TUCOMET™ PRODUCTS

WELDSTONE
TUNGSTEN COMPONENTS

TUCOMET™
TUNGSTEN-COPPER

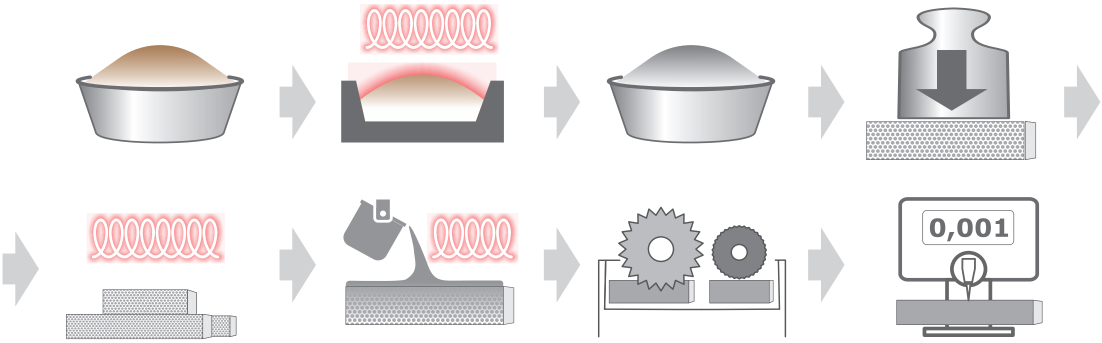
IBG GROUP

Brand

TUCOMET™ is the brand name of a product group which is made from tungsten and copper. TUCOMET™ products are well known for their high quality, reliabilty and impressive performance. These properties are achieved by a special developed production process designed by Weldstone.

Production

TUCOMET™ materials are typically made by infiltration of pressed or pre-sintered tungsten blanks. This material can be called a tungsten alloy. The infiltrated material can then be easily machined.



Applications

Resistance Welding

Resistance welding is a method for joining materials by using heat and pressure. The work piece is heated by electrical current using conductive electrodes. The welding arrangement consists of individual series-connected contact and material resistances, which convert electrical power into heat in proportion to their size.

Contact resistances occur at the points of interface between the electrode and work piece, or between the work pieces. They are determined by temperature, pressure, contamination, oxide layers, coatings, alloying, the electrode caps and component fit. The material resistances result from the specific material resistances and temperature. Welded joints are made using a compatible resistance, heat distribution and sufficient energy supply, typically in the form of welding lenses. To reduce losses and provide targeted energy input into the weld zone, electrode materials with specific properties are used. These properties include high conductivity, high melting points, and low contact resistance. In order to achieve consistent contact resistance and welding results, the electrodes must be dimensionally stable. For this reason electrode materials with high hardness and strength are used. It is important that these material properties are maintained during the welding process after long exposures to heat. Therefore, the materials generally are characterized by high softening temperature, and high tempering resistance.

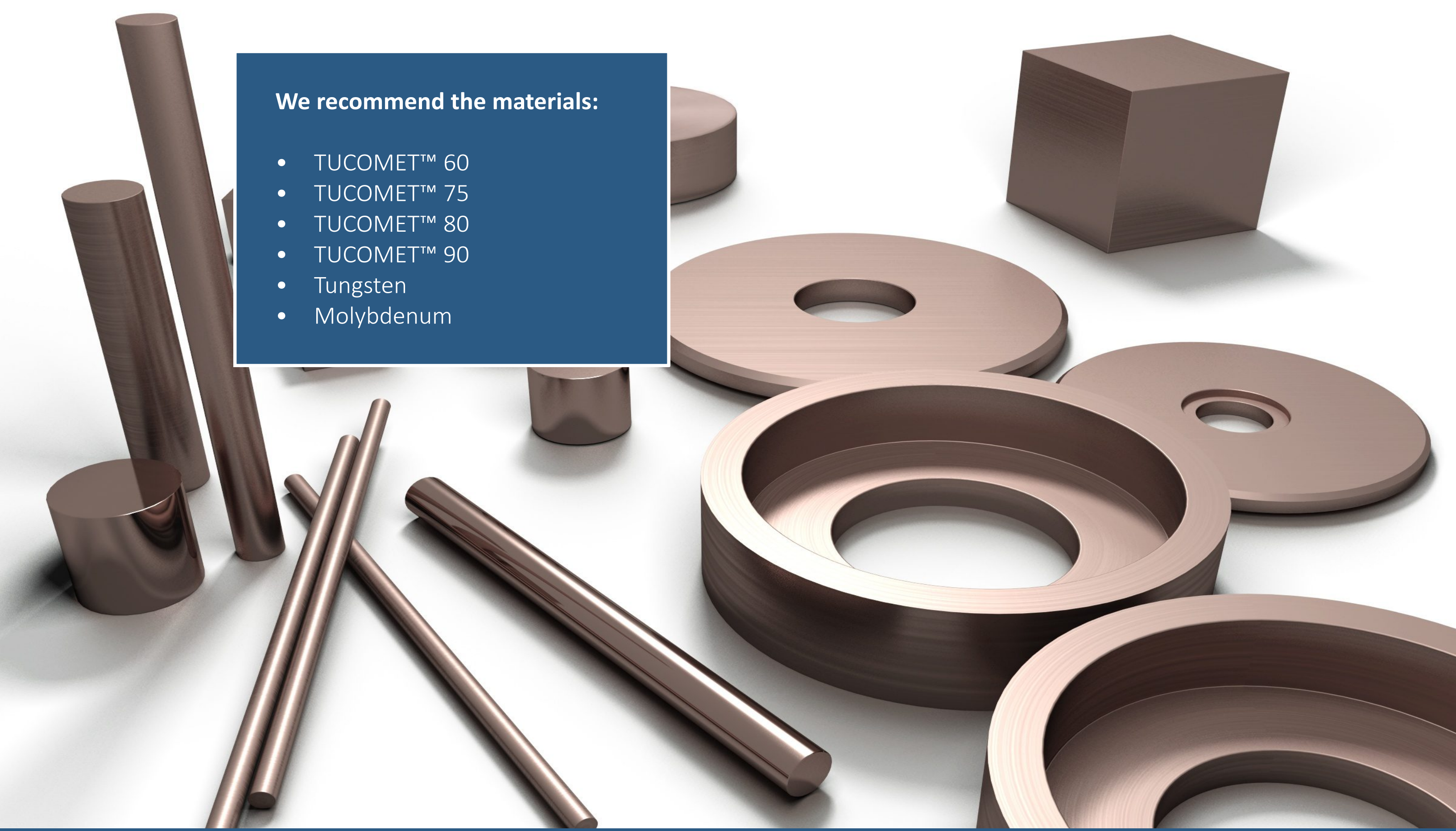
When choosing the electrode, the lowering of the melting point due to the formation of mixed crystals of the electrode materials and work piece must be considered. Accordingly, the electrode material should be quite similar to the work piece material or have a higher melting point.

For process variations we recommend the following materials:

- Resistance spot welding
  TUCOMET™ 80, W, WCu-composite, CuCrZr, CuCoBe
- Resistance projection welding
  TUCOMET™ 80
- Resistance seam welding
  Mo, TZM, TUCOMET™ 80, TUCOMET™ 75
- Resistance butt welding
  Anviloy® 180F, ANVILOY® 173M, TUCOMET™ 80, TUCOMET™ 90
- Discharge welding
  TUCOMET™ 80, TUCOMET™ 90
- Resistance stud welding
  TUCOMET™ 80, TUCOMET™ 90
- Flash butt welding
  TUCOMET™ 80, ANVILOY® 180F, ANVILOY® 173M

Electrical discharge machining for high-precision material processing is called “erosion” or “spark erosion”. Here, numerous small discharges between the electrode and work piece, inside the dielectric, erode small pieces of an electrically conductive work piece. For example, a hole can be drilled (drill EDM) or a work piece can be cut by a wire (wire EDM). Thus, a complex tool contour can be negatively reflected (imaged) on a work piece (die sinking EDM). An application that is gaining in popularity is disc eroding which is used for sharpening PCD (poly crystal diamonds) or hard metal saw blades and wood cutting tools. In this application a rotating disk serves as an electrode. The accuracy of these processes depends on the stability of the tool electrode, because the spark also removes electrode material even if it is at a much lower extent. This is why the electrode material from which the electrodes are made is of particular importance. The electrode material determines critical process parameters such as removal rate, wear, burrs, thermal expansion and requirements regarding rinsing.

The high-melting refractory metals tungsten and molybdenum as well as their alloys meet all requirements in this respect. They allow higher tool sharpness than copper and graphite and thus allow a more focused spark, better accuracy, smaller tolerances and form fidelity. Also the very low tool warpage supported by a balanced temperature contributes to it, as the refractory metals with their high thermal conductivity and low thermal expansion, prevent uneven heat distribution. Homogeneous and fine grain structures improve the machinability of TUCOMET™ materials and make it possible to achieve a low roughness and high surface quality of the electrodes. Accordingly, the material erosion of the tool is lower and, because of more homogenous sparks distribution, finer. Therefore flushing and removal of erosion are much easier and the risks of short circuits are reduced.



We recommend the materials:

- TUCOMET™ 60
- TUCOMET™ 75
- TUCOMET™ 80
- TUCOMET™ 90
- Tungsten
- Molybdenum

The requirements of computing power and microelectronics in computer and communication technology, as well as power electronics in laser, aviation and aerospace technology are demanding. Chip development is being characterized by increasing energy density and high heat losses, while at the same time reducing the structures size. Therefore these systems are in principle more sensitive to degradation and must be protected from overheating by an effective thermal management. That is why Si and GaAs semiconductors must be mounted on substrates or floor panels, which function simultaneously as a heat sink. In order to avoid thermal stresses, materials of the same thermal expansion rate and high thermal conductivity are required. Materials made of TUCOMET™ alloys meet these characteristics perfectly.

Since the thermal expansion rate of WCu heat sinks corresponds (up to a temperature of 800°C) to the thermal expansion of packing materials, they can interact with each other with minimal creation of stresses. This and the additional heat capacity increases the life of semiconductor laser diodes significantly when used in an intermittent laser operation.

Weldstone supplies plates and heat sinks according to customer specifications in the computer industry, optoelectronics, telecommunications, aviation and aerospace.

- Base plates (heat-slugs) for IC Packages
- Heat sinks for optoelectronics and lasers
- Heat sinks for microwave applications and optical fiber for packages
- Heat sinks for high-performance chips

Electrical contacts build electrical connections between components in overvoltage protections, relays and switches. The requirements for the switch contacts are different depending on the switching power, switching voltage, switching frequency, continuous current, and the starting and breaking current. Accordingly, the requirements for the contacts and the methods to ensure their safe function vary.

To prevent oxidation, the contacts can be made corrosion resistant by coatings with precious metals or by operating the contacts in a vacuum, inert gas or oil. Other problems include contact erosion, erosion by spark flashover, or arcing and welding at high power. These problems can be solved by using refractory metals like tungsten.

At the same time a low contact resistance must be ensured. This however can be provided by low-melting but highly conductive metals such as copper and silver. Depending on the requirement, the properties of the high melting metals are combined with those of highly conductive metals. Therefore, alloys are produced in which both components are present in a suitable ratio to each other. This creates contacts with very good welding resistance and good contact resistance. The erosion resistances of TUCOMET™ and tungsten-silver alloys even exceed that of pure tungsten. This is due to the cooling effect of evaporating copper (2,927 °C) or silver (2,162 °C) while tungsten begins to melt only at 3,410 °C and therefore remains .

There are different materials for choice:

- Tungsten/Silver W50Ag, W60Ag, W70Ag, W80Ag
- Tungsten/Copper TUCOMET™50, TUCOMET™ 60, TUCOMET™ 70, TUCOMET™ 80, TUCOMET™ 90
- Tungsten
- Composite material W/Cu, WLa/Cu, W/WCu, W/CuCrZr

Tungsten/Silver W50Ag, W60Ag, W70Ag, W80Ag

Tungsten-silver contact materials are characterized by a high conductivity, resistance to erosion as well as welding resistance. In the case of welding the removal force is very low. After a long period of operation tungsten-silver contacts are prone to oxidation and tungstate formation whereby the contact resistance can increase.

Due to these properties tungsten-silver contact materials are used preferably in low-voltage switchgears and circuit breakers such as engine circuit breakers, miniature circuit breakers and residual current circuit breakers.

Tungsten/Copper TUCOMET™50, TUCOMET™ 60, TUCOMET™ 70, TUCOMET™ 80, TUCOMET™ 90

TUCOMET™ contact materials are also very good at resisting erosion during switching. This erosion is generally flat and uniform. The welding resistance of the materials is good and increases with increasing tungsten content. The tendency to formation of tungstate's is not very pronounced; therefore contact resistance and chopping gap during the lifetime of the switch remain very stable. TUCOMET™ materials are well suited for driving and switching of high currents. Their high thermal conductivity coupled with low thermal expansion makes them very resistant to thermal shock and mechanical stresses. Tungsten is characterized by an extremely low solubility of gases. Correspondingly low is the release of gas in vacuum. For use in vacuum switches, particularly low-gas tungsten-copper contact materials can be supplied.

Because of these properties, contact materials made of TUCOMET™ are particularly suitable for burn up contacts in circuit breakers, switches and load-break switches between high and medium voltage switchgears. Furthermore, these materials are suitable for electrodes in lightning protection equipment. Low gas TUCOMET™ materials are used in vacuum contactors.

Tungsten

Tungsten has the highest hardness and the highest melting point of contact materials. Thus, it is used in arc exposed areas and has good resistance to erosion. Tungsten does not tend to weld and thus has excellent separation ability for safety. Since there is minimal material migration, it is used in applications such as car horns and interrupter contacts. The switching voltage however should be above 6V and the contact force should also exceed 0.5 N. Other applications are found in medium and high voltage switching devices for circuit breakers, switches and load-break switches.

Composite material W/Cu, WLa/Cu, W/WCu, W/CuCrZr

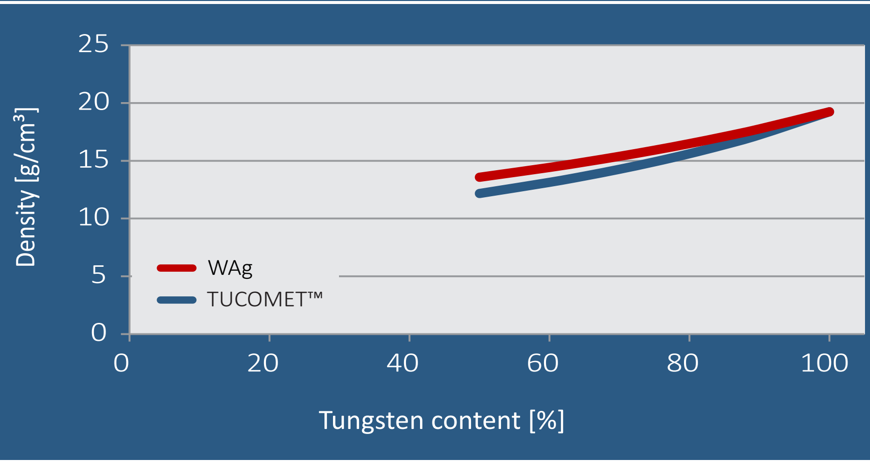
According to the individual requirements composite materials can combine optimized functional materials in one component. Examples include burn up contacts in SF6 circuit breakers, load break switches and transformer tap changers.

Weldstone creates these material compositions according to customer requests by soldering, welding, infiltration or back casting.

	Hardness HV 10	electric Conductivity $m/\Omega \times mm^2$ (IACS)	theor. Density g/cm^3	Av. thermal expansion coefficient α at 20°C	Thermal Conductivity λ bei 20°C	Heat Capacity cp	Softening temperature °C
TUCOMET™ 50	125	27,7 (48%)	12,2	11,3	242	199	>1000
TUCOMET™ 60	155	25,1 (43%)	13,1	10,1	224	181	>1000
TUCOMET™ 70	180	22,9 (39%)	14,3	8,9	200	166	>1000
TUCOMET™ 75	200	22,0 (38%)	14,9	8,2	202	160	>1000
TUCOMET™ 80	215	21,1 (36%)	15,6	7,5	196	154	>1000
TUCOMET™ 85	285	20,3 (35%)	16,4	6,8	190	149	>1000
TUCOMET™ 90	300	19,5 (34%)	17,3	6	184	143	>1000
W50Ag	130	28,1 (48%)	13,6	10,5	247	171	>900
W60Ag	150	25,3 (44%)	14,4	9,4	228	162	>900
W65Ag	165	24,1 (42%)	14,9	8,8	219	158	>900
W70Ag	175	23,1 (40%)	15,4	8,1	211	154	>900
W75Ag	185	22,1 (38%)	15,9	7,5	204	150	>900
W80Ag	200	21,1 (37%)	16,5	6,9	197	147	>900
CuCo2Be*	230 - 300	45 - 55 (86%)	8,8	16,7 - 17,8	226		500
CuCrZr*	160 - 180	44 - 50 (81%)	8,9	16,3 - 18,0	314 - 335		500

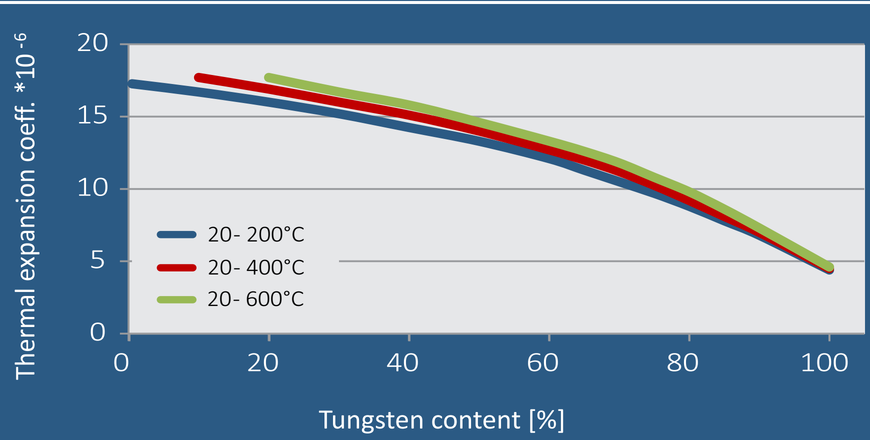
* for comparison

Density

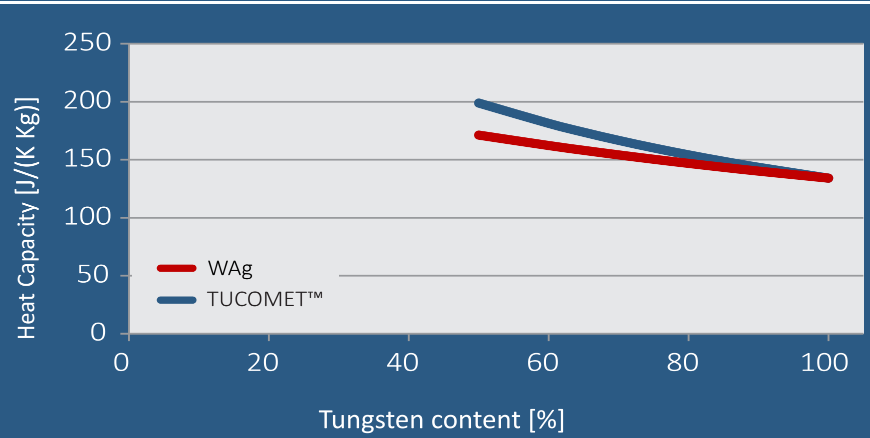


All values are typical values without guarantee. Binding are the characteristics mentioned in our order confirmaton

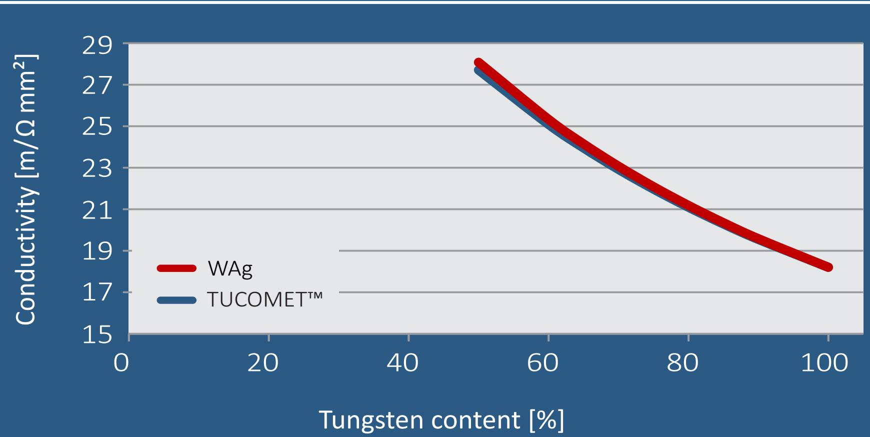
Thermal expansion



Heat Capacity



Conductivity



Turning

All turning operations- inside and outside- can be accomplished with common tools made from tungsten carbide listed in the ISO groups of machine cuttings K 05 to K 20. Using tungsten carbide turning tools, cuts without chamfer, with a setting angle of 6°, and a face angle of 6°- 12° should be selected. For cutting, positive rakes are preferred with a chip breaker and without chamfers. Cutting speeds of 80- 120 m/min can be achieved. Also High Speed Turning is possible. Cooling agents are not required.

Drilling

Drilling requires drills made from high-speed steel (preferably material NR. 1.3342 or 1,3343) or tungsten carbide of the ISO group of machine cuttings K 10 suitably. The tip angle of the drill should be 120°. Depending on the choice of the tool material cutting speeds from 20 to 80 m/min are possible. Since no cooling agent is used, the drilling made of high-speed steel needs often to be ventilated, in order not to let cutting edge of the drill rise to a temperature over 550°C.

Milling

Face Mills with positive indexing inserts, made from tungsten carbide of the ISO machine cutting groups K 10 / K 20 or P 20 to P 30, have proven to work well. With an angle of the major cutting edge of 80°, the face angle of the indexing insert should be 6° - 10°. Likewise the angles of inclination should be 6°, and the setting angle 6°. A cutting speed 80- 120 m/min is recommended. High Speed Milling is possible. No cooling agent is needed.

Grinding

For sharpening Tungsten alloys, ceramic bound grinding wheels made of silicon carbide can be used. With a granulation of 50- 120 the degree of hardness of the disk should be H to K. For cooling of the disk and reliable clearing of the splinters, the grinding area must be rinsed with a strong cooling agent jet. The cooling agent can be a mixture of water and a commonly used additive.

Bonding

All Tungsten alloys can be well hard brazed. As solder, the silver solder 8427 at 840°C and 8449 at 690°C working temperature perform satisfactorily. In special cases Tungsten alloys can be connected also by friction welding with steel, copper, aluminum and their alloys.

Electrical Discharge Machining

Tungsten heavy metal alloys can be processed by Electrical Discharge Machining (EDM). The high melting refractory metals contained in the alloys require high-melting electrode materials. Therefore we recommend TUCOMET™ 80 and ANVILOY® 170C which you can also order from us. It has to be ensured that the electrode is used as cathode.

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