

T.I.C. Activities

The Eighth General Assembly of the T.I.C. was held in Brussels on October 11, 1977. The feature of the meeting was the completion of the plans for the First International Symposium on Tantalum to be held from May 10, 1978 through May 12 at Rothenburg ob der Tauber, West Germany. Details of the programme are provided below.

The guest speaker at the General Assembly was Mr. José Nicolai, Adviser for Domestic Market and Industrial Affairs to the European Economic Communities (EEC). His talk, which covered the relations between the industrialized countries and the developing countries with respect to the production and supply of raw materials, will be published in Issue No. 13 of the T.I.C. Quarterly Bulletin.

THE FIRST INTERNATIONAL SYMPOSIUM ON TANTALUM

The chronological schedule for the World Symposium on Tantalum was provided in Issue No. 11 of the T.I.C. Quarterly Bulletin. To recapitulate, participants should plan to arrive at Rothenburg on the evening of Tuesday, May 9. The Symposium will close on the evening of Friday, May 12 in Nürnberg.

The papers which will be presented at the Symposium are as follows:

I. Raw materials, supply and demand situation.

- "The Situation with Respect to the Supply of Tantalum."
Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany.
- "Tantalum Supply and Demand Outlook - Is the Balance Favorable?"
T.C. Barron, Emory Ayers Associates, U.S.A.
- "The Interplay of Industry and Trade Press with Special Reference to the Problems of Representative Price and Market Information."
T.J. Tarring, Metal Bulletin, London.

II. Present situation and future trend of capacitors.

- "The Relationship between Cost of Tantalum and Tantalum Capacitor Demand."
R.W. Franklin, ITT Components Group Europe, Tantalum Capacitor Division, Paignton, England.
- "Capacitor Trends - An Impact Study, and the Alternative to the Usage of Solid Electrolyte Tantalum Capacitors Due to Current Trends in the Price of Ta_2O_5 ."
W.E. McLean, Sprague Electric Co., U.S.A.
- "Future of Tantalum Powder for Capacitor Use."
John A. Cenerazzo, Kawecki Berylco Industries Inc., U.S.A.

III. Tantalum products and processes.

- "Use of Tantalum Carbide in Cemented Carbides."
Sven Ekemar, Sandviken, Sweden.
- "Tantalum Developments in Europe."
G.J. Korinek, Hermann C. Starck, Germany.
- "Specific Problems Related to Tantalum Products."
H.J. Heinrich, GFE Gesellschaft für Elektrometallurgie mbH., Düsseldorf, Germany.

IV. Tantalum for chemical equipment.

- "Engineering Aspects of Tantalum Chemical Equipment."
Gerald D. Corey, Fansteel Inc., U.S.A.

T.I.C. EIGHTH GENERAL ASSEMBLY

On October 11, 1977, the Eighth General Assembly of the T.I.C. convened in Brussels, Belgium. Thirty two participants represented twenty three of the twenty nine members. A presentation was made by Mr. José Nicolai, Adviser for Domestic Market and Industrial Affairs to the European Economic Communities (EEC) in which he presented a general picture of EEC policy regarding relations between the industrialized and the developing countries as producers and suppliers of raw materials to the Western World.

The Ninth General Assembly will be held concurrent with the Tantalum Symposium, May 10-12, 1978 in Rothenburg ob der Tauber, West Germany.

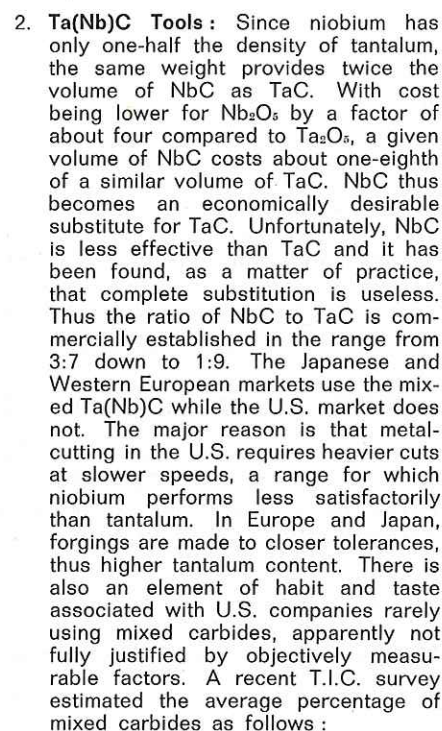
- "Tantalum in Chemical Plants."
F. Sperner and C.H. Lissner, W.C. Heraeus, Germany.

An outline of the programme and a registration form will be mailed by the T.I.C. Secretariat as soon as possible to all people and institutions who are known to be interested in attending. If others, not so addressed, are interested in attending the First International Symposium on Tantalum, please signify your interest in order to receive the necessary registration form by contacting the Secretary, Tantalum Producers International Study Center, 1 rue aux Laines, 1000 Brussels, Belgium.

All hotel reservations will be arranged by the T.I.C. and confirmed with the final acceptance of the application early in 1978.

The cemented carbide industry (producers of metal cutting tools, mining tools, "hard metal" wear resistant parts, etc.) is the world's second largest consumer of tantalum in the form of pentoxide and carbide. Although the latter products are primarily supplied by basic tantalum processors who use ores and slags as their

cratering resistance of both the TiC and TaC with some of the high temperature and shock-resistance characteristics added by the TaC. 50 % of all WC-base cutting tools fall into this category with the TaC running from 2 % content to as much as 10 %. Statistically, the average content of TaC is about 8.5 % over the free world, ranging from a low 7.6 % in Western Europe to a high of 9.6 % in the United States. This divergence results from the use of NbC to provide part of the tantalum need in Western Europe and Japan.



Cemented carbides are products in which fine particles of very hard metal-carbide alloys are cemented together in a solid mass by a binder metal. Although the composition and properties of individual cemented carbides differ widely, most of these products use tungsten-carbide as a base with various other carbides as alloying constituents, generally bound together with metallic cobalt.

The first solution to the cratering problem was to add a small percentage of titanium carbide (TiC), but WC/TiC tools are much more brittle than straight WC tools. A compromise was required that reduced cratering by the addition of small amounts of TiC but allowed some cratering to maintain the toughness of the basic WC. The search for a better solution led to the use of tantalum carbide (TaC). In addition to providing superior cratering resistance, the TaC provides the ability to machine at much higher cutting-edge temperatures and produces shock-resistance, making tools using TaC more suitable for discontinuous cutting. Few straight WC/TaC grades are used today and such are specialty items designed for particular applications. The TaC content of WC/TaC grades will vary from 2.5 % to as much as 28 %.

Market Area	% TaC	%NbC
U.S.	99 % +	1 %
Europe	80 %	20 %
Japan	85 %	15 %

The present trend in Europe seems to be toward a 70 % to 30 % ratio. The current higher tantalum prices may force a change in the habits in the U.S., leading to greater use of the mixed carbide.

3. **TiC-Coated Tools :** During the last fifteen years, the technological progress made in chemical-vapour-deposition (CVD) has resulted in a new cutting tool consisting of a tough WC or WC/TaC base with a TiC coating which resists cratering. This product has made substantial gains in the me-

1. **WC/TiC/TaC Tools :** These tools are used for steel cutting, providing the

TYPE OF CEMENTED CARBIDE TOOL	PRIMARY PURPOSE FOR WHICH TANTALUM ADDED	1976 TANTALUM CONTENT (WHEN ADDED)				APPLICATION
		USAGE RANGE	U.S. AVERAGE	EUROPE AVERAGE	JAPAN AVERAGE	
1. "Straight" Tungsten Carbide (WC/Co)	Grain growth inhibitor Toughness	0.5%-1.3% 2.0%-5.0%	2.0%	2.0%	2.0%	{ Metal cutting Wear resistance
2. Complex or Multi-Carbides			9%	7.2%	7.65%	
• WC/Ta(Cb)C/Co	Thermal Deformation	0.2%-33%	12%	9.6%	10.2%	Metal cutting, primarily steels
• WC/TiC/Ta(Cb)C/Co	Optimal Crater Resistance and Toughness	1.0%-18%	10%	8.0%	8.5%	
• TiC/WC/Co		0	0	0	0	
• Other (e.g., Cr ₃ C ₂ Ni)		0	0	0	0	
3. TiC Base		0	0	0	0	
4. Coated Inserts			6.75%	5.76%	6.12%	
• Straight WC Substrate	Same as above for straight and complex grades; to prevent tool failure when the coating surface is worn through					{ Metal cutting, primary steels
• Complex Carbide Substrate						

tal cutting tool market, now accounting for about 21 % of the total market with the trend increasing. Initially, the TiC coatings were placed on manufacturers' regular tool grades to extend the life of those tools. Recently, however, research has shown that specially designed substrates can be used which are essentially WC/TaC but with the TaC reduced to only 6 %. Some grades, which started at 10 %, are now down to 3 %.

The cemented carbide producers also use some tantalum oxide as a WC grain-size refiner. It is added in an amount ranging from 0.6 % to 1.6 % to inhibit grain growth. The use, however, is decreasing as the tantalum oxide is being replaced by other metallic oxides and the demand for fine grain carbides is not increasing very rapidly.

In summary, the use of tantalum in cemented carbides is shown best by the table at the foot of page 2.

CONSUMPTION RELATED TO PRICE

The price of tantalum carbide has ranged from as low as \$28 per kg. in 1970 up to \$66 in 1974, softening slightly in 1975 and again climbing to the current level of \$88. Although there has been a wide variation of usage over this period, such is directly traceable to the demand for cemented carbides, not the price of TaC. Within particular grades of tools, the usage of TaC has been almost constant. Actually the consumption of TaC by the free-world cemented carbide industry appears to have increased from about 3.0 % of total cemented carbide production in 1971 to 3.3 % in 1976. Even with the three to one increase in TaC prices, the actual contribution to cost increase per kg. of cemented carbide product has only been a little over \$2. Since tungsten prices have also increased significantly, the impact of the TaC price increase has not been too great.

Historically, however, the cemented carbide industry has been very competitive which has engendered technological development to provide lower cost use of their product. This same motivation is still in force and can be expected to continue the effort to develop lower cost products. A T.I.C. survey of cemented carbide producers made in 1976 indicated that carbide costs resulting from tantalite at \$25 per lb. Ta_2O_5 would have no effect for at least two years, because of the lead-time needed to redesign products to use less TaC. With continuation of tantalite prices at \$25, however, it was the consensus of the industry that consumption of TaC would drop 15 % over the span of five years. A more recent survey indicates the market for TaC is still holding up but some producers acknowledge that efforts to reduce the use of TaC are under way.

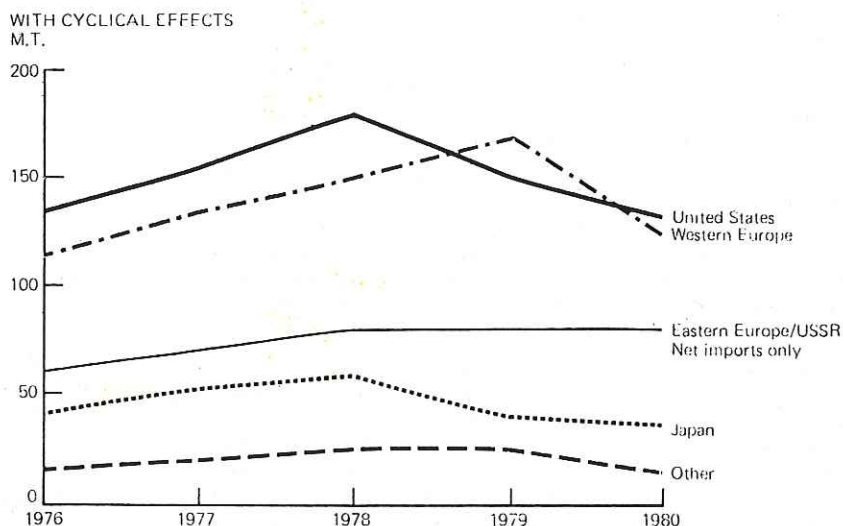
USE OF SCRAP AS A SOURCE FOR TaC

The use of TaC by the cemented carbide industry provides a use for some types of tantalum scrap which would otherwise be lost. Most applications of tantalum, if scrap is to be used as a source of supply, require very high purity scrap. Since much of the scrap generated does not qualify for those uses, it would be lost as uneconomic to process. The process of mak-

ing TaC, however, allows the use of this scrap, particularly reject anodes from the capacitor industry. In addition, as much as 25 % of the annual cemented carbide production is recycled, more than 1,000 m.t. - 1,200 m.t. in the U.S. alone in 1975. Not all of this material, which probably averages about 2.2 % TaC, is reprocessed into WC powder. Considerable amounts are reprocessed chemically and the tantalum content is discarded (perhaps 3-4 m.t. annually). However, it is estimated that scrap from various sources accounts for 25 % - 30 % of the TaC used by the cemented carbide industry.

FORECAST REQUIREMENT FOR TaC

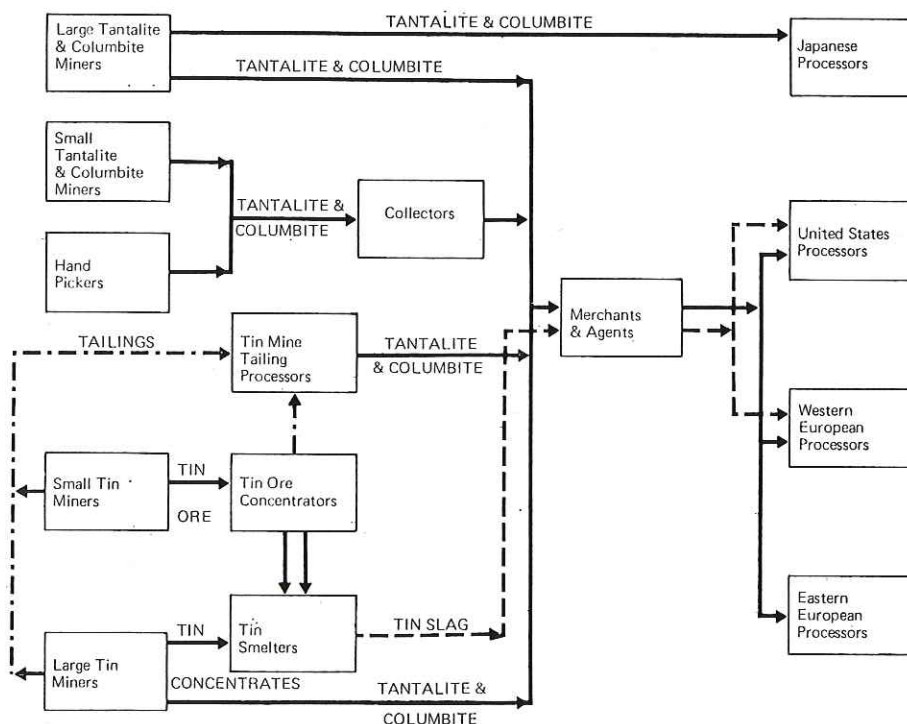
A recent T.I.C. study (October 1976) provides a forecast through 1980 of the total world consumption of tantalum carbide (expressed in m.t. Ta) by the cemented carbide industry. This projection assumes an economic cyclical pattern based on an economic downturn equivalent to the 1970 recession affecting the U.S. and Japan in 1979 and Western Europe in 1980. This forecast is provided in graphic form as follows:



The Outlook for Tantalum Supply

Concerns of tantalum product manufacturers and tantalum end-product users about the future supply of tantalum source materials can be relieved for the short term into the early 1980's with a full under-

standing of the supply situation. The long term supply situation, however, depends on factors related to the political climate in source countries and the availability of capital for exploration and development.



SOURCES OF TANTALUM SUPPLY

Tantalum source materials are produced by mines operated specifically to obtain tantalum containing minerals, tin mines from which tantalum source materials are obtained as concentrator co-products, tin smelters producing slags which contain tin, and old tailing dumps which can often be reworked to recover tantalum unwanted at the time they were developed. The following chart shows the sources and the movements of the various materials to the processors who extract tantalum from the minerals (see chart at the foot of page 3).

The few large mines producing tantalite and columbite are independent of tin production. There are also a number of small mines which usually produce tantalite in conjunction with other metals and minerals, e.g. beryl. In some areas, individuals hand-pick tantalite and microlite from exposed surface deposits. Although the large miners can sell directly to merchants or through agents, there are many collectors who periodically visit the producing areas to buy the output of the small producers. These collectors, generally associated with merchants, accumulate enough material to make lot assays and shipments.

The tin mining community is similarly divided by size. Large miners have their own concentration plants, and during processing separate recoverable tantalite out of the tin ores. Small miners who cannot afford concentration facilities utilize custom processors who collect enough tin ore from many small miners in an area. These concentrators also generate tantalite and columbite from the tin ore.

There is always residual tantalum in tin concentrates, as complete separation by ore dressing methods cannot be effected. In addition, some concentrators are not equipped with the additional facilities needed to recover the tantalite. Thus, upon smelting, the tantalum is separated from the tin and is a residual element in the slag. Depending on the amount of tantalum in the ore and the proportion removed, tin smelter slags will vary in tantalum content from as little as 1 % to as much as 30 % or more. The high extreme is rare, however, and the great bulk of tantalum bearing slags varies from about 1.8 % to 15 %.

Most tantalum source material is sold to merchants and agents, as the various producing sources are not set up to market their products directly to the processor. Generally, processors are not prepared to handle the sampling and shipping arrangements which can be routinely managed by the merchants. However, there is a small portion of the material purchased directly by processors, particularly those in Japan.

Raw material sources in 1977 by geographic distribution are shown in the following chart. Tin slags account for 52 % of the total. The combination of tin slags, tantalites, and columbites from southeast Asia and Australia amounts to 53 % of the total. The combination supply from Africa is another 20 %, leaving only 27 % from all other sources.

SOURCE COUNTRIES
1977-1980

SIZE	TIN SLAGS	TANTALITE & MICROLITE	COLUMBITE (Less than 10% Ta ₂ O ₅)
LARGE PRODUCTION	Malaysia Thailand } 80%	Canada Brazil Mozambique } 65%	Nigeria — 100%
MEDIUM PRODUCTION	Nigeria Australia } 9%	Australia Thailand } 15%	
SMALL PRODUCTION	Belgium Brazil Rhodesia South Africa Spain Zaire } 11%	Malaysia Nigeria Portugal Rhodesia Rwanda South Africa Southwest Africa Spain Zaire } 20%	

RECENT PRODUCTION, 1973-1976

As a result of thorough research work done for the Phase II study of the T.I.C., the production of usable tantalum source material from 1973 through 1976 has been found to be :

WORLD WIDE TANTALUM SUPPLY
(m.t. cont. Ta₂O₅)

SOURCE	1973	1974	1975	1976
Tin slags	608	593	506	624
Tantalites	440	497	502	499
Columbites	58	16	14	27
Total all sources	1,106	1,106	1,022	1,150

Some key factors affecting the production in those years included :

- Tin slags containing less than 3.5 % Ta₂O₅ were not used as source materials in the period of 1973 through 1975.
- Tin slag production during the same years reflects the drop in tin production due to the imposition of export controls in later 1974 and during 1975. Relief in the tin market occurred during 1976, however, and slag production increased to the 1973 level.
- The production of tantalites responded in 1974 to the rapidly rising market price by increasing 13 %. The reduced level of market demand during 1975 then caused production to stabilize.
- Although tantalite output appears stagnant through 1976, labor problems at one major producer actually reduced output while other producers were responding to the recovery from the recession.

FORECAST PRODUCTION, 1977-1980

The same research by producer has produced a forecast for the years 1977-1980 :

WORLD WIDE TANTALUM SUPPLY FORECAST
(m.t. cont. Ta₂O₅)

SOURCE	1977	1978	1979	1980
Tin slags	652	674	676	688
Tantalites	554	566	568	541
Columbites	41	50	50	50
Total all sources	1,247	1,290	1,294	1,279

The 1976-1980 production forecast shows an increase from 1,150 m.t. to 1,279 m.t. if market prices remain at current levels. This is based on an implicit assumption that tin output will rise 1.8 % per year through 1980. After 1977, tantalite production shows no significant growth. Since only 25 % of the tantalite produced is a co-product of tin concentrates production, the slow growth in the tin market is not the primary cause of stagnation. The main inhibitor is the lack of new reserves available to current producers. The total increase in tantalum supply from all current sources from 1973 through 1980 will be at an average annual rate of only 2.1 %. In view of a 200 % price rise during the past four years, this demonstrates again the tantalum price insensitivity. This is to be expected, because 64 % of the tantalum raw materials are co-products or by-products of tin production, which makes it impossible to increase output because of tantalum price alone.