

T I C

TANTALUM-NIOBIUM INTERNATIONAL STUDY CENTER

PRESIDENT'S LETTER

The demand for tantalum and niobium products continues to increase, influenced both by significant growth in the markets for telecommunications, computers, automotive and consumer electronics, and by recovered economic conditions in Asia, notably Japan. Also new technologies and new electronic applications are requiring increased usage of tantalum and niobium products.

The organisation committee for Symposium 2000 has made tremendous progress in a very short time. Technical papers are being selected and in March 2000 all the authors and presenters will be notified as to the details of abstracts and programme printing.

A detailed update of the Symposium 2000 will be presented at the next Executive Committee meeting in Brussels on April 4th 2000.

Please mark your calendar now and plan to attend Symposium 2000, October 22nd-25th 2000 in San Francisco, California, U.S.A.

Charles Culbertson II
President

OBITUARY

Mr Hiroshi Tashiro

The T.I.C. learned with great sadness of the death on February 24th 2000 of Mr Hiroshi Tashiro, Chairman of H.C. Starck-V Tech. Mr Tashiro was the T.I.C. delegate of this company from 1986 when it became a member, as V Tech Corporation, until 1997 when he was appointed Chairman. He attended many meetings of the association, taking an active part, and was well known and respected in the T.I.C. and in the industry. We shall miss him.

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SYMPOSIUM 2000

The next International Symposium on Tantalum and Niobium will be held at the Grand Hyatt Hotel in San Francisco from October 22nd to 25th 2000. This will be another milestone for the industry, following the successful conferences in Goslar, Orlando and Rothenburg-ob-der-Tauber.

Recent developments, future directions for research, trends in commercial products – all these will feature in a full programme rounded off by a visit to a plant in nearby Silicon Valley. Speakers will be drawn from companies engaged in raw material production, processing and manufacturing, as well as institutes involved in academic and applied research. The manufacture of products for electronics will be covered thoroughly, as it is a mainstay of the tantalum industry. The widening variety of applications for niobium as well as the staple product, ferroniobium, will be discussed.

As well as the technical presentations, the General Assembly of members of the T.I.C. will be held, on the morning of October 23rd, when applications for membership can be accepted.

The welcome reception will be hosted by Kemet Corporation. And the host for the gala dinner will be the H.C. Starck group of companies.

The detailed programme and information on booking will be sent out to the nominated delegates of T.I.C. member companies, and also to those who have already expressed interest in this event by contacting us. If you have not yet been in touch with the T.I.C., why not do it now – don't miss your chance of attending this major conference for everyone in niobium and tantalum.



It has to be ... San Francisco

THE FUTURE ROLE OF TANTALUM CAPACITORS IN MOBILE PHONES

by Mr Søren Kjaer, Senior Component Engineer, and Ms Merja Kangas, Technology Component Engineer, Nokia Presented at the meeting of the T.I.C. in Perth, Western Australia, October 1999

Within the next decade cellular telephones will outnumber traditional landlines, forecast a report by the United Nations released recently. Already in a handful of countries, some rich, some poor, cellular phones have moved ahead. By the beginning of 1999, the world had about 319 million users of mobile telephones, 27.5 per cent of the world's total lines. In 1990 there were just 11 million users, but by 1999 the number was near 400 million, said Tim Kelly of the International Telecommunication Union (ITU).

NEW USERS

Mobile phones are expected to capture future communications users. In Finland in 1998, mobiles accounted for 51 per cent of all telephone lines, and one out of five households no longer had a fixed telephone line. In Cambodia, 72 per cent of subscriptions were on mobile phones. In Rwanda, cellular phones account for 58 per cent of the market.

The Finns, who have been leaders in the development and manufacture of cellphones, have been further spurred to take up mobile connections by aggressively low pricing. Cambodia and Rwanda, both of which have suffered from internal conflict, had much less extensive fixed networks than European countries to begin with. In Cambodia it is far easier and less dangerous to put up cellular antennae than to run phone lines across terrain strewn with land mines. South Korea and Italy are other examples of other countries where cellphones are moving ahead.

By 2010, at the latest, the ITU sees cellular networks overtaking traditional ones throughout the world. They have potential both in rich countries and in nations where telephone networks were never fully developed, are subject to long waiting lists, or have been damaged by conflict. Cellphones could overtake landlines as early as 2001, but most probably by 2006-7, Tim Kelly said.

In Lebanon, the government – which owns the fixed network – has limited further mobile growth because cellular 'is challenging the viability of fixed lines', the ITU reported.

But in the United States incompatible cellular systems and other factors – including free local calls on fixed lines – have held back mobile growth, noted the report. In 1998, some 28 per cent of US telephone subscribers were on cellular phones. However, the country is still the world's largest cellular market, with some 69 million subscribers.

While cellphones are growing at a rate of 20 to 30 per cent a year in the United States, other countries are moving faster. For example, mobile subscribers in France doubled last year. Prepaid mobile services are helping to speed the cellular revolution, the 190-page study said. With this system, the chip inside the phone comes loaded with a number of calling units that can be replenished as needed without the caller having to have a monthly subscription. Italy leads the way in prepaid cellular services, which account for three-quarters of its cellular users. Mexico, with 60 per cent, is close behind. And the simpler system is proving increasingly popular in developing Asian countries such as Indonesia and the Philippines.

Call prices for both mobile and land-based calls are falling at an average rate of around 4 per cent a year, although reductions in international call prices have been greater. While almost 100 countries have a competitive mobile market, less than a third of that number have similar competition in basic telephones. The report noted that companies specialising in cellular services appear to be charging generally lower rates, 'following a more aggressive business strategy', than those which have a fixed-line business. (AP)

INTRODUCTION

GSM

The future GSM phones will require high capacitance, low ESR, low profile tantalum capacitors. The reason for this is that more and more phones will be able to support HSDC, which means that they will be utilising multislots transmission.

Tantalum capacitors in mobile phones are most widely used directly on power lines, and for GSM applications especially in conjunction with the RF Power output. Especially for this application we need as low ESR value and as high capacitance value as possible. Looking at the usage of tantalums in GSM applications, the trend is for smaller packages such as 0603 and 0805, typically in the 2 μ 2 to 47 μ range. Low profile high CV products with low ESR in smaller/thinner packages are required, also highly reliable parts robust enough to withstand surges.

WCDMA (3G)

Looking at the usage of tantalums in future 3G Wideband CDMA applications, there will be more focus on smaller CV products such as 2 μ 2 to 47 μ . The focus should be on the small size 0603/0805 tantalums, as we believe them to be the market drivers.

As far as Nokia is concerned, the perfect tantalum capacitor has these properties:

- High CV
- High reliability, no field failures in finished products
- No derating required
- No burning, total safety
- ESR in the range of 10-40 m ohm
- Low profile
- Low price
- ... and comes in an endless supply!

SHAPING THE FUTURE

Nokia strives for leadership in the most attractive global communications segments. Net sales in 1998 amounted to 79 231 million Finnmarks, a 51% increase over 1997.

Nokia's ambitions are to be the world leader in wireless handsets, first or second in wireless systems, a leader in Internet solutions, and a leading company in multimedia terminals and high performance, large screen display products.

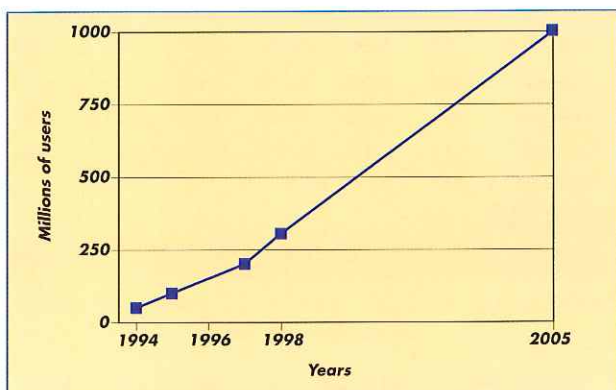
Of Nokia's employees, 30 per cent are in research and development, and expenditure in 1998 in this field was 6.8 million Finnmarks, or 8.6 per cent of net sales, whereas in 1994 it was just under 2 per cent. The company has a global network with 44 R&D centres in 12 countries. Over 13 000 people were employed in R&D at the end of 1998. The Nokia Research Center is the corporate R&D unit of Nokia.

Nokia had over 44 000 employees at the end of 1998, 9819 of which had been newly recruited during that year. A recent employee opinion survey was encouraging, showing improvements in all categories. Nokia has competitive compensation and benefits programmes: the Nokia 'Connecting People Bonus' will be paid at its maximum – 5% of annual base salary. Nokia has thousands of new opportunities available globally in 1999.

Nokia has a global market presence. Its biggest markets are in the US and China, and Nokia is the leader in digital wireless in the US. The company is increasing its manufacturing capacity in Finland, Germany, Hungary and Mexico, and in China, where it has a sound base with local manufacturing and R&D. Nokia is also at the forefront of third generation development in Japan. Net sales in 1998 were 79.2 million Finnmarks with the market being split 58% Europe, 21% Americas, 21% Asia-Pacific.

Nokia had a record year for operating profits in 1998, rising from approximately 3.75 million Finnmarks in 1994 to a high of nearly 15 million Finnmarks in 1998.

As wireless growth continues, 'Brand' is becoming increasingly important. At the end of 1998 Nokia had 305 million subscribers with an annual sales volume of 163 million units. Strong growth continued in 1999 in all regions, with a projection of 1 billion subscribers in the year 2005. The consumer market is the volume driver. Personalisation and brand will make a difference. The upgrade market accounts for 40% of sales with product portfolio and distribution management increasing in importance.



The growth in the world market

Nokia is already 'number one' in the wireless handsets market. Net sales in 1998 were 48 billion Finnmarks, and the company employs 18 600 sales personnel. Nokia is the world's largest manufacturer of mobile phones. The company has a product portfolio covering all main standards and consumer segments

in the world. It has eight factories in seven countries which have so far produced over 100 million phones. Nokia has sales in over 130 countries and is the market leader in wireless data products and solutions. The company also had a leading role in the foundation of industry initiatives such as WAP, Symbian and Bluetooth.

The Internet and wireless are major drivers in converging digital industries. Nokia is concentrating on the access element of the IP networks by creating services and added value for customers. It is the leader in wireless data solutions. Currently, media phones with Internet capability are rapidly emerging. Nokia is strengthening its competence through acquisitions and partnerships such as Vienna Systems Corporation and Ipsilon Networking, Inc.

	Net sales (million FIM)	Personnel
Americas	16700	6800
Europe	44000	32000
Asia-Pacific	16900	5600
TOTAL	79231	44543

Nokia worldwide, 1998

Comparing the penetration of global major markets, it can be seen that by April 1999 cell phones accounted for over 50% of the market in the Scandinavian countries and Israel. Japan has 35% of its market taken by cellular phones, the US and UK have around 27%, and the People's Republic of China a small but none the less increasing 2%.

SUMMARY

- The mobile phone industry is still very young and its influence on our lives will continue to grow.
- Any business that continually gives better performance at a lower cost year after year must be attractive to the end user.
- The lifecycle for these products is getting shorter, not because they are less reliable than earlier products but because they are outdated by changes in technology.
- Each generation has more features and functions than the previous one, placing more demands upon designers and component suppliers.
- Only by meeting these demands and creating new products can component suppliers continue to contribute to long term growth.

PLANT TOUR - Wodgina



The group - visitors and Gwalia staff (With thanks to Janis Studer for photograph)

PRODUCTION OF NIOBIUM AND TANTALUM FROM THE PITINGA HARD ROCK TIN MINE

by Mr Jorge Jose Correia Salles, Marketing and Strategic Planning Manager, Paranapanema
Presented at the meeting of the T.I.C. in Perth, Western Australia, October 1999

The Paranapanema Group was formed in 1996 by a merger of Paranapanema with three other Brazilian companies, under the shareholding control of a pool of pension funds. It now has four business units, the Tin, Copper, Zinc and Copper Products Divisions. The Tin Division includes Mamoré Mineração e Metalurgia as well as Mineração Taboca, Ebasa, and Paranapanema International Inc. The group is one of the world's largest tin producers, the sole Brazilian copper producer and the second largest Brazilian zinc producer.

Paranapanema began its mining activities in 1965. In the 1970's it developed its alluvial cassiterite concentration technology, and also initiated tin metallurgy producing high grade tin and tin alloys. During the 1980's it consolidated its position as one of the largest tin producers in the world, based on the massive volume and high purity of its ore reserves. It operated a consistent technology development policy and an aggressive marketing strategy, including the operation of trading offices in the U.S.A. and Europe.

The Tin Division produces tin products, tantalum and niobium products, and industrial minerals – graphite, barytes and vermiculite. In 1998 tantalum and niobium represented 9.1 per cent of the revenues of the Division. The annual income in 1998 was US\$97 million, and in 1999 it was US\$95 million. Mining operations at Pitinga produced 9931 t tin and 2900 t niobium in 1998, while in 1999 the production was 9300 t tin and 3500 t niobium.

Recently Paranapanema entered the niobium and tantalum market through the commercialisation of a ferro-niobium-tantalum alloy. The metallurgy division, with 267 employees, produced 1482 t ferro-niobium-tantalum in 1998, and 1823 t in 1999. The ratio of Nb₂O₅ to Ta₂O₅ is about 10:1.

The concentration scheme at Pitinga, in the State of Amazonas in the north-east of Brazil, works on both soft rock and weathered rock. Mobile plants and dredges are used to pre-concentrate the soft rock, and the pre-concentrated ore from weathered rock and soft rock is fed into the gravitational plant UBM-1. Middlings from this plant and also from treatment of coarse tailings by the gravitational concentration plant UBM-4 are fed into the electrostatic electromagnetic concentration plant UBM-3. This plant separates cassiterite concentrate from the columbite concentrate containing niobium and tantalum oxides. The coarse tailings are treated by a ball mill, vibrating screen, spirals and tables. The resulting middlings, with those from UBM-1, are deslimed, filtered and dried. Electrostatic treatment separates the non-conducting zirconium and yttrium oxides and silica, and gathers the tantalum, niobium, tin and iron oxides together. They pass through magnetic separation which leaves the iron compounds as tailings, and produces the concentrates of columbite and cassiterite (see Figure 1).

www.tanb.org

e-mail to tantniob@agoranet.be

Current sources of niobium and tantalum show that the columbite contains 17 737 t of Nb₂O₅ and 1846 t of Ta₂O₅, with the oxides recovered from tin slag, the amounts are 28 657 t and 3876 t, respectively (see Table 1).

Sources	Nb ₂ O ₅	Ta ₂ O ₅
Current sources:		
Weathered ore	6 207	734
Coarse tailings	8 360	798
Soft rock	3 170	314
Subtotal: columbite	17 737	1 846
Tin slag	10 920	2 030
Subtotal with slag	28 657	3 876
Additional source:		
Hard rock (*)	156 100	19 600
Total	184 757	23 476

*Only proven and probable reserves included

Table 1: Sources (current and with hard rock) of niobium and tantalum: recoverable oxides contents (t)

The geological resources and mineable reserves of Pitinga are shown in Table 2.

Geological resources						
	Mt (000)	%Sn	%Nb ₂ O ₅	%Ta ₂ O ₅	%U ₃ O ₈	%ZrO ₂
Measured	164	0.141	0.202	0.024	0.031	0.796
Indicated	260	0.098	0.173	0.019	0.036	0.801
Inferred	194	0.082	0.169	0.018	0.043	0.845
Subtotal	618	0.104	0.179	0.020	0.037	0.813
Potential	568					
Total	1 186					
Mineable reserves*	201	0.176	0.223	0.028	0.030	0.808

Ore/Waste = 0.31

* Drilled - for the first 15 years (proven & probables)

Table 2: Hard rock potential

The hard rock project flowsheet (see Figure 2) outlines the methods by which the products are obtained from the ore. After crushing and grinding of the ore and pre-concentration, a concentrate containing the tantalum and niobium is separated from the cassiterite. This concentrate can be treated by aluminothermic reduction to produce the ferro-niobium-tantalum alloy which can be marketed. Alternatively, it can be attacked with hydrofluoric acid and after solvent extraction the oxides are produced, as another marketable commodity.

The last two lines of Table 1 indicate the large increase in source material available at Pitinga when the hard rock is included in the recoverable oxides.

The routes for production of niobium and tantalum from columbite concentrate and by recovery from the tin slag are shown in Figure 3. Carbothermic reduction of the columbite concentrate gives an alloy containing tin, which is used to obtain that metal in another part of the plant, and niobium/tantalum pre-reduced slag (NTPRS). The NTPRS is reduced aluminothermically to give a niobium/tantalum steel alloy (NTSA) which is a product sold by the company. As noted above, the columbite concentrate can be treated directly by aluminothermic reduction to make Fe-Nb-Ta alloy, either for sale or for further treatment to produce oxides.

If the tin slag contains sufficient niobium and tantalum, the tailings can produce a niobium/tantalum carbide (NTC) by carbo-

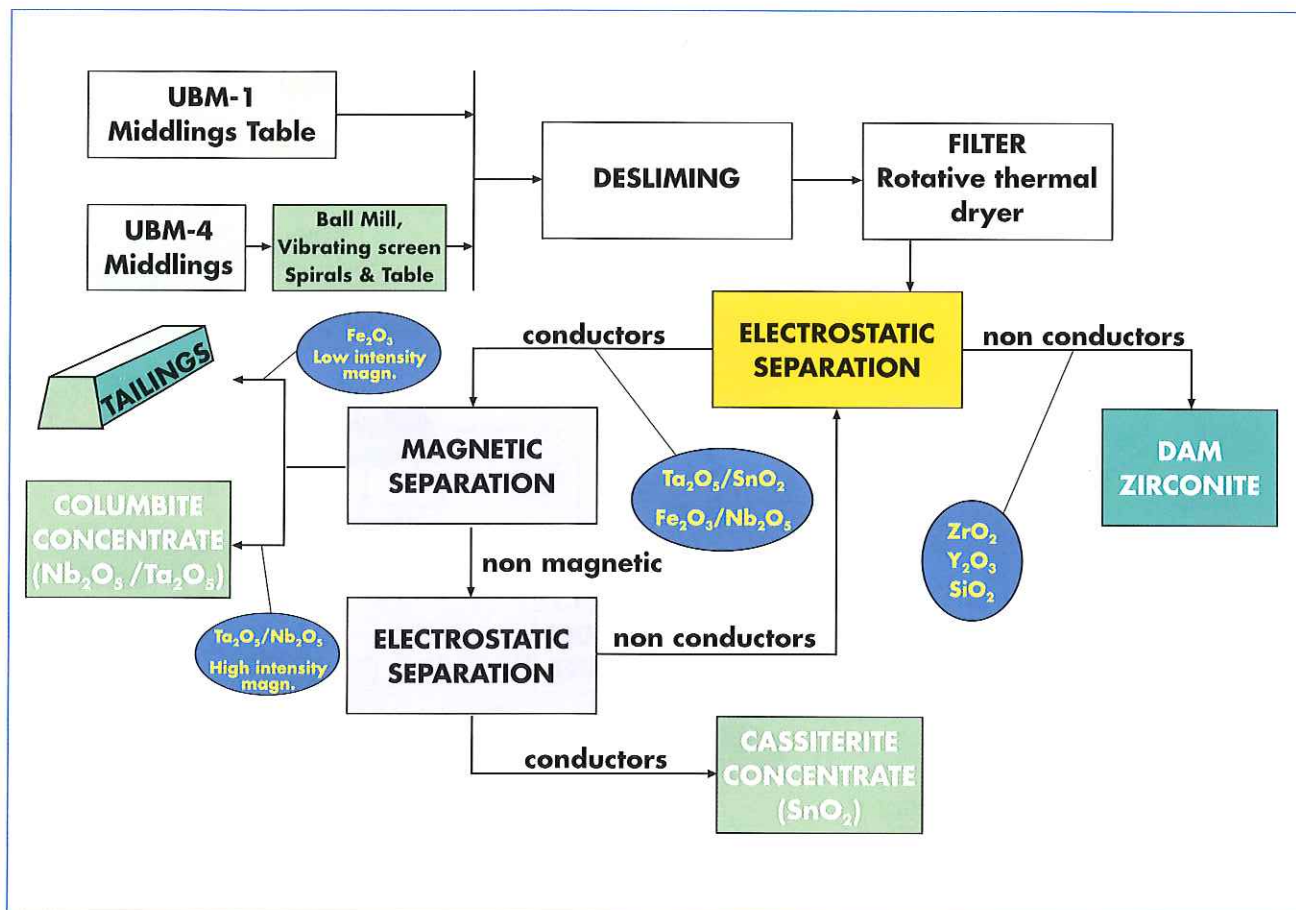


Figure 1: Flowsheet of the electrostatic electromagnetic concentration plant

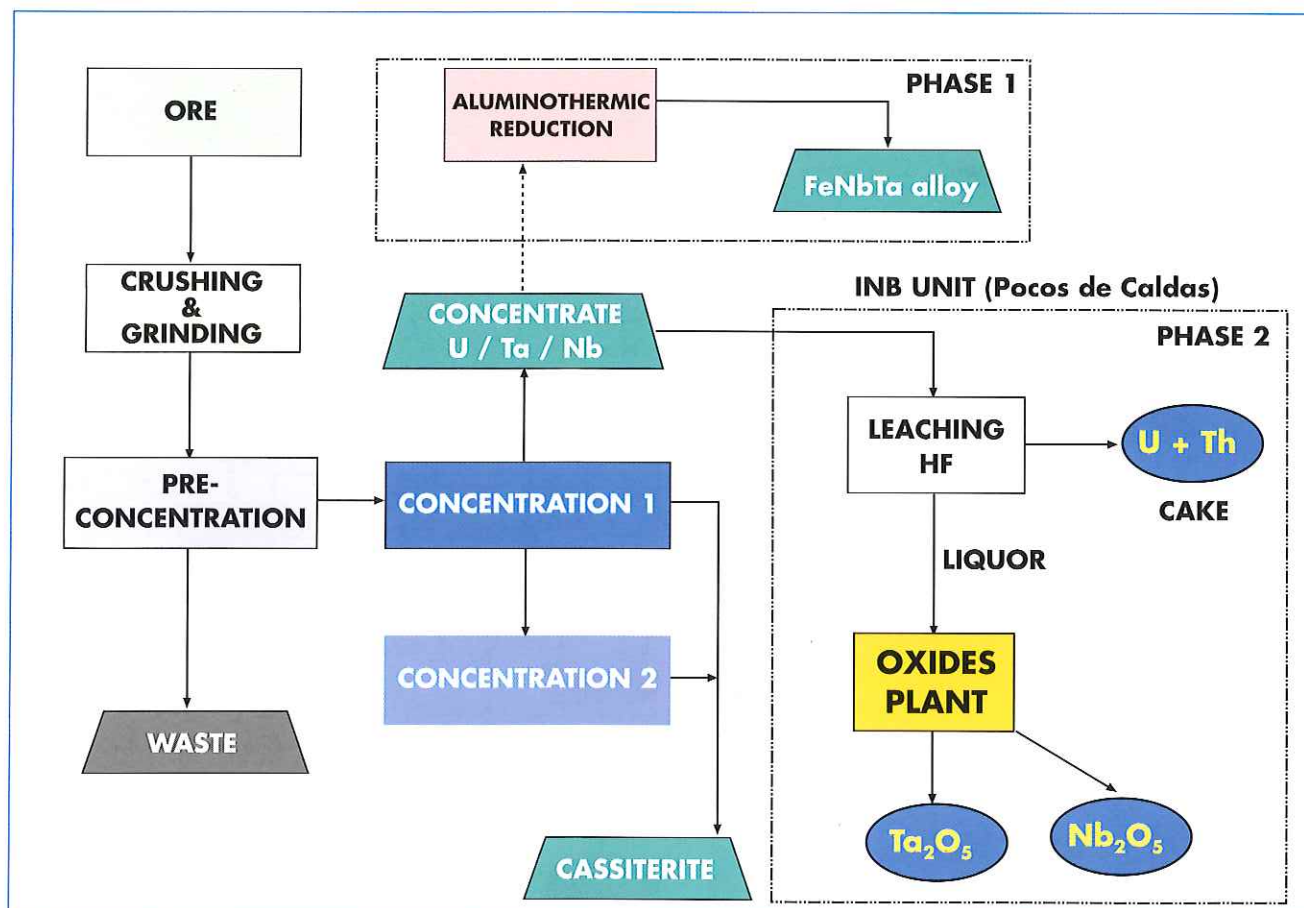


Figure 2: Hard rock project flowsheet

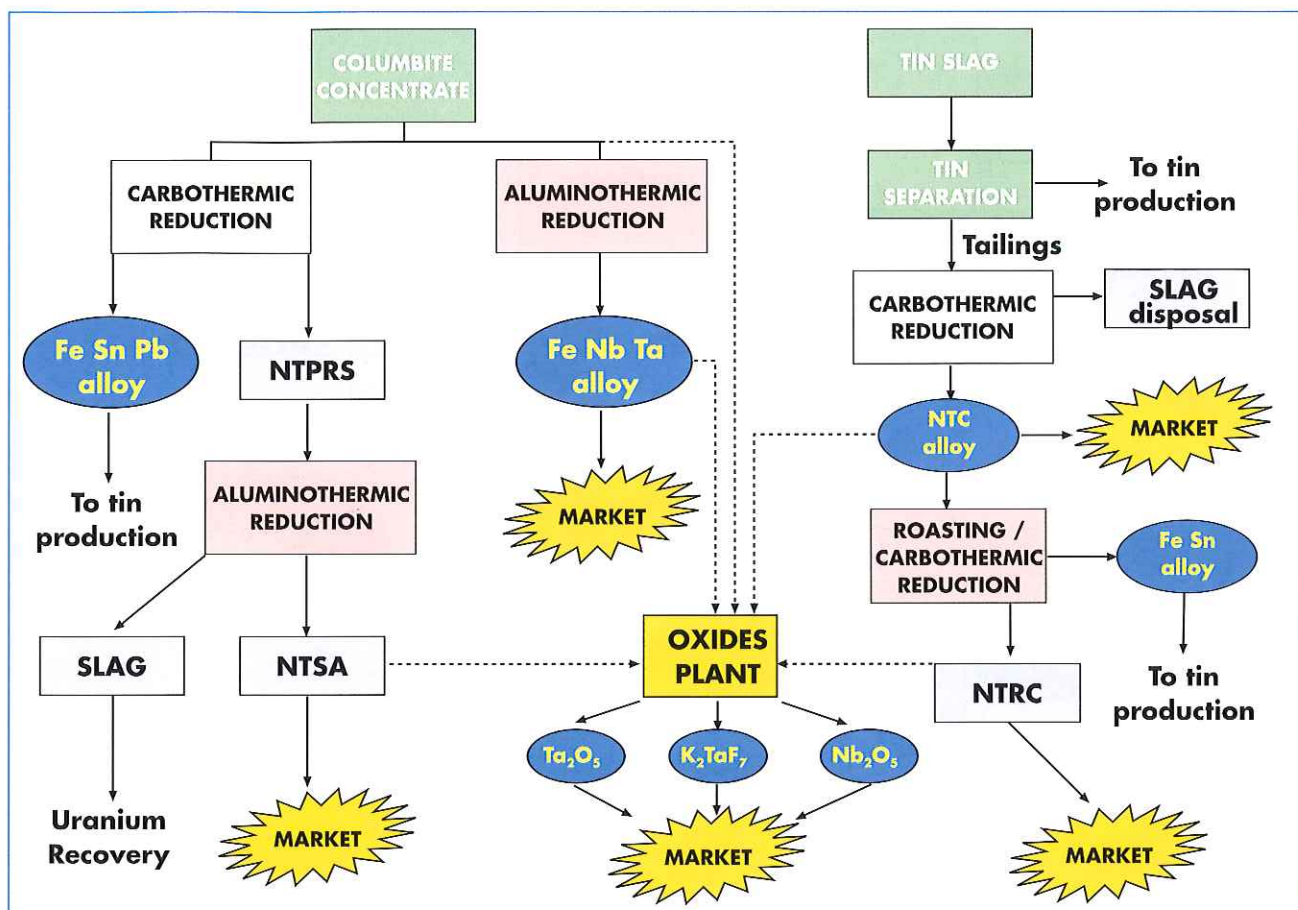


Figure 3: Routes for Nb/Ta production

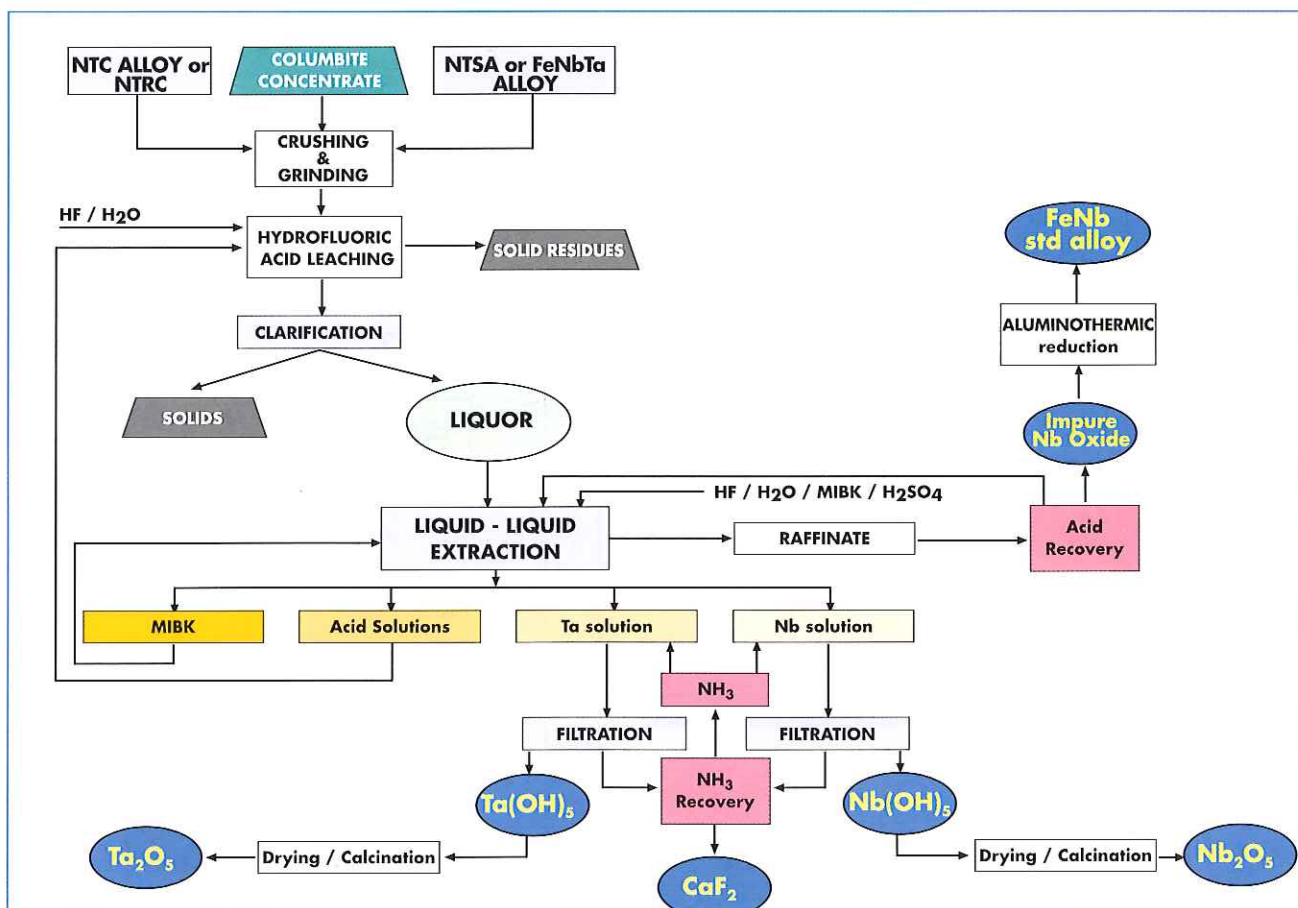


Figure 4: Tantalum/niobium flowsheet – oxides plant

thermic reduction. This may be fed into the oxides plant, or roasted and reduced again to niobium/tantalum rich concentrate (NTRC), which is either an end-product or feed for the oxides plant.

The characteristics of the various products containing niobium and tantalum are shown in Table 3, as percentages. The 10:1 ratio for niobium to tantalum is clearly shown in the alloy products. More tin is left in the niobium/tantalum carbide alloy than in the other products. The proportion of uranium and thorium is suitably low for saleable material.

	FeNbTa	NTSA	NTC alloy	NTRC
Nb	42-48	57-64	25-35	45-55
Ta	4-4.5	6-8	6-9	7-11
Sn	4.5-5.5	0.5-1.5	5-10	0.5-1
U	<0.07	<0.1	<0.08	<0.08
Th	<0.04	0.1	0.05	0.05
Sb	<0.02	<0.02	<0.02	<0.02
R	9.5-12	7.5-11	3.5-5.5	4-7

Table 3: Characteristics of niobium/tantalum products

To produce niobium/tantalum steel alloy, the columbite concentrate is mixed with charcoal and flux for charging into an electric arc furnace. An alloy of iron, tin and lead drawn off is used for tin production, and the Nb/Ta pre-reduced slag by-product is crushed and ground: after magnetic separation any remaining tin is sent to the tin production plant. The slag which still contains niobium and tantalum is reduced aluminothermically: the niobium/tantalum steel is left as a block, which is then crushed and either used to produce oxides, or sold.

Tin slag can also be used to produce niobium/tantalum carbide. The slag is first crushed and ground, and it passes over shaking tables so that tin and tin alloy materials can be removed for tin production. The detinned slag is mixed with coal and flux before being heated in an electric arc furnace. The carbide block which leaves the furnace is crushed and ground and subjected to magnetic separation to leave a niobium/tantalum carbide product which can be marketed. If this product is kept by Mamoré, it is roasted and again treated in an electric arc furnace to remove any tin alloy, then the niobium/tantalum rich concentrate becomes a final product for sale or a feed for the oxides plant.

In the oxides plant, the various intermediate products – carbide alloy, rich concentrate, columbite concentrate, steel alloy or ferro-niobium-tantalum alloy – are crushed and ground to give particles of an appropriate size to be efficiently attacked by hydrofluoric acid. After filtering, liquid-liquid extraction with MIBK is operated to separate the tantalum and niobium compounds. Neutralisation by ammonia gives the hydroxide of each metal, and final calcination results in tantalum pentoxide and niobium pentoxide. The full scheme is shown in Figure 4.

Mamoré Mineração e Metalurgia, as part of the Paranapanema Group, looks forward to continuing to supply tantalum and niobium to the market.

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MEMBER COMPANY NEWS

AVX

The web site at avxcorp.com includes a large amount of information, especially in the section on Technical Papers. A basic paper on the general manufacturing techniques for solid tantalum capacitors appears among these papers: it purports to be destined for 'the lay person' but nevertheless it covers the process in considerable detail.

Cabot Performance Materials

Cabot Corporation, of which CPM is one of five 'reportable segments', announced an increase in both net earnings and operating profit for the quarter ended December 31st 1999 over the comparable quarter in 1998. Mr Samuel W. Bodman, Chairman and CEO, commented that the performance for the quarter was encouraging, and that the tantalum business, CPM, along with two other segments, achieved 'greater year-over-year volumes and earnings'.

The company's announcement in January 2000 added 'The tantalum business contributed an incremental US\$3 million in operating profit year-over-year. Strong demand in the telecommunications and electronics sectors resulted in increased demand for tantalum capacitors'.

Cambior

Cambior reported niobium production for the fourth quarter of 1999 as 279 tonnes, bringing total production for the year to 1147 tonnes. Its target for 2000 is 1180 tonnes, based on current estimates of production programmes.

Cluff Mining

On the web site of Cluff Mining, this information appears: 'In November 1999, Cluff acquired a 49.9% interest in Niobium Resources BV, and the latter firm has a 70% interest in Somima, a Gabonese registered company which holds the mineral and mining rights to the Mabounié niobium deposit in Gabon.

The Mabounié niobium carbonatite deposit has a resource delineated of 14.8 million tonnes at a grade of 1.69% Nb₂O₅ using a cut-off of 0.3%. Preliminary ore processing testwork in a mini-pilot project has demonstrated that it is possible to concentrate the pyrochlore and produce niobium concentrate.

'During 2000, a full pilot plant test using a bulk sample of 1200 tonnes of representative ore to allow completion of the final cleaning stages to produce saleable or usable concentrate will be undertaken. When in production, the project is expected to produce approximately 6000 tonnes of ferroniobium containing 4000 tonnes of Nb per annum.'

Epcos

Epcos has announced an increase in prices of its tantalum chip capacitors, it has been obliged to follow this course because raw material prices have increased, and because yield is reduced when the specified powder for the application can not be obtained. However, its market position will be improved once its production capacity is extended in October 2000, when a new A/B line and a new D/V/E line will be available, it commented.

Gwalia

In its report on the quarter ended December 31st 1999, Sons of Gwalia announced record tantalum production for the quarter – 285,702 lb, which would give an annualised rate in excess of 1.1 million lb. Production at both the Greenbushes and Wodgina mines had increased, with a threefold increase at Wodgina following the commissioning of the new processing plant (seen by the visitors from the T.I.C. meeting in October). An underground Feasibility Study in respect of the Greenbushes Tantalum Mine was nearing completion. The increased production levels had contributed to financial results for the period July-December 1999 which exceeded the company's forecasts.

Sales from the two tantalum mines totalled a record 455 000 lb for July-December 1999, and the company estimated total production for the year to the end of June 2000 would be 1.1-1.2 million lb, all of which would be sold under long term contracts to its two major customers. It was noted that demand for tantalum continued to increase, primarily driven by the requirements of the electronics industry.

Heraeus

The Heraeus Group, including T.I.C. member W.C. Heraeus, closed 1999 with a sales increase of 11.5% over 1998, according to preliminary sales figures. Final figures are due to be reported in the annual report at the end of April 2000.

Hitachi AIC

On its web site at hitachiaic.co.jp, the company includes a technical paper with a wealth of information, description of the products in general, and considerations on selecting tantalum capacitors for the purpose required.

Kemet

In January 2000 Kemet Corporation reported record net sales for the second consecutive quarter, net sales were US\$215.1 million for the quarter ended December 31st 1999, compared with US\$141.9 million for the same quarter of 1998. Kemet achieved record shipments and bookings in this period as the growth momentum for both tantalum and ceramic capacitors continued to build, stated Mr David Maguire. Continuing capital investments have enabled the company to move quickly in adding new capacity to meet customers' needs, as shown by its commitment in opening world-class facilities such as the Ciudad Victoria, Mexico, tantalum plant which began production in December, he continued. Strong earnings reflected improving margins as average selling prices returned to more normal levels and manufacturing efficiencies increased, added Mr Maguire, and he described his company as excited about the robust growth period it had begun, which provided opportunities for the present and fuelled long-term health for its business. Net sales of both surface-mount and leaded capacitors had increased over the same quarter of 1998, and exports had increased considerably, led by improving sales in both Europe and Asia.

Reference Metals

The most recent technical improvement in the ferroniobium production line of the mine site of parent company CBMM is the installation of a robot to speed up the special packaging sector. With the help of this robot, the weighing and packaging of 7-17kg cans and sacks has gained in speed and precision. The entire packaging sector for 200kg drums and 1 tonne sacks has been automated, improving efficiency and productivity in the processes of weighing, calibrating and palleting.

Seco Tools

The company reported a 'strengthened operating margin' during the fourth quarter of 1999. Demand in Europe stabilised towards the end of the year, while development in the US and Asia remained positive, it said. Also it was strengthening its position through a number of acquisitions. For 2000 a continuing improvement of the business climate is foreseen, and a programme of rationalisation will continue.

In December 1999 Seco Tools moved to acquire the French company EPB S.A., based in Bouxwiller, near Strasbourg.

Special Metals Fabrication

Mr Andrew Towey has taken over the position of Managing Director from Mr Graham Russ, who has moved to another company, and has become the T.I.C. delegate.

Vishay Sprague

In February 2000 Dr Felix Zandman, Chairman and Chief Executive of Vishay Intertechnology announced that net earnings in the fourth quarter of 1999 were a record US\$36 million for the group. 'Business continues to be strong, particularly in wireless communications market where we sell 35% of our products, driven by cell phones', he said. Capacity in major product lines is being increased to meet continuing demand.

REPORTS

The T.I.C. has contributed the reports on tantalum and niobium which will form part of the Financial Times' new publications 'Executive Commodity Reports'. These are substantial and comprehensive reviews, much more than short journal articles. Fax to +44 20 7896 2275 for an order form to buy copies from FT.

The chapter on tantalum in 'Minor and Specialty Metals Databook' was also contributed by the Technical Promotions Officer on behalf of the T.I.C. The book is available from Metal Bulletin Books Ltd, Park House, Park Terrace, Worcester Park, Surrey KT4 7HY, England, fax +44 20 727 6425.

The chapter 'Economics of Tantalum' for the new edition of the 'Handbook of Chemical Industry Economics: Inorganic' has been prepared on behalf of the T.I.C. by Dr John Lambert. This book is published by John Wiley & Sons.