Tungsten-Copper (WCu)

Tungsten-Copper (WCu) is a composite material with a heterogeneous structure. Typically, a porous blank is produced by pressing and sintering tungsten powder. The remaining pores are sealed by immersing in liquid copper (=infiltration). Furthermore, the production of WCu can also be carried out by means of liquid-phase sintering. Depending on the grain size of the W-powder as well as pressing and sintering parameters, various contents of Tungsten respectively Copper can be selected. Tungsten-Copper combines many typical characteristics of the single elements Tungsten and Copper as for example the hardness, wear and burn-off resistance of Tungsten together with the good electrical and thermal conductivity of Copper.

Typical Applications of Tungsten-Copper

Tungsten-Copper is used for example for eroding electrodes (EDM), heat sinks, electrical contacts, medium and high voltage breakers (SF6), welding electrodes (contact / resistance welding), balancing weights and others. Tungsten-Copper is frequently used as an electrode material, in case that the typical copper contact materials (e.g. Copper-Chrome-Zirconium CuCrZr and others) have reached their limits.

Significant Characteristics and Applications

Good machinability
High density
Very good dimensional stability
Low coefficient of expansion
High surface quality
High wear resistance
High thermal conductivity
High burn-off resistance

Machining

The machining is carried out by carbide tools. The properties when machining are very good. Compared to various Copper alloys there are no deformations due to the high hardness and high E-Modulus. A very good surface quality can be achieved with almost burr- and nick-free edges.

ASTM Standard Specification

ASTM B702 (Copper-Tungsten Electrical Contact Material)

Properties of the most important material types

	Tungsten-Copper WCu					
	50/50 Class A	60/40 Class B	70/30 Class C	75/25 Class D	80/20 Class E	90/10 —
Chemical Composition						
Copper (Cu) [%]	50±2	40±2	30±2	25±2	20±2	10±2
Tungsten (W) [%]	Rest	Rest	Rest	Rest	Rest	Rest
Additives [max. %]	1	1	1	1	1	1
Physical Properties						
Density [g/cm³]	11.7	12.7	13.7	14.3	15.0	16.5
Electrical Conductivity [% IACS]*	56-64	49-57	44-52	41-48	38-45	<30
Coefficient of Thermal Expansion [10-6 K-1]	13.0	11.9	10.3	9.5	8.8	<7.5
Thermal Conductivity [W/m · K-1]	—	—	200	190	180	170
Mechanical Properties						
Hardness [HRB]	69-83	77-90	85-98	89-102	94-106	—
E-Modulus [GPa]	—	—	220	260	280	290
Tensile Strength Rm [MPa]	344-413	379-448	516-585	585-654	620-689	700

Typical values, partly standardised according to ASTM B702
* International Annealed Copper Standard, 100 % IACS is equivalent to 58 MS/m

Tungsten Alloys

Tungsten Alloys are composites materials with a very high percentage of Tungsten. Nickel-Iron is used as a composite metal, respectively for paramagnetic applications Nickel-Copper is used instead. Tungsten Alloys are produced by mixing, pressing and sintering of the corresponding metal powder portions. Tungsten Alloys and pure Tungsten have a lot of characteristics in common as for example the very high density or the very good shielding against X-ray radiation, however the machinability of Tungsten Alloys is much easier. Tungsten Alloys are both at processing and application, neither polluting nor harmful.

Typical Applications of Tungsten Alloys

Shielding against X-ray and Gamma radiation, collimators, balance and counterbalance weights (replacement of Lead), ballistic projectiles, mould inserts and ejectors for Aluminum and Magnesium pressure die-casting moulds, electrical contacts, electric resistance electrodes, tool holder, vibration-reducing drilling rods and others.

Significant Characteristics and Applications

Good machinability
Very high density
Very good dimensional stability
Very good mechanical properties
High surface quality
High shielding against X-ray and Gamma radiation

ASTM Standard Specifications

ASTM B777 (Tungsten Base, High-Density Metal)
AMS 7725E (AMS T-21014A)
MIL-T-21014D

Properties of the most important Material Types

	W90NiFe/W90NiCu Class 1	W92.5NiFe/W92.5NiCu Class 2	W95NiFe/W95NiCu Class 3	W97NiFe Class 4	W90NiFeMo (no standard)
Chemical Composition					
Tungsten (W) [%]	90	92.5	95	97	90
Nickel (Ni) [%]	6	5.25	3.5	2.1	4
Iron (Fe) /Copper (Cu) [%]	4	2.25	1.5	0.9	2
Molybdenum (Mo) [%]	—	—	—	—	4
Physical Properties					
Density [g/cm³]	16.85-17.25	17.15-17.85	17.75-18.35	18.25-18.85	17.10-17.30
Thermal Conductivity [W/m · K^{-1}]	70/95	75/100	85/105	90/115	80
Coefficient of Thermal Expansion [$10^{-6}K^{-1}$]	5.8	5.5	5.2	5.0	5.3
Specific Electrical Resistivity [$10^{-6}\Omega$·m]	0.17/0.13	0.15/0.12	0.13/0.11	0.10/0.09	—
Mechanical Properties					
E-Modulus [GPa]	320-340	340-360	350-380	360-380	350
Tensile Strength R_m [MPa]	750-1200	750-1400	720-1200	680-1000	700-1000
Yield Strength $R_{p\ 0,2}$ [MPa]**	517	517	517	517	650
Elongation A [%]	5-30	5-25	3-15	2-10	2-15
Hardness [HRC]*	24-32	25-33	25-34	30-35	24-32

Typical values, partly standardized according to ASTM B777
* Higher values allowed for deformed or aged material
** Minimum value according standard (Class 1-4), deviations allowed for paramagnetic type WNiCu

Tungsten-Silver

Tungsten-Silver materials are used in industrial and domestic circuit breaker applications where good weld and erosion resistance is important. Various grades are available: - the higher silver grades have higher conductivity, and the higher tungsten grades have greater erosion and weld resistance. High contact pressures are required to ensure effective operation if used for frequent high current switching, where mixed oxides of Tungsten-Silver can be formed, giving high contact resistance.

Features and application

Tungsten-Silver alloys have high hardness, resistance against arc erosion, good anti gelling and anti-fusion welding ability etc characters. Tungsten-Silver is widely used in high temperature resistant material, high voltage switch, microelectronics material, electric processing electrode material. Tungsten content more than 60% of alloy general use penetration method to produce, used as a low voltage power switch, the reuse of the switch, the locomotive of the switch, large current switch contact, as well as the heavy load relay, air circuit breaker etc.

Silver tungsten data sheet

Grade	Ag%(WT)	W%(WT)	Density (Min)	Electric Conductivity (Min)	Hardness (Min)
AgW55	45±2	Balance	13.55g/cm3	58%IACS	115HB
AgW60	40±2	Balance	14.00g/cm3	56%IACS	125HB
AgW65	35±2	Balance	14.50g/cm3	53%IACS	135HB
AgW70	30±2	Balance	14.90g/cm3	51%IACS	150HB
AgW75	25±2	Balance	15.40g/cm3	48%IACS	165HB
AgW80	20±2	Balance	16.10g/cm3	45%IACS	180HB