future alloys

TANTALUM – DATASHEET

SUMMARY PROPERTIES

Property	Value
Name	Tantalum
Type	Refractory Metal
Chemical Symbol	Ta
Atomic Number	73
CAS No.	7440-25-7
Density (gm/cc)	16.6
Atomic Mass (g)	180.95

COMPOSITION - TANTALUM

Substance	Symbol	%
Carbon	C	0.010
Oxygen	O	0.015
Nitrogen	N	0.010
Hafnium	Hf	0.0015
Niobium	Nb	0.100
Iron	Fe	0.010
Titanium	Ti	0.010
Tungsten	W	0.05
Molybdenum	Mo	0.020
Silicon	Si	0.09
Nickel	Ni	31.75
Tantalum	Ta	Balance

TENSILE STRENGTH, YIELD & ELONGATION - TANTALUM

Property	2% Offset Yield Strength (PSI)	2% Offset Yield Strength (MPa)	Tensile Strength (PSI)	Tensile Strength (MPa)	Elongation (%) 1-IN Gauge Length
<0.060 Thick	20,000	138	30,000	207	20
>0.060 Thick	15,000	103	25,000	172	-

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MACHINING - TANTALUM

Tantalum can generally be worked and fabricated using conventional tool and techniques. However annealed tantalum is 'sticky' and has a tendency to seize, tear and gall similar to lead, copper and stainless steel. Forming, bending, stamping or deep drawing processes are usually done cold. Heavy sections can be heated for forging to approximately 800 Degrees F.

Forming and Stamping:

Sheet Metal
Most sheet metal work in tantalum uses thicknesses in the range from 0.004" to 0.060". The instructions given here apply to sheet metal in this thickness range.

Blanking or punching is straightforward. Steel dies can be used. The punch and die clearance should be around 6% of the thickness of the metal being worked and the use of light oil or Perchloroethylene or Trichloroethane is suggested to prevent scoring of the dies.

Form stamping techniques are similar to those used with mild steel, except that precautions should be taken to prevent the metal tearing. Dies can be steel except where there is considerable slippage of the metal, in which case aluminum bronze or beryllium copper, should be used instead.

For deep drawing operations, only annealed tantalum sheet should be used. Tantalum doesn't work harden as quickly as most metals, and work hardening begins to appear at the top rather than at the deepest part of the draw.
If the work is to be drawn through one operation, a draw in which the depth is equal to the diameter of the blank should be made. In the case of more than one drawing operation having to be performed, the first draw should have a depth of no more than 40 to 50 percent of the diameter. The dies should be made of aluminum bronze, the punch can be steel providing there is not too much slippage.

Tantalum annealing is achieved by heating the material in a high vacuum to temperatures above 2,000 Degrees F. Spinning is done using conventional methods – steel roller wheels for tools, although yellow brass may be utilised for shorter runs.

Cleaning:
Cleaning and degreasing presents no special problems and conventional methods and materials may be used, although hot caustics must be avoided. Tantalum parts must never be cleaned by hydrogen firing.

Hot Hydrochloric Acid Cleaning
Electronic tube components which must be chemically cleaned, however will need to be treated more carefully. Tantalum parts that have been blasted with steel grit must first be immersed in hot strong hydrochloric acid to remove any iron particles. The acid will not react with the tantalum. The work should then be rinsed thoroughly with distilled water (tap water often contains calcium salts which may be converted to insoluble sulphates in the subsequent cleaning processes). If the tantalum parts have not been grit blasted, the hydrochloric acid cleaning may be missed out, and cleaning may start with a second step as follows.

Tantalum parts can be made chemically clean by use of a hot chromic acid cleaning solution typically used for cleaning glass. A saturated solution of potassium dichromate in hot concentrated sulphuric acid is sufficient for this purpose, although chromium trioxide is preferable to potassium dichromate because using it will eliminate the probability of residues of potassium on the tantalum components.

The temperature of the cleaning solution should be about 110 oC, and should be kept red at all times. When the substance becomes muddy or turns green it should be discarded. Following the chromic acid wash, the parts must be thoroughly rinsed, ideally with hot distilled water. In the absence of running distilled water, three dip washes will be sufficient, however it is important that all cleaning solution is removed. The component parts should be dried in warm, clean air, in a dust free environment. They should not be wiped with paper or cloth, or handled with fingers.

Grit Blasting:
Tantalum components for electronic tubes are typically blasted with steel grit to provide a better radiation surface. The recommended procedure is a few seconds blast with No. 90 steel grit at 20 to 40 psi pressure followed by thorough cleaning in hot hydrochloric acid as previously described. Sand, silicon carbide, alumina, or other abrasives should never be used as they become embedded within the tantalum and cannot be removed with any chemical treatment easily which would risk damaging the tantalum.

The purpose of grit blasting is to increase the amount of surface per unit of area, and hence the grit blasting method should aim to produce fine 'whiskers' rather than surface indentations. Sharp grit particles will achieve this, whilst dull particles tend to indent the surface. Best results can be achieved by holding the blasting nozzle at an angle almost tangential to the part, rather than being perpendicular to the part.

Machining:
For lathe operations, cemented carbide tools with high cutting speeds, have been found to produce the best results. Tools must be kept sharp, and grounded with as much positive rake as the tool will withstand. Tantalum can be machined well using the same rakes and angles as are used with soft copper. A minimum speed of 100 surface ft/minute is ideal for most turning operations. Slower speeds will cause the metal to tear, particularly where annealed metal is being cut. Perchloroethylene or trichloroethane is recommended for a cutting medium and the parts must be kept well flooded constantly. Also when filing or using emery cloth, the file or cloth must be kept well wetted with one of these compounds.

Welding:
Tantalum can be welded to itself using inert gas arc welding and certain other metals using resistance welding. Acetylene torch welding is unsuitable and causes damage to the metal.

Resistance welding can be achieved using conventional equipment, using similar methods as for welding other materials. Due to its melting point being 2,700 o F higher than that of SAE 1020 steel and its resistivity being only two thirds that of SAE 1020 steel, tantalum requires a higher power input to accomplish a good weld. The duration of the weld should be maintained as short as possible (between one and ten cycles (60 cps)) to prevent excessive external heating. If possible, the work should be flooded with water for cooling and reduction of oxidation.

RWMAC class 2 electrodes are suggested, with internal water cooling. As in all resistance welding techniques the work must be clean and free of dirt and oxides. The contours of the electrode should be maintained with constant area and contours to stop the lowering of current and pressure densities. A common error when welding tantalum is to apply too much electrode force which has the result of causing little interface resistance and hence no weld at all.

Strong, ductile welds can be achieved using tungsten inert gas welding (tig). With this method extra care must be taken to cover all surfaces with an inert gas which may be raised higher than 600 oF by the welding heat. Helium or argon gasses, or a mixture of the two creates an atmosphere which prevents embrittlement by absorption of nitrogen, oxygen, or hydrogen into the hot metal. Where a pure, inert atmosphere is present, the fusion area and adjacent area will be ductile. Very high ductility can be achieved using a welding chamber that is evacuated and purged with inert gas. Where the use of a welding chamber is not feasible, the heated surfaces can be protected by gas backed fixturing. This helps hold the work in alignment, to chill the work in order to limit the heated area, and also to act as a conduit for the inert gas and to exclude air from the heated area. Weld ductility around 180 degrees bend over on metal thickness can be achieved if back up gas fixtures and gas filled trailing cups are used.