

TUNGSTEN RODS  
AND WIRES

**TUNGSRAM**

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## Tungsten Metals

Listed metal types contain dopants for specific applications.

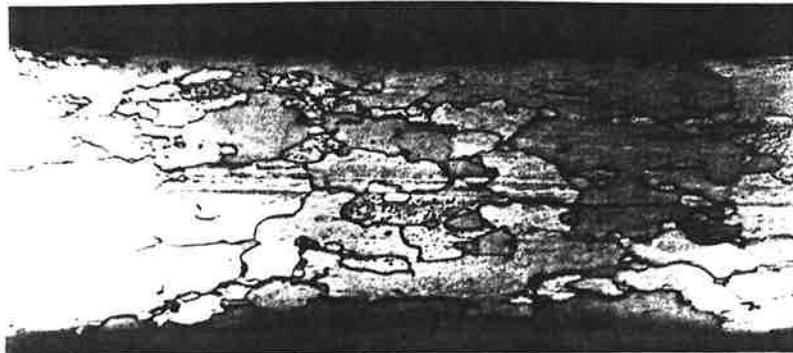
- GK 21 Tungsten wires, split-controlled, for applications as lead-in wires and electrodes
- GK 31 Tungsten wires, split-controlled, for use as coils in GLS lamps and non-halogen filled lamps and as cathodes in discharge lamps
- GK 41 Tungsten wires, split-controlled, for use as lead-in wires and electrodes, cathodes and metallizing parts
- GK 61 Tungsten wires with improved non-sag characteristics, shock-resistant, split-controlled, especially for halogen lamps

Wire Finish

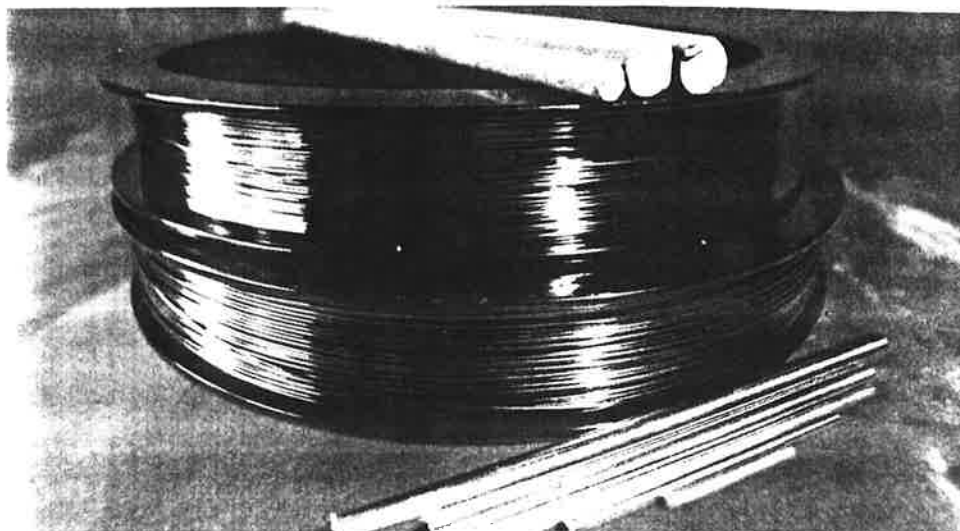
F	Black
T	Cleaned
TL	Cleaned and Annealed
E	Straightened
ET	Straightened and Cleaned
ETL	Straightened, Cleaned, and Annealed

GK 21 - Tungsten Rods and Wires. Split-Controlled. for applications as Lead-in wires and Electrodes

Product	Size Range	Tolerance	Packing	Packing Length
Swaged Rod	9.5 - 5.5 mm	$\pm 0.13$ mm	Packed in Case	Not more than 400 mm
Swaged Rod, Ground	8.5 - 5.5 mm	$\pm 0.02$ mm	Packed in Case or Box	Not more than 400 mm
Swaged Rod	6.0 - 2.0 mm	$\pm 0.08$ mm	Packed in Case or Box	Not more than 1,000 mm
Swaged Rod, Ground	5.5 - 1.5 mm	$\pm 0.02$ mm	Packed in Case or Box	Not more than 1,000 mm
Wire 'F' or 'T'	1.5 - 0.5 mm	$\pm 0.015$ mm	Self-Contained Coil	25 m at least
Wire 'F' or 'T'	0.5 - 0.1 mm	$\pm 0.01$ mm	Spool Types CsV-800 or CsV-820	35 m at least

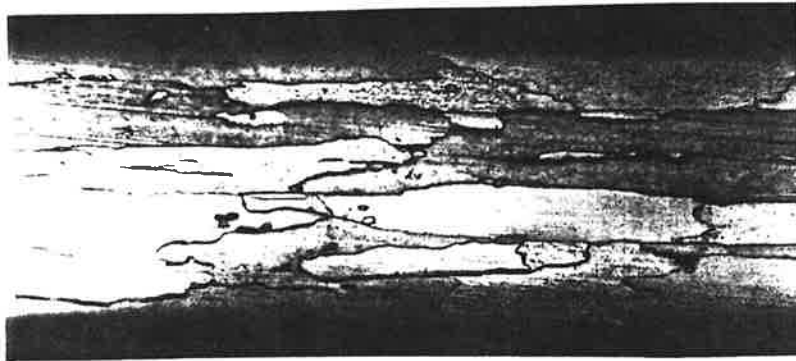


Metallographic section, type GK 21

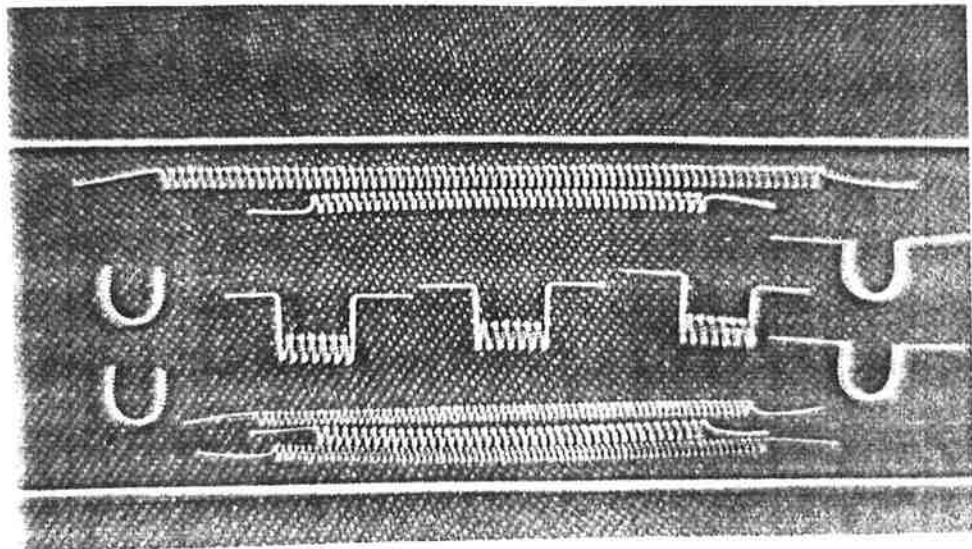


GK 31 - Tungsten Wires, Split-Controlled, for use as Coils  
in GLS Lamps, Non-Halogen Filled Lamps and as  
Cathodes in Discharge Lamps

Product	Size Range	Tolerance	Packing	Minimal Length
Wires 'F' and 'T'	1.5 - 0.5 mm	$\pm$ 0.015 mm	Self-Contained	35 m
Wires 'F' and 'T'	0.5 - 0.3 mm	$\pm$ 0.01 mm	Spool Type CsV-820	50 m
Wires F, T, TL, E, ET, and ETL	400 - 100 mg/200 mm	$\pm$ 1.5 %	Spool Type CsV-800	100 m
Wires F, T, TL, E, ET, and ETL	100 - 50 mg/200 mm	$\pm$ 1.5 %	Spool Type CsV-800	150 m
Wires F, T, and TL	50 - 20 mg/200 mm	$\pm$ 1.5 %	Spool Type CsV-800	300 m
Wires F, T, and TL	20 - 4 mg/200 mm	$\pm$ 1.5 %	Spool Type CsV-800	400 m
Wires F, T, and TL	4 - 0.3 mg/200 mm	$\pm$ 1.5 %	Spool Types CsV-310, CsV-22-01, and CsV-510/A	400 m

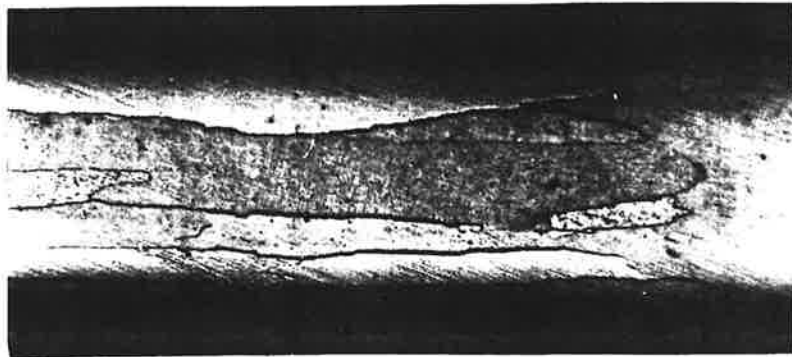


Metallographic section, type GK 31

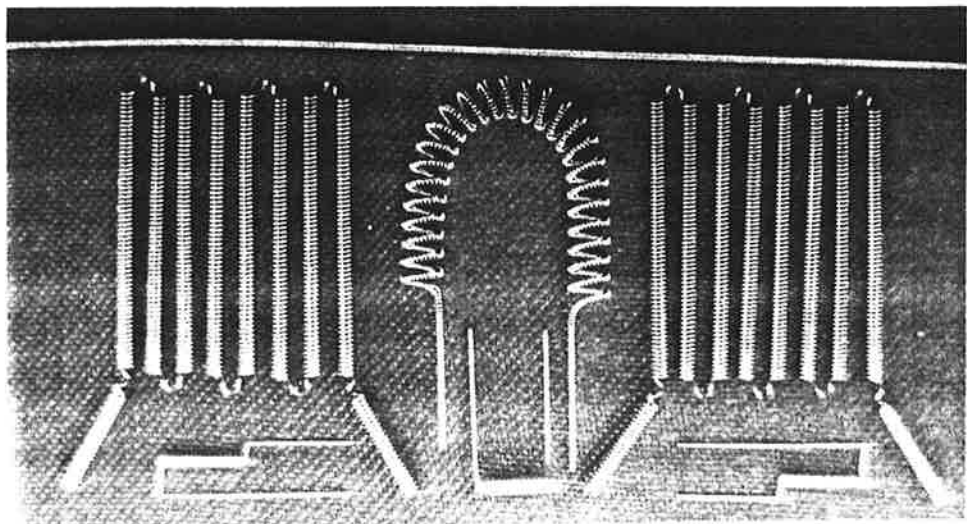


GK 61 - Tungsten Wires with Improved Non-Sag Characteristics, Shock-Resistant, Split-Controlled, Especially for Coils in Halogen Lamps.

Product	Size Range	Tolerance	Packing	Minimal Length
Wires F and T	1.5 - 0.5 mm	$\pm 0.015$ mm	Self-Contained Coil	35 m
Wires F and T	0.5 - 0.3 mm	$\pm 0.01$ mm	Spool Type CsV-820	50 m
Wires F, T, TL, E, ET, and ETL	400 - 100 mg/200 mm	$\pm 1.5$ %	Spool Type CsV-800	100 m
Wires F, T, TL, E, ET, and ETL	100 - 50 mg/200 mm	$\pm 1.5$ %	Spool Type CsV-800	150 m
Wires F, T, and TL	50 - 20 mg/200 mm	$\pm 1.5$ %	Spool Type CsV-800	300 m
Wires F, T, and TL	20 - 4 mg/200 mm	$\pm 1.5$ %	Spool Type CsV-800	400 m
Wires F, T, and TL	4 - 0.3 mg/200 mm	$\pm 1.5$ %	Spool Types CsV-310, CsV-22-01, and CsV-510/A	400 m



Metallographic section, type GK 61



Tensile Strength of Tungsten Metal Types GK 31 and GK 61, specific of each Size.

Finish	D i a m e t e r		Tensile strength in N/mg/200 mm
	in $\mu$ m	in mg/200 mm	
F	Below 25	Below 2.0	0.80 to 1.10
	25 to 50	2.0 to 8.0	0.65 to 1.05
	50 to 90	8 to 25	0.65 to 0.90
	90 to 250	25 to 200	0.50 to 0.90
	250 to 575	200 to 1,000	0.50 to 0.75
T	25 to 50	2 to 8	0.68 to 1.10
	50 to 90	8 to 25	0.68 to 0.95
	90 to 250	25 to 200	0.52 to 0.95
	250 to 575	200 to 1,000	0.52 to 0.80
ET	90 to 250	30 to 200	0.55 to 0.85
TL	80 to 250	20 to 200	0.55 to 0.65
ETL	90 to 250	30 to 200	0.55 to 0.65



Physical Properties of the Tungsten

	in SI Units	in Conventional Units
Atomic Number	74	74
Atomic Mass	183.86 kg.kmol <sup>-1</sup>	183.86 g.mol <sup>-1</sup>
Lattice type	Body - centered Cubic	
Lattice Constant	3.158x10 <sup>-10</sup> m	3.158 Å
Density	19.26x10 <sup>3</sup> kg.m <sup>-3</sup>	19.26 g.cm <sup>-3</sup>
Melting Point	3,683 K	3,410 °C
Boiling Point	6,203 K	5,930 °C
Vapor Pressure		
at 1,527 °C	2.57x10 <sup>-13</sup> Pa	1.93x10 <sup>-15</sup> mmHg
at 2,127 °C	1.05x10 <sup>-6</sup> Pa	7.90x10 <sup>-9</sup> mmHg
at 2,727 °C	8.67x10 <sup>-3</sup> Pa	6.50x10 <sup>-5</sup> mmHg
at 3,227 °C	6.24x10 <sup>-1</sup> Pa	4.68x10 <sup>-3</sup> mmHg
Specific Heat at 20 °C	140 J.kg <sup>-1</sup> .K <sup>-1</sup>	0.039 cal.g <sup>-1</sup> .°C <sup>-1</sup>
Coefficient of Linear Thermal Expansion		
at 20 °C	4.5x10 <sup>-6</sup> K <sup>-1</sup>	4.5x10 <sup>-6</sup> °C <sup>-1</sup>
at 1,000 °C	5.2x10 <sup>-6</sup> K <sup>-1</sup>	5.2x10 <sup>-6</sup> °C <sup>-1</sup>
at 2,000 °C	7.3x10 <sup>-6</sup> K <sup>-1</sup>	7.3x10 <sup>-6</sup> °C <sup>-1</sup>
Heat of Fusion	184.2x10 <sup>3</sup> J.kg <sup>-1</sup>	44 cal.g <sup>-1</sup>
Elasticity		
Young's Modulus	411x10 <sup>3</sup> MPa	41.9x10 <sup>3</sup> kg.mm <sup>-2</sup>
Shear Modulus	161x10 <sup>3</sup> MPa	16.4x10 <sup>3</sup> kg.mm <sup>-2</sup>
Poisson's Number	0.28	0.28
Resistivity		
at 24 °C	5.89x10 <sup>-4</sup> Ωm	5.89 /μΩcm
at 700 °C	22.43x10 <sup>-4</sup> Ωm	22.43 /μΩcm
at 1,500 °C	49.66x10 <sup>-4</sup> Ωm	49.66 /μΩcm
at 2,100 °C	69.61x10 <sup>-4</sup> Ωm	69.61 /μΩcm

Chemical Properties of the Tungsten

Substance	Temperature	Reaction
Air or Oxygen	20 °C	No Reaction
	400 °C	Starting Oxidation
	Above 1,400 °C	Rapid Oxidation
	Below 1,200 °C	No Reaction
	Above 1,200 °C	Negligible Absorption
Ammonia		No Reaction
Nitrogen	1,500 °C	No Reaction
	2,500 °C	Nitridation
Water		No Reaction
Water Vapor	Above 200 °C	Rapid Oxidation
Carbon Monoxide	Above 1,000 °C	Carburization
Carbon Dioxide	Above 1,200 °C	Oxidation
Fluor	20 °C	Fluoride Formation
Chlorine	Above 300 °C	Chloride Formation
Bromine	R e d - H o t	Bromide Formation
Iodine	R e d - H o t	Iodide Formation
Sulfur	R e d - H o t	Slow Reaction
Phosphorus	R e d - H o t	No Reaction
Carbon (Solid)	Above 800 °C	Carbide Formation
Hydrocarbons	Above 700 °C	Reactiv
Silicium	Above 1,000 °C	Silicide Formation
Mercury Vapor		No Reaction
Sodium	600 °C	No Reaction
Gallium	600 °C	No Reaction
Magnesium	20 °C	No Reaction
10 % NaOH solution		No Reaction
Sodium hydroxide melt		Rapid Etching
Sulfuric Acid, Diluted	20 °C	No Reaction
	100 °C	Slight Etching

Substance	Temperature	Reaction
Sulfuric Acid, Concentrated	20 °C 110 °C	Slight Etching Slow Etching
Hydrochloric Acid, Concentrated	20 °C 100 °C	No Reaction Slight Etching
Nitric Acid, Concentrated	100 °C	Slight Etching
Hydrofluoric Acid	100 °C	Slight Etching
Mixture of HF and HNO <sub>3</sub>	20 °C	Rapid Etching
Argon		No Reaction
Helium		No Reaction
Potassium or Sodium		
Nitrite or Nitrate		
in Aqueous Solution:		Very slight Reaction
in Melt:		Completely Soluble
Oxidizing Agents		

Relationship between Wire Diameter and Mass:

$$d = K \cdot \sqrt{m}$$

$$m = C \cdot d^2$$

where  $d$  = Wire Diameter in  $\mu\text{m}$

$m$  = Wire Mass in  $\text{mg}/200 \text{ mm}$

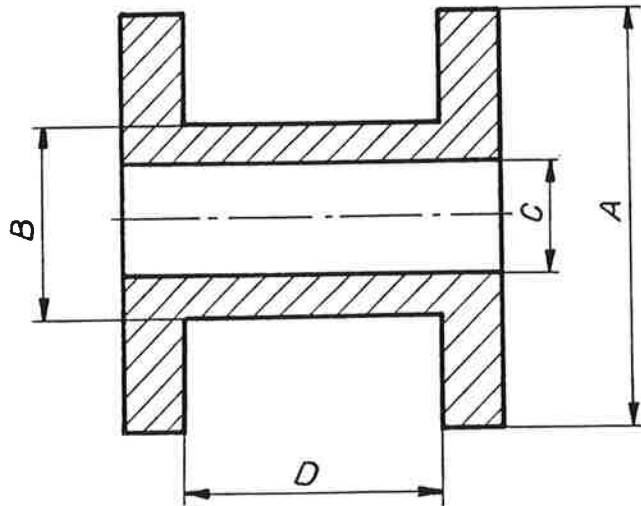
$K = 18.18$

$C = 3.0256 \times 10^{-3}$

Spools

Spool Type	Spool Material	Spool Sizes in mm				Wire Diameter in mm
		A	B	C	D	
CsV-22-01	AlMgSi	28	18	12	10	0.007-0.015
CsV-310	AlSi12Mg	78	64	12	20	0.015-0.036
CsV-510/A	Keripol	80	64	12	20	0.015-0.036
CsV-800	K24	118	100	98	20	0.015-0.4
CsV-820	Aluminium	192	153	150	30	0.2---1.5
Self-Contained Coil (Outer Diameter: 200-400 mm)						0.5---1.5

On special demand, delivery on spools type DIN 46399



- Packing:
- On Spools, in Plastic Bags, in Cardboard Boxes
  - On Spools, Vacuum Packing, in Cardboard Boxes
  - Self-Contained Coil, Bundled, in Cardboard Boxes
  - Self-Contained Coil, Vacuum Packing, in Cardboard Boxes