction begins at red heat
Iodine	Reaction begins at red heat
Inert gases	No reaction
Nitrogen	No reaction up to 2000° C
Nitric oxides	Oxidation at higher temperature
CO	Carbide forming above 800° C
CO_2	Oxidation starts above 1200° C
Water vapour	Rapid oxidation at red heat
H_2S	Slight reaction at red heat
SO_2	Oxidation at elevated temperatures
Hydrogen	No reaction
Hydrocarbons	Carbide forming above 700° C
HCI conc. or dil.	No reaction
HCI + HNO_3	Slight reaction at room-temperature
HF	Cold or warm, no reaction
HF + HNO_3	Dissolves rapidly
HNO_3 dil.	When warm, slow oxidation
HNO_3 conc.	No reaction
H_2SO_4	When warm, very slight reaction
H_2SO_4 + HNO_3 + H_2O	No reaction
KOH, NaOH	When molten, slight reaction
K_2CO_3, Na_2CO_3	When molten, slight reaction
KOH, NaOH	When molten, vigorous reaction
K_2CO_3, Na_2CO_3	together with oxidizing agents
KNO_2, KNO_3	When molten, vigorous reaction
$NaNO_2$, $NaNO_3$	When molten, vigorous reaction
KOH + $K_3Fe(CN)_6$(soln.)	Slightly soluble
NH_4OH + Cu^{++}	Slightly soluble
Sulphur (molten)	Slow reaction
Phosphor	No reaction at red heat
Silicon	Silicide formed above 1000° C
Carbon (solid)	Carbide forming above 1100° C

Dimensions and dimensional tolerances, tungsten

(concerning gold plated wires see page 20) Tolerances in per cent of the wire weight in mg/200 mm. (Weight tolerance = double the diameter tolerance)

Wire size			
Microns Ø	mg/200 mm	Standard tolerance	Tolerance available on request
<3	<0,027	±9 %	minimum ±6 %
≥3<5	≥0,027<0,075	±7 %	minimum ±4 %
≥5<10	≥0,075<0,301	±4 %	minimum ±1 %
≥10<18	≥0,301<0,976	±3 %	minimum ±0,5 %
≥18	≥0,976	±2 %	minimum ±0,5 %

Diameter microns	mils	Weight mg/200 mm	Weight g/1000 m	Diameter microns	mils	Weight mg/200 mm	Weight g/1000 m
2,5	0,098	0,0188	0,094	31	1,22	2,89	14,5
3,0	0,118	0,0271	0,136	32	1,26	3,08	15,4
3,5	0,138	0,0369	0,185	33	1,30	3,28	16,4
4,0	0,157	0,0482	0,241	34	1,34	3,48	17,4
5,0	0,197	0,0753	0,377	35	1,38	3,69	18,5
6,0	0,236	0,108	0,540	36	1,42	3,90	19,5
7,0	0,276	0,148	0,740	37	1,46	4,12	20,6
8,0	0,315	0,193	0,965	38	1,50	4,35	21,8
9,0	0,354	0,244	1,22	39	1,54	4,58	22,9
10	0,394	0,301	1,51	40	1,57	4,82	24,1
11	0,433	0,364	1,82	41	1,61	5,06	25,3
12	0,472	0,434	2,17	42	1,65	5,31	26,6
13	0,512	0,509	2,55	43	1,69	5,57	27,9
14	0,551	0,590	2,95	44	1,73	5,83	29,2
15	0,591	0,677	3,39	45	1,77	6,10	30,5
16	0,630	0,771	3,86	46	1,81	6,37	31,9
17	0,669	0,870	4,35	47	1,85	6,65	33,3
18	0,709	0,976	4,88	48	1,89	6,94	34,7
19	0,748	1,09	5,45	49	1,93	7,23	36,2
20	0,787	1,20	6,0	50	1,97	7,53	37,7
21	0,827	1,33	6,65	52	2,05	8,14	40,7
22	0,866	1,46	7,30	54	2,13	8,78	43,9
23	0,906	1,59	7,95	56	2,20	9,44	47,2
24	0,945	1,73	8,65	58	2,28	10,13	50,7
25	0,984	1,88	9,40	60	2,36	10,84	54,2
26	1,02	2,04	10,2	62	2,44	11,57	57,9
27	1,06	2,20	11,0	64	2,52	12,33	61,7
28	1,10	2,36	11,8	66	2,60	13,12	65,6
29	1,14	2,53	12,7	68	2,68	13,92	69,6
30	1,18	2,71	13,6	70	2,76	14,75	73,8

TUNGSTEN

Diameter microns	Diameter mils	Weight mg/200 mm	Weight g/1000 m
72	2,83	15,61	78,1
74	2,91	16,49	82,5
76	2,99	17,39	87,0
78	3,07	18,32	91,6
80	3,15	19,27	96,4
82	3,23	20,25	101
84	3,31	21,25	106
86	3,39	22,27	111
88	3,46	23,32	117
90	3,54	24,39	122
92	3,62	25,5	128
94	3,70	26,6	133
96	3,78	27,7	139
98	3,86	28,9	145
100	3,94	30,1	151
105	4,13	33,2	166
110	4,33	36,4	182
115	4,53	39,8	199
120	4,72	43,4	217
125	4,92	47,1	236
130	5,12	50,9	255
135	5,31	54,9	275
140	5,51	59,0	295
145	5,71	63,3	317
150	5,91	67,7	339
155	6,10	72,4	362
160	6,30	77,1	386
165	6,50	82,0	410
170	6,69	87,0	435
175	6,89	92,2	461
180	7,09	97,6	488
185	7,28	103,1	516
190	7,48	108,7	544
195	7,68	114,5	573
200	7,87	120,4	602
205	8,07	126,6	633
210	8,27	132,8	664
215	8,46	139,2	696
220	8,66	145,7	729
225	8,86	152,5	763
230	9,06	159,3	797
235	9,25	166,3	832
240	9,45	173,4	867
245	9,65	180,8	904
250	9,84	188,2	941
255	10,04	195,8	979
260	10,24	203,5	1020
265	10,43	211,5	1060
270	10,63	219,5	1100
275	10,83	227,7	1140
280	11,02	236,1	1180
285	11,22	244,6	1220
290	11,42	253	1270
295	11,61	262	1310
300	11,81	271	1360
310	12,20	289	1450
320	12,60	308	1540
330	12,99	328	1640
340	13,39	348	1740
350	13,78	369	1850
360	14,17	390	1950
370	14,57	412	2060
380	14,96	435	2180
390	15,35	458	2290
400	15,75	482	2410
410	16,14	506	2530
420	16,54	531	2660
430	16,93	557	2790
440	17,32	583	2920
450	17,72	610	3050
460	18,11	637	3190
470	18,50	665	3330
480	18,90	694	3470
490	19,29	723	3620
500	19,69	753	3770

Gold plated tungsten wire

For some applications tungsten wire has to be plated to meet special requirements. This may for instance be to protect the wire from corrosion, to solder it together to other metals or to reduce the secondary emission of electrons.

Luma started to produce plated wire in the fifties and did at that time co-operate with the Swedish Ericsson-group with a view of developing grid wire for high quality electronic tubes.

This co-operation resulted in an improvement of the wire drawing and plating process to secure the high quality demanded, such as a compact and well adhesive goldcoat. Since then our machinery and knowledge has been further improved to meet the demands for high quality gold plated wire of today.

Among our customers we have for example universities and institutes all over the world dealing with basic research as well as industrial enterprises with sophisticated manufacturing.

Luma gold plated tungsten wire has as standard a coat thickness corresponding to 4±1 % of the wire weight up to wire diameters of 50 microns.
For wires above 50 microns diameter the coat thickness is 0,5 micron.

Upon request we also manufacture wire with non standard coat thicknesses.

To get maximum possible wire strength and/or resistance we recommend tungsten wire with 3 % rhenium (quality 861/60).

Above: Checking of wire quality.
Multi step drawing equipment in which the temperatures, the drawing speed and the geometry are carefully controlled.

Center: Hydrogen peroxide based dissolving of filaments.

Below: Spooling of wire and checking of mechanical properties of wire.

Dimensions and dimensional tolerances for gold plated tungsten wire

Tolerances in per cent of the wire weight in mg/200 mm
(Weight tolerance = double the diameter tolerance)

Wire size			
Microns Ø	mg/200 mm	Standard tolerance	Tolerance available on request
≥4,0<5,0	≥0,0482<0,0753	± 7 %	minimum ± 4 %
≥5,0	≥0,0753	± 4 %	minimum ± 1,5 %

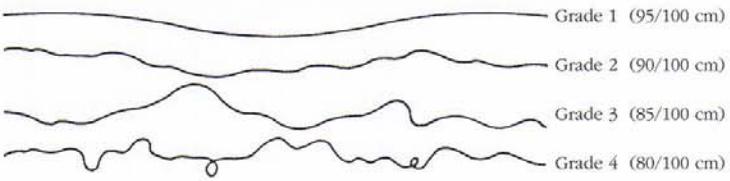
Plated wire					Basic material			Plating	
Diameter		Weight		Weight %	Diameter	Weight		Coat thickness	Coat weight
microns	mils	mg/200mm	±%	Au	microns	mg/200 mm	±%	microns	mg/200 mm
4	0,157	0,0482	7	4±1	3,92	0,0463	6	0,040	0,0019
4,5	0,177	0,0610	6	4±1	4,41	0,0586	5	0,045	0,0024
5	0,197	0,0753	4	4±1	4,90	0,0723	3	0,050	0,0030
6	0,236	0,108	4	4±1	5,88	0,104	3	0,060	0,004
7	0,276	0,148	4	4±1	6,86	0,142	3	0,070	0,006
8	0,315	0,193	4	4±1	7,84	0,185	3	0,080	0,008
9	0,354	0,244	4	4±1	8,82	0,234	3	0,090	0,010
10	0,394	0,301	4	4±1	9,80	0,289	3	0,10	0,012
11	0,433	0,364	4	4±1	10,8	0,349	3	0,11	0,015
12	0,472	0,434	4	4±1	11,8	0,417	3	0,12	0,017
13	0,512	0,509	4	4±1	12,7	0,489	3	0,13	0,020
14	0,551	0,590	4	4±1	13,7	0,566	3	0,14	0,024
15	0,591	0,677	4	4±1	14,7	0,650	3	0,15	0,027
16	0,630	0,771	4	4±1	15,7	0,740	3	0,16	0,031
17	0,669	0,870	4	4±1	16,7	0,835	3	0,17	0,035
18	0,709	0,976	4	4±1	17,6	0,937	3	0,18	0,039
19	0,748	1,09	4	4±1	18,6	1,05	3	0,19	0,044
20	0,787	1,20	4	4±1	19,6	1,15	3	0,20	0,048
21	0,827	1,33	4	4±1	20,6	1,28	3	0,21	0,053
22	0,866	1,46	4	4±1	21,6	1,40	3	0,22	0,058
23	0,906	1,59	4	4±1	22,5	1,53	3	0,23	0,064
24	0,945	1,73	4	4±1	23,5	1,66	3	0,24	0,069
25	0,984	1,88	4	4±1	24,5	1,80	3	0,25	0,075
26	1,02	2,04	4	4±1	25,5	1,96	3	0,26	0,082
27	1,06	2,20	4	4±1	26,5	2,11	3	0,27	0,088
28	1,10	2,36	4	4±1	27,4	2,27	3	0,28	0,094
29	1,14	2,53	4	4±1	28,4	2,43	3	0,29	0,101
30	1,18	2,71	4	4±1	29,4	2,60	3	0,30	0,108
31	1,22	2,89	4	4±1	30,4	2,77	3	0,31	0,116
32	1,26	3,08	4	4+1	31,4	2,96	3	0,32	0,123
33	1,30	3,28	4	4±1	32,3	3,15	3	0,33	0,131
34	1,34	3,48	4	4±1	33,3	3,34	3	0,34	0,139
35	1,38	3,69	4	4±1	34,3	3,54	3	0,35	0,148
36	1,42	3,90	4	4±1	35,3	3,74	3	0,36	0,156

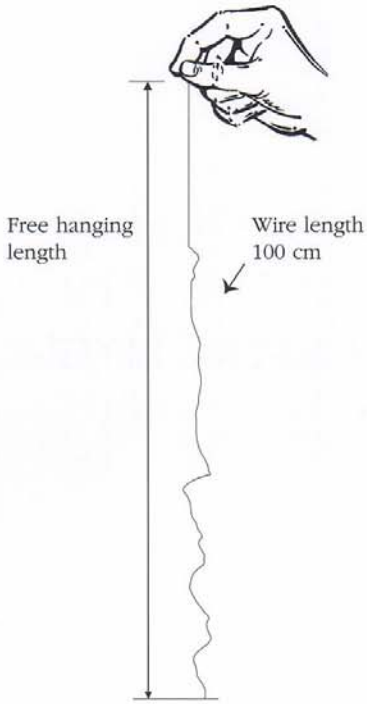
Plated wire					Basic material			Plating	
Diameter		Weight		Weight %	Diameter	Weight		Coat thickness	Coat weight
microns	mils	mg/200mm	±%	Au	microns	mg/200 mm	±%	microns	mg/200 mm
37	1,46	4,12	4	4±1	36,3	3,95	3	0,37	0,165
38	1,50	4,35	4	4±1	37,2	4,18	3	0,38	0,174
39	1,54	4,58	4	4±1	38,2	4,40	3	0,39	0,183
40	1,57	4,82	4	4±1	39,2	4,63	3	0,40	0,193
41	1,61	5,06	4	4±1	40,2	4,86	3	0,41	0,202
42	1,65	5,31	4	4±1	41,2	5,10	3	0,42	0,212
43	1,69	5,57	4	4±1	42,1	5,35	3	0,43	0,223
44	1,73	5,83	4	4±1	43,1	5,60	3	0,44	0,233
45	1,77	6,10	4	4±1	44,1	5,86	3	0,45	0,244
46	1,81	6,37	4	4±1	45,1	6,11	3	0,46	0,255
47	1,85	6,65	4	4±1	46,1	6,38	3	0,47	0,266
48	1,89	6,94	4	4±1	47,0	6,66	3	0,48	0,278
49	1,93	7,23	4	4±1	48,0	6,94	3	0,49	0,289
50	1,97	7,53	4	4±1	49,0	7,23	3	0,50	0,301
55	2,17	9,11	4	3,6±0,7	54,0	8,78	3	0,50	0,33
60	2,33	10,84	4	3,3±0,7	59,0	10,48	3	0,50	0,36
65	2,56	12,73	4	3,1±0,6	64,0	12,34	3	0,50	0,39
70	2,76	14,76	4	2,8±0,5	69,0	14,34	3	0,50	0,42
75	2,95	16,94	4	2,7±0,5	74,0	16,49	3	0,50	0,45
80	3,15	19,28	4	2,5±0,5	79,0	18,80	3	0,50	0,48
85	3,35	21,76	4	2,3±0,5	84,0	21,35	3	0,50	0,51
90	3,54	24,40	4	2,2±0,5	89,0	23,86	3	0,50	0,54
95	3,74	27,18	4	2,1±0,4	94,0	26,61	3	0,50	0,57
100	3,94	30,12	4	2,0±0,4	99,0	29,52	3	0,50	0,60
110	4,33	36,45	4	1,8±0,4	109,0	35,79	3	0,50	0,66
120	4,72	43,37	4	1,7±0,3	119,0	42,65	3	0,50	0,72
130	5,12	50,90	4	1,5±0,3	129,0	50,12	3	0,50	0,78
140	5,51	59,04	4	1,4±0,3	139,0	58,20	3	0,50	0,84
150	5,91	67,77	4	1,3±0,3	149,0	66,87	3	0,50	0,90

Straightness, tungsten

Wires in finishes 20, 21, 31 and 41 do not have any specific demands on straightness.

Wires requiring straightness (finishes 32, 42 and 60) will be delivered according to any of the 4 different grades below.





Pure tungsten wires in finishes 32 and 42 are available in the following grades of straightness.

Grade of straightness	Ø micron <15	Ø micron 15-30	Ø micron >30
3	standard	-	-
2	on request	standard	-
1	not available	on request	standard

Tungsten wires with 3 % rhenium in finishes 32 and 42 are available in the following grades of straightness.

Grade of straightness	Ø micron <15	Ø micron 15-30	Ø micron >30
4	standard	-	-
3	on request	standard	-
2	on request	on request	standard
1	not available	on request	on request

Gold plated tungsten wires (finish 60) with or without 3 % rhenium are available in the following grades of straightness.

Grade of straightness	Ø micron <15	Ø micron ≥ 15
4	standard	-
3	on request	standard
2	on request	on request
1	not available	on request

Ovality (out of roundness), tungsten

Luma tungsten wire has an out of roundness, measured in percentage by the following formula, conforming to the table below.

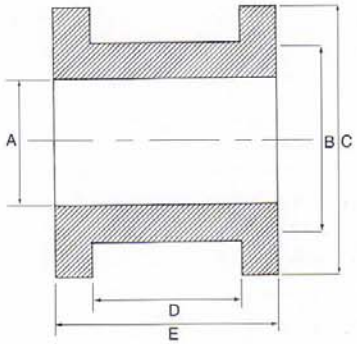
$$\frac{2(D-d)}{D+d} \cdot 100\ \%$$

Where D = the greatest diameter
d = the smallest diameter

mg/200 mm	micron	standard	available on request
< 0,677	< 15	max 6 %	max 3 %
≥ 0,677	≥ 15	max 5 %	max 2 %

Spools, tungsten

Spool	A mm	B mm	C mm	D mm	E mm	Net grams
R 3	11	17	20	11	15	3,2
R 15	10	40	52	20	26	25 or 33
R 24	95	102	116	20	27	45
R 100	16	63	100	80	100	125



Wire qualities, molybdenum

710
Is Luma standard quality containing min 99,9 % Mo.

Used as mandrel wire and support wire for filaments in lamps, as grid wire in electronic tubes (also gold plated) and in electro discharge machining tools.

720
Is a special quality containing min 99,9 % Mo, which has a good workability even in the recrystallized state.

Used in such cases when heat treatment in the high temperature range is necessary e.g. for secondary mandrel when coiling CC filaments.

Finishes, molybdenum

Quality	No	Finish	Elongation %	Supplied in dimensions (microns)
710	21	Black drawn wire	< 2	> 25
	22	Black drawn wire, straightened	< 2	> 25
	31	"21" wire, electrolytically cleaned	< 2	> 25
	32	"21" wire, straightened and electrolytically cleaned	< 5	> 25
	41	"21" wire electrolytically etched to the final dimension	< 2	15-25
	42	"21" wire, straightened and electrolytically etched to the final dimension	< 5	15-25
	52	"31" wire, annealed in protective gas to a tensile strength of minimum 48 g/mg/200 mm	10-20	> 25
	53	Cleaned straightened grid wire, annealed in protective gas to a tensile strength of minimum 40 g/mg/200 mm	15-25	> 25
	54	"53" wire with a highly polished surface, known as extra bright wire	15-25	> 25
	60	"54" wire, gold plated	15-25	> 25
720	21	Black drawn wire	< 2	> 25
	31	"21" wire, electrolytically cleaned	< 2	> 25

Physical properties, molybdenum

Atomic number	42
Atomic weight	95,95
Melting point	2620° C
Boiling point	4800° C (approx)
Lattice type	body-centered cubic
Lattice constant	3,140 Å
Density	10,14 g/cm³
Work function	4,20 eV
Specific heat at 20° C	272 J/kg · ° C
Specific electrical resistance at 20° C	0,052 Ohm · mm²/m
Modulus of elasticity at 20° C	320 kN/mm²
Modulus of rigidity	14 kN/mm²
Vapour pressure	
1500° C	$8{,}5 \cdot 10^{-7}$ Pa
2000° C	$5{,}3 \cdot 10^{-3}$ Pa
2500° C	1,3 Pa
Linear thermal expansion coefficient:	
Recrystallized (20° C)	$5{,}4 \cdot 10^{-6}$ per ° C
Recrystallized (20° C – 700° C)	$5{,}8\text{-}6{,}2 \cdot 10^{-6}$ per ° C
Thermal conductivity	
20° C	159W/m · ° C
800° C	116W/m · ° C
1000° C	104W/m · ° C
1200° C	92W/m · ° C
1400° C	80W/m · ° C
1600° C	68W/m · ° C

Chemical behaviour, molybdenum

Substance	Molybdenum reaction
Air or oxygen	Oxidation starts above 400° C
Ammonia	No reaction below 600° C
Fluorine	Attacked rapidly at 20° C
Chlorine	Reaction begins above 250° C
Bromine	Reaction begins at red heat
Iodine	No reaction
Inert gases	No reaction
Nitrogen	No reaction up to 1500° C
Nitric oxides	Oxidation to MoO_3 at red heat
CO	Carbide forming above 700° C
CO_2	Oxidation starts above 1200° C
Water vapour	Rapid oxidation at 700° C
H_2S	MoS_2 formed at 1200° C
SO_2	Rapid oxidation at red heat
Hydrogen	No reaction
Hydrocarbons	Carbide forming above 700° C
HCl dil. or conc.	Cold or warm, very slow reaction
Aqua regla cold, dil. or conc.	No reaction
Aqua regla warm, dil. or conc.	Rapid attack, forming H_2MoO_4
HF dil. or conc.	Cold or warm, no reaction
$HF+HNO_3$	Dissolves rapidly
HNO_3 conc.	Cold or warm, slow attack
HNO_3 dil. (1:1)	Cold or warm, dissolves rapidly
H_2SO_4 dil. (1:1)	Cold or warm, no reaction
H_2SO_4	When warm, very slight reaction
$H_2SO_4+HNO_3+H_2O$	Dissolves rapidly
KOH, NaOH	When molten, slight reaction
K_2CO_3, Na_2CO_3	When molten, slight reaction
KOH, NaOH	When molten, vigorous reaction
K_2CO_3, Na_2CO_3	together with oxidizing agents
$KOH+K_3Fe(CN)_6$(soln.)	Slightly soluble
NH_4OH+Cu^{++}	Slightly soluble
Sulphur	No reaction up to 440° C
Phosphor	No reaction even at high temperatures
Silicion	Silicide formed at high temperatures
Carbon	Carbide forming above 1100° C

MOLYBDENUM

Dimensions and dimensional tolerances, molybdenum

(Concerning gold plated wires see page 30). Tolerances in per cent of the wire weight in mg/200 mm. (Weight tolerance = double the diameter tolerance)

	710/21 710/22 710/31 710/32	720/21 720/31	710/52	710/53 710/54 710/41 710/42
Standard tolerance	± 2 %		± 5 %	± 3 %
Tolerance available on request	Minimum ± 0,5 %		Minimum ± 1 %	Minimum ± 1 %

Diameter microns	Diameter mils	Weight mg/200 mm	Weight g/1000 m	Diameter microns	Diameter mils	Weight mg/200 mm	Weight g/1000 m
20	0,787	0,637	3,19	51	2,01	4,14	20,7
21	0,827	0,703	3,52	52	2,05	4,31	21,6
22	0,866	0,771	3,86	53	2,09	4,47	22,4
23	0,906	0,843	4,22	54	2,13	4,65	23,3
24	0,945	0,918	4,59	55	2,17	4,82	24,1
25	0,984	0,996	4,98	56	2,20	5,00	25,0
26	1,02	1,08	5,40	57	2,24	5,18	25,9
27	1,06	1,16	5,80	58	2,28	5,36	26,8
28	1,10	1,25	6,25	59	2,32	5,55	27,8
29	1,14	1,34	6,70	60	2,36	5,73	28,7
30	1,18	1,43	7,15	61	2,40	5,93	29,7
31	1,22	1,53	7,65	62	2,44	6,12	30,6
32	1,26	1,63	8,15	63	2,48	6,32	31,6
33	1,30	1,73	8,65	64	2,52	6,52	32,6
34	1,34	1,84	9,20	65	2,56	6,73	33,7
35	1,38	1,95	9,75	66	2,60	6,94	34,7
36	1,42	2,06	10,3	67	2,64	7,15	35,8
37	1,46	2,18	10,9	68	2,68	7,37	36,9
38	1,50	2,30	11,5	69	2,72	7,58	37,9
39	1,54	2,42	12,1	70	2,76	7,81	39,1
40	1,57	2,55	12,8	75	2,95	8,96	44,8
41	1,61	2,68	13,4	80	3,15	10,20	51,0
42	1,65	2,81	14,1	85	3,35	11,51	57,6
43	1,69	2,95	14,8	90	3,54	12,90	64,5
44	1,73	3,08	15,4	95	3,74	14,38	71,9
45	1,77	3,23	16,2	100	3,94	15,93	79,7
46	1,81	3,37	16,9	105	4,13	17,56	87,8
47	1,85	3,52	17,6	110	4,33	19,28	96,4
48	1,89	3,67	18,4	115	4,53	21,07	105
49	1,93	3,82	19,1	120	4,72	22,94	115
50	1,97	3,98	19,9	125	4,92	24,89	124

MOLYBDENUM

Diameter microns	Diameter mils	Weight mg/200 mm	Weight g/1000 m	Diameter microns	Diameter mils	Weight mg/200 mm	Weight g/1000 m
130	5,12	26,9	135	310	12,20	153,1	766
135	5,31	29,0	145	320	12,60	163,1	816
140	5,51	31,2	156	330	12,99	173,5	868
145	5,71	33,5	168	340	13,39	184,1	921
150	5,91	35,8	179	350	13,78	195,1	976
160	6,30	40,8	204	360	14,17	206,4	1030
170	6,69	46,0	230	370	14,57	218,1	1090
180	7,09	51,6	258	380	14,96	230,0	1150
190	7,48	57,6	288	390	15,35	242,3	1210
200	7,87	63,7	319	400	15,75	255	1280
210	8,27	70,3	352	410	16,14	268	1340
220	8,66	77,1	386	420	16,54	281	1410
230	9,06	84,3	422	430	16,93	295	1480
240	9,45	91,8	459	440	17,32	308	1540
250	9,84	99,6	498	450	17,72	323	1620
260	10,24	107,7	539	460	18,11	337	1690
270	10,63	116,1	581	470	18,50	352	1760
280	11,02	124,9	625	480	18,90	367	1840
290	11,42	134,0	670	490	19,29	382	1910
300	11,81	143,4	717	500	19,69	398	1990

Dimensions and dimensional tolerances for gold plated molybdenum wire

Tolerances in per cent of the wire weight in mg/200 mm.
(Weight tolerance = double the diameter tolerance)

Wire size			
Microns Ø	mg/200 mm	Standard tolerance	Tolerance available on request
25-150	1,01-36,4	± 4 %	Minimum ± 1,5 %

Plated wire					Basic material			Plating	
Diameter		Weight		Weight %	Diameter	Weight		Coat thickness	Coat weight
microns	mils	mg/200mm	±%	Au	microns	mg/200 mm	±%	microns	mg/200 mm
25	0,984	1,01	4	4±1	24,7	0,972	3	0,14	0,042
30	1,18	1,47	4	4±1	29,7	1,41	3	0,16	0,058
35	1,38	1,99	4	4±1	34,6	1,91	3	0,19	0,080
40	1,57	2,61	4	4±1	39,6	2,50	3	0,22	0,106
45	1,77	3,28	4	4±1	44,5	3,15	3	0,24	0,130
50	1,97	4,06	4	4±1	49,5	3,90	3	0,27	0,163
55	2,17	4,91	4	4±1	54,4	4,71	3	0,30	0,199
60	2,36	5,84	4	4±1	59,3	5,60	3	0,33	0,239
65	2,56	6,86	4	4±1	64,3	6,59	3	0,35	0,274
70	2,76	7,95	4	4±1	69,2	7,63	3	0,38	0,321
75	2,95	9,13	4	4±1	74,2	8,77	3	0,40	0,362
80	3,15	10,39	4	4±1	79,1	9,97	3	0,43	0,415
85	3,35	11,74	4	4±1	84,1	11,27	3	0,46	0,472
90	3,54	13,14	4	4±1	89,0	12,62	3	0,48	0,521
95	3,74	14,66	4	4±1	94,0	14,08	3	0,51	0,584
100	3,94	16,23	4	4±1	98,9	15,58	3	0,54	0,651
110	4,33	19,71	4	4±1	109	18,93	3	0,59	0,783
120	4,72	23,50	4	4±1	119	22,56	3	0,65	0,942
130	5,12	27,6	4	4±1	129	26,5	3	0,70	1,10
140	5,51	32,1	4	4±1	139	30,8	3	0,75	1,27
150	5,91	36,4	4	4±1	148	34,9	3	0,81	1,47

Ovality (out of roundness), molybdenum

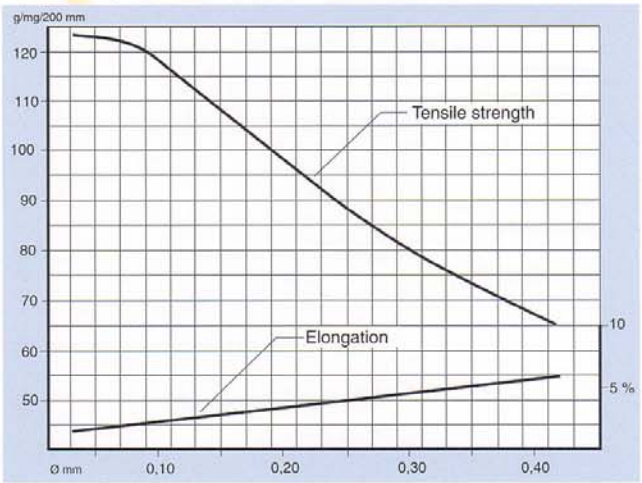
Luma molybdenum wire has an out of roundness, measured in percentage by the following formula, conforming to the table below.

$$\frac{2(D-d)}{D+d} \cdot 100\ \%$$

Where D = the greatest diameter
d = the smallest diameter

As standard the ovality is maximum 5 %
Available on request, maximum 2 %

Tensile strength and elongation, molybdenum



Tensile strength and elongation of drawn molybdenum wire.

Spools for molybdenum wire

Spool	A mm	B mm	C mm	D mm	E mm	Net grams
R 15	10	40	52	20	26	25 or 33
R 24	95	102	116	20	27	45
R 100	16	63	100	80	100	125