TANTALUM PRODUCERS INTERNATIONAL STUDY CENTER

QUATERLY BULLETIN SEPTEMBER 1975 THIRD QUARTER

TANTALUM PRODUCERS ASSOCIATION MEETING

On July 15, 1975, the Tantalum Producers Association, popularly known as the T.P.A., held a special meeting in New York City to which they invited Dr. Herkstroeter, President of T.I.C., and Mr. Becker-Fleugel, member of the T.I.C. Executive Committee. The purpose of the meeting was to provide an opportunity for the T.P.A. members to learn directly of the T.I.C. program. The T.P.A. members present were :

ompany	*Representative*
Fansteel Inc.:	*Mr. Keith Garrity*
Kawecki Berylco Industries :	*Mr. Joe Ables*
	Mr. Arthur Asch
	Mr. Larry Belz
Kennametal Inc. :	*Mr. Charles Hanna*
Mallinckrodt Inc. :	*Mr. Hunt Boyce*
Norton Co. :	*Dr. Chris Fincham*
	Mr. Dave Nocella
Wah Chang of Albany :	*Mr. Chet LeRoy*

In addition, Mr. Charles Stockinger, Executive Secretary of the T.P.A., and Mr. Ken E. Conklin, Attorney for the T.P.A., were present.

Dr. Herkstroeter first described the history and purpose of the T.I.C. and then expressed the need for a common tantalum raw material association including both the producers and the processors. He further commented that the alternatives open to the T.I.C. would be a merger of the T.I.C. and the T.P.A., common membership in both organizations, or opening T.I.C. membership to processors on a worldwide basis. In some fashion, the two organizations, as representing the two segments of the tantalum producing community, should develop a common confidence in each other. The specific actions taken are not important as long as a dialogue between the groups provides understanding and a common bond of interest. Dr. Herkstroeter continued that he believed that this meeting was a sign of desire on the part of both organizations that they should work together. He suggested that the T.P.A. should consider from their viewpoint the means by which they believed the two organizations should collaborate.

After some questioning by T.P.A. members, Dr. Herkstroeter and Mr. Becker-Fleugel left the meeting to allow for further discussion among the members.

T.I.C. THIRD GENERAL ASSEMBLY

On March 20, 1975 the Third General Assembly of the T.I.C. convened in Brussels. All members except Sociedade Mineira de Marrapino were in attendance. In addition to discussion of the general business at hand, a presentation was made concerning tantalum capacitors by Mr. Peter Fenwick of the Aicliffe, England plant of Union Carbide Corp. The next General Assembly will be held in Brussels on Thursday, September 18, 1975.

U.S. SHIPMENTS OF TANTALUM AND COLUMBIUM PRODUCTS

The Bureau of Mines, U.S. Department of Interior, reports annually *the U.S. shipments of tantalum and columbium products by U.S. processors.* The data for 1970 through 1974 is as follows (1,000 lb. units):

Product	*1970*	*1971*	*1972*	*1973*	*1974*
Tantalum					
Oxides & Salts	90.2	60.9	54.9	142.3	226.1
Alloy Additive	28.2	48.8	43.0	17.3	24.8
Carbide	145.6	135.0	146.9	173.4	163.4
Powder & Anodes	498.7	398.7	540.7	790.5	929.4
Ingot	54.4	42.4	(1.9)	16.0	1.7
Mill Products	213.3	223.3	246.4	321.2	288.8
Scrap	78.6	52.4	58.1	40.5	45.6
Other	9.2	—	.3	1.3	1.3
Total	**1,118.2**	**961.5**	**1,088.4**	**1,502.5**	**1,681.1**
% Change	13.5	(14.0)	13.2	38.0	11.9
Columbium					
Compounds	1,098.6	689.6	925.2	1,216.8	1,520.5
Metal	203.6	270.5	101.9	143.0	133.4
Misc.	15.6	6.8	62.8	.3	34.0
Total	**1,317.8**	**966.9**	**1,089.9**	**1,360.1**	**1,687.9**
% Change	(25.4)	(26.7)	12.7	24.8	24.1

Trends in shipments are generally consistent with few discontinuities which can be explained with reasonable accuracy. The large jump in shipments of « oxides and salts » after 1972 is believed to be the result of a major Japanese producer of tantalum products changing source for potassium fluotantalate from a European producer to a U.S. producer. The 20 % drop in shipments of « powder and anodes » in 1971 was due to the electronic industry recession in that year. Since 1971, however, the wide-scale adoption of tantalum capacitors for commercial products (television, radio, tape players, etc.) has resulted in an average annual growth of about 33 %. The large shipments of « mill products » in 1973 was probably due to the building of a single large chemical processing plant.

From the reported shipments of products, an estimate can be made of the source material requirements. To do so requires making allowance for unrecoverable losses in processing and scrap purchased by the processors for recycling. Calculation provides the following estimates of the tantalum and columbium content of ores and slags consumed each year by U.S. processors (1,000 lb. units) :

Year	*lb. Ta_2O_5*	*lb. Cb_2O_5*
1970	1,500	2,150
1971	1,290	1,590
1972	1,450	1,740
1973	2,000	2,090
1974	2,250	2,700

Because of the large increase after 1972, it is concluded that inventories, both private and government (U.S. National Stockpile) were reduced during 1973 and 1974.

The Bureau of Mines reports reductions in consumers and dealers stocks from 1,120 tons tantalite at the end of 1972 to 745 tons at the end of 1973, a change of 375 tons (about 250,000 lb. Ta_2O_5).

GREENBUSHES MINERAL FIELD AUSTRALIA

General

Greenbushes townsite is located on the South West Highway 254 kilometres south of Perth. The surrounding mineral field covering 93 sq. kilometres is situated in hardwood forest. Topographically, the field is a laterite capped plateau with numerous old and rejuvenated streams flowing from it into the Blackwood River Valley. The highest point in the field is 329 metres above sea level, and the lowest point is approximately 122 metres above sea level.

Climatic conditions are temperate with a December high of 28 °C to a July low of 4.22 °C. The average annual rainfall is 100 centimetres, mostly during the winter months, although some rain can be expected throughout the year.

History of tin mining

The mining history of the area really began in 1884 when a local kangaroo shooter, on the advice of a geologist, began prospecting for alluvial cassiterite. His efforts were rewarded in 1888. From that time individual miners and small companies have worked the primary pegmatites and secondary alluvial deposits. Mining activity has varied over the years. Peak production between 1889 and 1943 occurred in 1906 with 795.81 tonnes of cassiterite concentrate being produced.

Geology

Primary Deposit

The main pegmatite dyke outcrops for about 2.4 kilometres. It runs almost parallel to the South West Highway, dipping to the west at roughly 65 degrees from the horizontal. Its width varies from 60 to 250 metres and both the pegmatite and « greenstone » country rocks are weathered down to at least 48 metres. The zones of cassiterite and tantalite mineralisation mainly occur on the western and eastern margins where the pegmatite contacts the « greenstone ».

Secondary Deposits

The main pegmatite body is elevated and most of the gritty material has washed from the weathered pegmatite and accumulated in surrounding areas as alluvial deposits. These deposits are loosely cemented and never more than 9 metres thick. Most of the heavy minerals are found in the bottom 1.5 metres of the sediment.

Greenbushes tin N. L. operations

This company, the largest in the history of the field, started up in 1963 and has been in continuous operation ever since. Bucket dredging techniques were discountinued in 1972. Now open-cut mining methods are used exclusively. Digging in the pits is done mainly with backhoe hydraulic excavators. Haulage to the two wet concentrating plants is undertaken by 6 dump trucks and 6 dumping semi-trailers.

Treatment of the ore is aimed at separating the gritty and sandy material (mainly quarcz and tourmaline, with some cassiterite and tantalite) from the clay fraction, accomplished by the application of large volumes of water and revolving screens (26,000 litres per minute are used at the larger of the 2 plants). Then the coarser material is further separated using difference in specific gravity on jigs designed to momentarily suspend the particles in water and allow the heavier minerals to settle as a separate layer at the bottom. The rough concentrate, containing about 30 % cassiterite and tantalite, is refined at the dry concentrating plant. The feed material is attritioned in caustic soda to remove any ironoxide, dried, screened, passed over air-tables, electrostatic separators and electromagnetic separators. The process results in high grade final products of cassiterite and tantalite. At present, the company treats 457,000 cubic metres par annum.

Reserves of Cassiterite and Tantalite ores are presently set at 2,250,000 cubic metres. There is adequate material in the large pegmatite masses to develop additional reserves provided financial returns justify exploitation of lower grades.

Production of tantalite as concentrates

In pounds of Ta_2O_5 content, production has been as follows :

Year	*Production*
1966	22,400
1967	44,800
1968	40,320
1969	78,400
1970	89,600
1971	224,000
1972	336,000
1973	268,800
1974	224,000

Tantalite production generally is tied to cassiterite production, but the ratio of cassiterite to tantalite varies from 25 to 1 to 3 to 1, hence some flexibility of control over the relative production is possible.

Grades of products

The tantalite concentrates contain a fair proportion of niobium. The ratio varies but the combined pentoxide figure always exceeds 70 %.

Typical Assays

Ta_2O_5	47 %
Nb_2O_5	30 %
TiO_2	2 %
Sn	1.7 %

Some of the titanium and tin inclusions are accidental and improved product dressing may reduce these.

Tantalite in cassiterite concentrates

The cassiterite concentrates produced carry tantalite and assay 3.5 % Ta_2O_5. Grinding followed by magnetic separation does not produce any significant extraction of this tantalite. Smelting and slagging tests conducted in Australia in the Laboratory of the Australian Mineral Development Laboratories has indicated that a slag containing in excess of 16 % Ta_2O_5 with associated Nb_2O_5 can be produced. Greenbushes cassiterite concentrates are sold into the Penang market and some usable tantalite slag emanate from that area.

Production of tantalite concentrates in other categories

Stibniotantalite exists in the cassiterite concentrates and is recovered as a tantalite source material.

« Tin middlings » containing composite particles of cassiterite and tantalite or stibniotantalite are also recovered and sold as a tantalite source material. The stibniotantalite and middlings are presently processed at about 2 tonnes per month. This can be increased when the market requires such.

The stibniotantalite concentrates

This mineral is a small yellow grain which is non-magnetic and is a non-conductor. Consequently, the mineral is not extracted from the cassiterite at the magnetic separation stage for tantalite but is removed thereafter by electrostatic separatio Concentrates from the electrostatic separation are dressed on a wet shaking table to remove some cassiterite grains and a small amount of zircon.

Stibniotantalite has a varying percentage of antimony and tantalite and niobium but a mid-range assay is :

Ta_2O_5	26 %	
Nb_2O_5	10 %	
Sb	20 %	
Some Sn	10 %	Accidental inclusion only

Associated minerals

The Greenbushes Field has been shown to be a potential source for quality kaolin products and pilot plant testing has been commenced.

Gallium is known to be present in small amounts in the plentiful tourmaline minerals.

Zircon and ilmenite are as plentiful as cassiterite and tantalite and these minerals together with minus 50 micron cassiterite, tantalite and stibniotantalite are currently being recovered on a pilot plant test basis.

As a result, about 90 % of the ceramics used are below 0.1 microfarad, 90 % of the tantalums used are between 0.1 and 100 microfarads, and a large percentage of the aluminums used are over 100 microfarads. Each segment overlaps the other in market demand somewhat because of special applications.

Effect of tantalite prices on capacitor volume

In 1973-1974, when tantalite prices tripled, capacitor powder prices increased by 50 %. During the same period, however, tantalum capacitor price increased only an average of 20-25 %. Fortunately, capacitor producers were, during this same period, making great strides in the improvement of productivity. If such had not been the case, capacitor prices would have risen considerably more. Future increases in tantalite prices will cause comparable increases in capacitor powder prices with resultant higher prices for the capacitors. If such should occur, both ceramics and aluminums will make inroads into the tantalum market. The first effect will be found in the larger tantalum capacitors as the tantalum powder cost is a higher proportion of the total cost at that end of the spectrum. This will have the greatest impact on the volume of tantalum required as the amount of powder required to make one unit at the high end will make an average of 60 to 70 units at the lower end.

The tantalite price level at which the use will begin to reduce is almost impossible to determine. At the price levels of tantalite in 1974, there was a small, but tangible, effect on the future market for all sizes of tantalum capacitors. The fear of prices continuing upward inspired considerable effort on the part of the ultimate users of the capacitors to seek substitutes and to do some redesign to use other types. The easing of the tantalite price trend in 1975, coupled with the recession in the electronic market, has relieved most of the pressure to effect substitution.

UNION CARBIDE CAPACITOR PLANT

On July 24, Union Carbide Corporation announced plans to build a multi-million dollar new facility to produce solid tantalum capacitors to be located near Columbus, Georgia. The plant will employ about 750 people and will increase Union Carbide's domestic tantalum capacitor capacity by 40 %. The present large electronic components facility at Greenville, South Carolina, which produces tantalum capacitors, monolithic ceramic and precision film capacitors, has been recently expanded and employs about 2,500 people.

T.I.C. MEMBERSHIP

The current roster of T.I.C. member companies and their official delegates to the T.I.C. follows :

COBELMIN-ZAIRE
C/o COGEMIN S.A.
Avenue de l'Astronomie 23
1030 Bruxelles, Belgium
Delegate : Pierre Hauwaert, Cogemin S.A.

COMPANHIA DE ESTANHO SAO JOAO DEL REI S.A.
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Delegate : Dominique Wallon, Assistant Manager
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DATUK KERAMAT SMELTING SEDRIRIAN BERHAD
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GREENBUSHES TIN N.L.
P. O. Box 35, West Perth, Western Australia
Delegate : Any one of the Directors

HOCHMETALS AFRICA (Pty) Limited
P. O. Box 6458, Johannesburg, R.S.A.
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PRINTED BY PUVREZ
59, av. Fonsny, Brussels

TANTALUM CAPACITORS

Historical trends and patterns

Tantalum capacitors were introduced in the late 1950's and until 1965 were considered a premium-priced, high quality product. During that period the uses were in military applications and in very demanding industrial applications. The market was quite limited in comparison with other types.

From 1965 through 1972, there was continuing decrease in prices, a trend which opened up new industrial markets, applications such as computers, communication equipment, and process controls. Military applications dropped in importance.

From 1973 into 1975, a new broad category of applications, consumer products, created growth in the market. Decreasing prices with increasing production enabled many consumer products to use tantalum capacitors. They are advantageous because of their high reliability and the ability to put them in small packages. The fact that solid state development in consumer applications has accelerated requiring small capacitors compared to aluminum electrolytics has been the boon to the tantalum business.

Thus, after 1975, the highest growth area in the market will be consumer applications, automotive and home entertainment products. The smaller size of tantalum capacitors will not be the deciding point for tantalum capacitors in automobiles as adequate space generally exists for new electronic components. Rather, tantalum capacitors are needed because of their high reliability and environmental tolerance. They will function in the extreme cold of the Arctic and the extreme heat of the tropics. By 1980 forecasts indicate an average of $ 400 per automobile in electronics compared to $ 100 now. One emission control device now under development, which will automatically sense the nature of the emission and make corrections in the fuel mixture, will use eight capacitors. Additional safety devices will be electronic in nature, using solid state circuitry.

Home entertainment products have already shifted to tantalum capacitors because of the small size of integrated circuits. This has made possible the pocket-size radios, portable television sets, and many other similar items to which the consuming public has become adjusted. Cordless electric tools, electronic watches, pacemakers and other medical devices, are all consumer products which have become the way of life. Continued expansion of the market for miniaturized products is assured.

Military applications will remain rather static. Industrial applications will have a decreasing proportion of the market, although in terms of numbers of pieces, they will represent a growth area.

A summary of the trends, both historical and projected follows :

Application	Mid-60's	Mid-70's	Projected
Military/Aerospace	30 %	13 %	10 %
Computers	49 %	30 %	20 %
Communications	16 %	12 %	10 %
Automotive	0 %	18 %	25 %
Industrial	5 %	12 %	10 %
Entertainment	0 %	15 %	25 %
Total	100 %	100 %	100 %

During 1974, there were about 500,000,000 capacitors produced in the United States and about 1,000,000,000 worldwide. The production is expected to increase to 2,000,000,000 tantalum capacitors by 1980 of which 50 % will still be produced in the U.S. The quantity of tantalum required, however, will not double as there has been a continuing trend toward smaller units. Inthe mid-1960's about 1.5 pounds of powder was required to make 1,000 anodes. Today the average is probably closer to 0.85 pounds and by the end of the decade will be in the range of 0.70 pounds. This trend coupled with improved production yields will result in an increase of powder consumption of only 1.6 times, even though the number of capacitors produced will be doubling.

Advantages of tantalum capacitors

Contrary to general belief, tantalum capacitors are used in the range of .1 to 10 microfarads because they are no more expensive than other capacitors, while they have definite performance characteristics which cannot be matched by other types.

- Stability over an extreme temperature range. Aluminium capacitors freeze at low temperatures and boil at high temperatures because of the use of liquid electrolyte. The capacitance of high value ceramics drops drastically with both temperature extremes.
- Size. Particularly in larger sizes, the tantalum capacitor is much smaller than the aluminium. As a comparison, a 100 microfarad tantalum is about 3/8" diameter × 3/4" long; an aluminum is 3/4" diameter × 2" long, a volumetric difference of over 10 times.
- Reliability. The tantalum capacitor is 100 % solid state. There is no known mechanism by which it wears out. It is impervious to age. The liquid electrolyte in an aluminium will dry out and ultimately will totally lose capacitance.

As a result of these properties, there will always be applications for tantalum capacitors, irrespective of price. The large volume market, however, results from the tantalum capacitor offering a price advantage.

Price relationships

Average unit costs of tantalum capacitors have been reduced consistently over the last 15 years. In 1965 the average price per unit was about $ 0.60. Today it is about $ 0.20. Improved production techniques have been the primary reason for the reduction. Larger demand required investment in automated production techniques. As a result tantalum became a competitive alternative to aluminum electrolytes, ceramics, mylars, and paper types, all of which have been traditionally low priced.

In a general fashion, the price relationship between the tantalum capacitor and the two most competitive types, aluminum and ceramic, can be demonstrated as follows :