TANTALUM

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Tantalum was discovered in 1802 by Anders Ekeberg in mineral samples he collected in Finland and Sweden. He proposed the name tantalum after Tantalus, a character in Greek mythology, due to the difficulty of defining the chemical nature and other properties of the element. The metal was first prepared in a relatively pure form in the early 1900s, when filaments of the metal were used in incandescent light bulbs.

The major use for tantalum today is as the anode in a capacitor. It was not until the 1940s that the development of a "wet" capacitor, utilizing a tantalum anode and cathode, created a market for this element. Replacement of the gelled sulphuric acid electrolyte with manganese dioxide led to the "solid" capacitor. The chip-type capacitor design of the 1980s for tantalum capacitors led to widespread use in computer, telecommunications, automotive, and consumer electronics circuitry. This single application consumes about 60% of all tantalum processed in the world today. Specific tantalum products consumed in the capacitor manufacturing are tantalum powder and tantalum wire. Capacitor processing steps also require the use of fabricated furnace hardware of tantalum, such as heat shields, sintering trays, and thermocouple wells.

Tantalum finds use in high-temperature alloys for both air- and sea-based propulsion systems as well as land-based turbines for power conversion. The element is also used in high refractive index optics, sputtering targets for the "laying down" of a very thin film of either tantalum metal or the oxide, chemical processing equipment, and electronic chemicals. Medical applications are based on the total inertness of the metal to body fluids, thereby permitting its use in hip and knee replacement fixtures as a "sponge-like" material that supports bone growth, as well as in plates, screws, surgical clips and as components in pacemaker designs.

Tantalum powder shipments in 2000 show a 34.2% increase over the quantities shipped in 1999. Total demand for tantalum across all segments increased 28.7% over 1999. This unusually high growth rate resulted in some raw material shortages, followed by the escalation of non-contracted, spot market raw material prices beginning in the September quarter of 2000. A downturn in those same prices followed by the very end of 2000 as it became recognised that the shortage was partly due to excessive product inventories in the capacitor supply chain, up through and including cellular telephones at all major manufacturers.

The total demand for tantalum in 2000 was 4.927 Mlb of contained tantalum in all of its forms compared with a total of 3.827 Mlb in 1999.

Production

Tantalum ores are found primarily in Australia, Brazil, Africa, Canada, and China. Tantalum is also found in conjunction with cassiterite, an ore from which tin is extracted by a furnace smelting process. Tantalum values are recovered in the furnace slag. Tin slag containing tantalum is generated primarily in Thailand and Malaysia, with smaller quantities generated in Brazil and Africa. The production of tin slag in southeast Asia generated large quantities of tantalum oxide feed stocks in former times. That industry has remained depressed, resulting in low production of new slag. Most of the current slag availability results from reclamation operations from old slag dumps that are slowly being depleted.

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The largest tantalum mining operations in the world are the Greenbushes and Wodgina mines owned and operated by Sons of Gwalia in Western Australia. Published reports show that the output of tantalite from the combined operation of these two mines was 1.307 Mlb of contained Ta_2O_5 in 2000. This was a 37% increase in production over 1999. An expansion of both mining operations to a total of 2.4 Mlb of contained tantalum oxide in concentrates was announced in November 2000 at a cost of A$100 million. Expansion of open-pit mining at both sites as well as the development of underground operations at the Greenbushes facility are anticipated beginning in 2002. The output of these two mines is sold under long-term contracts.

The Tanco Mine in Manitoba Province, Canada, with an annual capacity of about 150,000 lb of tantalum oxide, has been in operation since about 1970. It is currently owned by Cabot Performance Materials. Output is expected to continue for another 10 years based on current reserves. This is a hard rock underground mine.

Last year, it was announced that the Kenticha tantalum mine in southern Ethiopia, operated by state-owned Ethiopian Mineral Resources Development Enterprise (EMRDE), had been sold to MIDROC, a wholly-owned subsidiary of National Mining Corp, a local company owned by Sheikh Mohammed al Amoudi. However, there have recently been unconfirmed reports that completion of the privatisation has not been successful, and that the mine continues to be owned and operated by EMRDE. Production is running at about 120,000 lb of tantalum oxide per year with all output sold by open tender to the highest bidder. Simple gravity-based washing techniques are applied to weathered pegmatite and alluvial ore. There have been no indications of any expansion plans in the near term.

The MIBRA Mine, located near São João del Rei in Rondonia State in Brazil, is owned by Metallurg International Resources. Production is expected to be about 100,000 lb/y. This company has facilities at Fluminese in the same area for processing the ore and extracting tantalum oxide, not only from the MIBRA mine, but also from other small local mining operations as well as from tin slag generated by their smelting of tin ores.

Mamoré Mineração e Metalurgia of the Paranapanema Group operates the Pitinga tin mine in the Amazonas region of western Brazil. This mine produces a cassiterite-columbite middling product, which is converted into a ferro-niobium-tantalum alloy. The alloy is further processed as a raw material source for tantalum and niobium. The tantalum content at 5% contributes about 220,000 lb/y to tantalum raw material supplies. Large stockpiles of tin slag at the Mamore smelter are estimated to contain some 5 Mlb of tantalum oxide at a concentration of 1.6%. Utilization of this low grade source is not anticipated in the near term due to processing difficulties.

There are numerous mining operations in China, the most notable being the Yichun Mine in central China with a capacity of 120,000 lb/y of tantalum oxide. Further expansion of this hard rock mine will require significant capital expenditures and additions of infrastructure. A new mine at Nanping was scheduled to begin production in September 2000 with output gradually increasing to 150,000 lb of tantalum oxide over a three to five year period. Additional production comes from the Altai Region, the Limu tin mine, and the Ma Ar Kan spodumene mine in Sichuan Province.

Central Africa contains significant tantalum resources. The Democratic Republic of Congo (DRC), Rwanda, Burundi, Uganda, Nigeria and Mozambique have all been producers of tantalum concentrates for many years. The deposits are alluvial and eluvial with production going up and down depending on the price of tantalite. Simple mining operations are conducted in all of

these countries, and production could become significant. However, the political unrest and associated financial risk has made investment difficult.

Typical production from this area is estimated at a nominal 300,000 lb/y with the possibility that an annualised rate of 1 Mlb of contained tantalum oxide was achieved during the period of high prices for spot purchases toward the end of 2000.

There have been numerous published reports and investigations by various organisations, including the United Nations, regarding the unauthorised and illegal mining activities in especially the eastern regions of the DRC. Invasion of the environmentally sensitive national parks in this region by military and civilian groups and their involvement in these mining activities has destroyed the habitat of endangered elephant and gorilla species. These protected species have been killed for food by those involved in the illegal mining operations. Efforts are being made by the United Nations to bring a stop to the plundering of these areas through the removal of all military and civilian contingents.

There are numerous "prospects" being carefully examined for their potential economic capabilities and/or limited production in primarily Australia and Canada.

Those currently identified in Australia are Bald Hill and Cattlin Creek in Western Australia (Haddington Resources), Dalgaranga (Australasian Gold/Kemet Electronics), Arthur River, Beryl Hill, Pilgangoora (Kanowna Lights Ltd), and Mount Weld (Anaconda).

Projects identified in Canada are the Pakeagama Lake Pegmatite (Houston Lake Mining Inc.), Lilypad Lakes, Separation Rapids and Raleigh Lakes in Ontario, East Braintree, in Manitoba (Avalon Ventures Ltd), and the Separation Lake Deposit, Ontario (Gossan Resources Ltd).

Evaluation of tantalite prospects in Nigeria is being conducted by Columbia River Resources of Vancouver, British Columbia.

A summary of tantalum raw material production is shown in the following table.

The Processor Receipts show greater availability of tantalum oxide units available for processing than the data on Raw Material Production. These data include mineral concentrate purchased from sales by the Defense National Stockpile Center (DNSC) of the US, as well as mineral concentrates purchased from non-TIC members. The DNSC sold a total of approximately 296,000 lb of contained tantalum in mineral concentrates in 2000 as well as an additional 37,500 lb of tantalum as carbide and ingot.

Consumption

The major processors of tantalum raw materials are H.C. Starck, Cabot Performance Materials, Ningxia Non-ferrous Metals Smelter, Metallurg International Resources, Mitsui Mining and Smelting Co., and NAC Kazatomprom. There are also companies in China that are processing ores and slags with conversion into chemicals. The processing companies generally manufacture a variety of chemicals, powder, ingots, and alloys.

Tantalum Raw Material Production (Mlb contained tantalum oxide)

	1998	1999	2000
Tantalite, columbite, struverite, others	1.619	2.390	2.594
Tin Slag, >2% tantalum oxide	0.527	1.717	0.722
Total	**2.146**	**4.107**	**3.317**

It should be stated that the above data do not include tantalum raw materials that were purchased by processors from companies that are not members of the Tantalum-Niobium International Study Center. These sources are reported through the category of "Processor Receipts" which also include the purchase of any tantalum-containing material that is destined for processing through "repurification" systems. These data are shown in the following table, with tin slags and all tantalum minerals consolidated in one category.

Source: Tantalum-Niobium International Study Center (TIC)

Processor Receipts (Mlb contained tantalum oxide)			
	1998	**1999**	**2000**
Tantalite, columbite, struverite, tin slag	2.929	3.216	4.278
Secondary materials, scrap, Ta_2O_5, K-Salt	0.943	1.202	1.498
Total	**3.872**	**4.418**	**5.776**

Source: Tantalum-Niobium International Study Center (TIC)

The worldwide demand for tantalum powder for capacitor applications has grown at an annualised rate of 18.3% since 1993. The mill products category also contributes product to the capacitor segment in the form of tantalum wire, fabricated heat shields and furnace trays. The following table shows the breakdown of processor shipments for the various forms of tantalum.

The tantalum powder shipments are 60.8% of the total with mill products reporting as 14.8% of the 4.927 Mlb in all categories. Approximately 50% of the mill products category is estimated to be tantalum wire, with most of that quantity being consumed in capacitor manufacturing.

Pricing

Tantalum-bearing materials are not traded on the London Metal Exchange. Also, there are no published prices for tantalum metal or tantalum chemicals. The only pricing information that is published is a reference to tantalite mineral concentrates in the *Metal Bulletin.* The Tantalum-Niobium International Study Center has no knowledge or comment concerning the accuracy of these published figures.

The larger processors of tantalum-bearing materials generally purchase a significant quantity of their requirements by negotiated long-term contracts with those companies that are producing such material on a continuing basis. Additional material is purchased by spot contracts from mining areas where production of the mineral concentrate is intermittent or offered via periodic tender, with the sale going to the highest bidder.

Tantalum Product Shipments (Mlb contained tantalum)			
	1998	**1999**	**2000**
Ta_2O_5, K_2TaF_7, Chemicals	0.352	0.248	0.324
Alloy Additive	0.159	0.320	0.282
Carbides	0.309	0.281	0.387
Powder/Anodes	1.753	2.234	2.997
Mill Products	0.498	0.566	0.729
Ingot, Unworked Metal, Scrap	0.186	0.178	0.208
Total	**3.259**	**3.827**	**4.927**

Source: Tantalum-Niobium International Study Center (TIC).

The pricing of tantalum chemicals, metal powders, alloys and fabricated articles is generally established by negotiation between buyer and seller. Specifications for a particular chemical, metal powder, or fabricated article of metal or tantalum alloy are dictated by the application. Specifications and their influence on processing requirements, and the volume of a specific product all influence the prices negotiated between buyer and seller.