

# GRAPHITE

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**T**he graphite market has been generally terrible compared with 2000, with the possibility of worse to come in 2002. The major graphite end uses (those related to steelmaking) had the worst year. The other end uses fared little better although the expanded graphite-foil end use had slow growth, and the same is likely in 2002. Graphite supply should still be more than adequate this year, even when considering likely additional mine closures around the world.

Graphite prices quoted in Industrial Minerals continued unchanged through 2001 and into early 2002; for example, large crystalline flake (94% C) was US\$570-750/t and large crystalline flake (90% C) was US\$480-US\$550/t. The United States Geological Survey's average prices for crystalline flake (US imports) show a small increase from US\$550/t in 2000 to US\$560/t in 2001.

## **Demand**

Most graphite is marketed to the steel industry, either directly or indirectly. For example, natural graphite is mostly used in refractories, as discussed below, and other items that are in turn used to make iron and steel, and synthetic graphite is used as electrodes in electric steel-making furnaces and as a powder (along with some natural graphite) added to molten steel to raise the carbon content. One of the smaller uses of natural graphite with better prospects, but still bad, is its use in powdered metal production, where the metal is almost entirely steel. Another is the use of natural graphite in foundry mould facings, where the molten metal poured in the moulds is mostly steel. Therefore, the outlook for steel determines the outlook for graphite.

The world steel industry has been in overcapacity for quite some time, so when a domestic economy looks good, steel

producers respond by increasing production, driving prices down, and exporting the excess. This generalisation is especially true for certain producing nations. The most prominent example is China, which has been rapidly adding new capacity, mostly in the form of electric-arc furnaces. The Chinese Government has cut back on lending for steel plants and has tried unsuccessfully to cut back on low-quality steel production made with environmentally-damaging outdated equipment. Chinese steel producers are poor at estimating domestic steel demand, overestimate it, and at the same time the Japanese economy and steel markets have been poor, so the excess steel winds up on global markets; ie, goes to the US. The same is true elsewhere in Asia; capacity that came on stream just before the Asian economic crisis cut domestic steel demand, is now being produced for export. The CIS (Russia) is a prolific source of steel exports, since the domestic consuming industries do not take the volumes they once did during the Soviet era.

The situation of the US steel industry should be examined against this backdrop. It has been characterised as 'pitiful', or 'flat on its back', taking into account the string of steel-company bankruptcies that have relentlessly continued throughout 2001. The steel firms' biggest problem is usually debt load, although higher costs for energy also present a major problem, as does the dumping of foreign steel. Some steel firms are closing their plants indefinitely and selling their low-cost electricity obtained under old long-term contracts to eager buyers. AISI statistics are not encouraging, but are not as dire as the above. For the first two months of 2001, total US steel shipped was down 12.7% from the same period in 2000, but for the first ten months it was only down 9.4% from the equivalent period. This suggests a bottoming out for steel.

As might be expected from the condition of the steel market, US demand for graphite electrodes was bad and some plant closures occurred. US graphite electrode demand in 2001 was down 20% from 2000. Several firms have closed electrode plants; in late 2001 SGL Carbon Group announced a broad restructuring that would close its Niagara Falls plant in mid-2002 plus two plants in Texas and one in Oregon, and mostly shift production to its plant in Morganton, North Carolina, and some to its St Marys, Pennsylvania, plant. The total job loss will be 230 in the US and 200 in Europe.

UCAR closed its Columbia and Clarksville graphite electrode plants, both in Tennessee, for an indefinite period, stating that these were its highest cost operations. The graphite machining section at Clarksville will continue to operate, getting input from other UCAR plants. The closure was completed by October 2001, and removed 20,000 t/y of net capacity, counting incremental electrode capacity additions in Mexico and Europe and the loss of 40,000 t in Tennessee. UCAR announced a second phase of restructuring and a rationalisation plan in January 2002, under which its graphite electrode plant in Caserta, Italy would be closed in the first half of 2002. World UCAR electrode capacity will still total 210,000 t. The firm's name is due to be changed from UCAR to GrafTech International Ltd.

The major graphite-using countries in 2001 were Japan and China, followed by the US, Germany and the Republic of Korea, according to statistics that are again more incomplete than those of the preceding year. Japan took a small but impressive jump (in view of the steel situation and the world economy) in its consumption of graphite other than flake and powder in 2001. US graphite consumption in 2001, as measured by imports, appears to have dropped by about 10%.

Japanese imports of crystalline flake and powder graphite in 2001 preliminarily totalled 34,600 t, compared with 42,372 t in 2000. Japanese imports of natural graphite

other than flake and powder in 2001 preliminarily totalled 109,000 t, compared with 101,534 t in 2000.

The decline and fall of the refractories industry In the latter part of the 1990s, the refractories industry underwent a worldwide consolidation. The leading companies are now: RHI AG (the old North American Refractories, Veitsch-Radex-Didier and Harbison-Walker) with 61 plants in 15 countries, and Cookson Group plc (formerly Vesuvius and Premier Refractories) with 47 plants in 27 countries. The consolidation was intended to facilitate a global purchasing strategy for raw materials, that more likely than not would put pressure on graphite and other raw material suppliers. Nothing like this has happened in Japan, where the industry remains highly fragmented, in spite of a few consolidations such as the one that augmented the present Krosaki Corp.

The decline of the refractories industry has mostly occurred in Asia, the fall elsewhere. The Japanese refractories industry has had a sluggish market in the past few years; demand in the 2001 first half was down 16% from first half 2000 for alumina-graphite shapes, 3.6% for carbon-magnesite brick, and roughly 3% for gunning and ramming mixes, reflecting almost static steel production. The Chinese refractories industry has grown rapidly over the past two decades, and China is almost self-sufficient in refractories now. The industry is confronting challenges of huge (60%-70%) overcapacity and cut-throat pricing, manufacturing efficiency (ie wasteful energy use), product quality and wasteful use of the final product. Somewhat over half of the 'refractories' produced in China is actually common fireclay bricks.

The fall of the refractories industry is centred around the large refractories firms, mostly recently consolidated, with plants mostly in North America and Europe. In mid-January 2002, RHI put all its US refractory assets such as plants up for sale because of its huge asbestos liabilities and the US steel crisis. Canadian and Mexican operations will be

retained. RHI's National Refractories unit declared bankruptcy earlier in January, and RHI has had a management shake-up that is expected to lead to other changes, including plant closures. RHI's Harbison-Walker unit declared Chapter 11 bankruptcy in February 2002. Cookson's Vesuvius is going to close 10 or 11 plants.

The underlying factors behind these events are the condition of the steel industry leading to refractories overcapacity, and large plants handling large volumes of raw materials at low freight costs specialising in producing large volumes of a single refractory product at a high fixed cost. The ultimate fate of most of these refractories firms may be to become wholesalers and/or distributors of refractory products sourced in Asia, or set up a network of small plants each supplying its local market, or some combination of these options.

### Supply

China's largest fine flake graphite producer, the Liumao mine, has had its capacity expanded from 30,000 t to 60,000 t in order to cut production costs, become more competitive, and to establish its position as the leader in Chinese graphite production. The producing firm is a joint venture between state-owned Liumao Graphite Mines (40%) and Mineral Resources (China) Ltd of Hong Kong (60%).

Woxna Graphite AB temporarily closed its graphite mine in Sweden as of July, 2001. Its parent, Tricorona Mineral AB, put Woxna up for sale in January 2002. While capacity had been brought up to 13,000 t, sales volume was only about 4,000 t. German and British graphite import statistics suggest that sales were usually less than that. While the plant was closed, the firm was to seek a government permit for increased ore production to obtain economies of scale that would allow reaching profitability, and install a chemical enrichment plant to make high purity graphite.

In mid-October 2000, UCAR International Inc. signed a letter of intent for a joint-venture with

Jilin Carbon Co. to produce and market up to 30,000 t/y of ultra-high power graphite electrodes in China. In mid-2001 they signed the joint-venture agreement.

Canadian exports of graphite probably dropped in 2001; exports to the US dropped to 9,850 t (preliminary) in 2001 from 14,300 t in 2000, the rest of the exports being usually minor. This probably reflects less sales to steel-related end uses.

The only significant activity among Canadian junior mining companies interested in graphite has been the completion of the first phase of UCAR's study of Mazarin Inc.'s Lac Knife graphite deposit in March, 2001, and moving into the testing of a large-scale sample later in 2001. Given the major UCAR restructuring plan now under way, the future of this project is impossible to predict.

Mexican graphite exports to the US rose slightly to 14,400 t in 2001 from 14,315 t in 2000. This was mostly amorphous graphite connected with older traditional uses such as lubricants, firebricks, and gunning and ramming mixes. Also included in the exports were minor amounts of fine crystalline flake.

After another failed joint venture attempt with Terramin Australia Ltd, the present owners of the Uley crystalline flake graphite operation in South Australia are considering auctioning the mine off. Some issues about water supply and aboriginal claims may have again got in the way.

### Outlook

The graphite industry will be waiting for the other shoe to drop in 2002, particularly in regard to plant closures. Overall graphite sales in 2001 were off at least 10% from 2000; but for certain important end-uses was much greater. Potential use in fuel cells has shifted towards the future.

Natural graphite (mostly flake) is used in carbon-magnesite brick and in alumina-graphite shapes, plus much smaller amounts

in crucibles, gunning and ramming mixes, and other uses. The bricks are used to line basic oxygen steel converters and electric-arc furnaces to withstand extreme conditions and the shapes are used as continuous casting ware in the form of nozzles and such to guide the molten steel from ladle to mould. The actual and expected closure of many North American refractory plants in 2001 and 2002 has drastically shrunk demand and will shrink it further. Consumption in 2001 in this major end-use, the largest for natural graphite, dropped 35% from 2000, and 2002 is likely to see another 15% drop.

Graphite electrodes, extruded as a shape and graphitised from petroleum coke, carry the electricity that heats electric-arc furnaces (almost all steel). The consumption in 2001 for this important end-use, the largest for synthetic graphite, was down 20% from 2000, and prices dropped 10% in the latter part of 2001. The first half of 2002 will be just as bad, but after that some levelling should occur; 2003 might see a turnaround.

The outlook for graphite (natural and synthetic) in fuel cells and Li-ion batteries is the most promising because they depend on low-pollution products, or on mobile phone and palm-size computer use. Demand could reach 80,000 to 100,000 t/y in the long term, but not beginning in 2002 for the fuel cell part, since California has eased off on its pollution mandates.

Natural graphite (amorphous and fine flake) is used in brake linings for heavier (nonautomotive) vehicles, substituting for the formerly used asbestos. The 2001 consumption was up 5% from 2000. The 2002 consumption is likely to be down by at least 5%.

Graphite (synthetic) powder is mostly used as a carbon-containing additive put into molten

steel to raise its carbon content, into brake linings, and into packings, seals, batteries and a few other very minor uses. Powder demand in 2001 ranged between being up 15% to being down 30% from 2000, depending on the product, its purity, its use and the time of year; the latter part of 2001 was horrendous and the first half of 2002 is likely to be as bad with powder prices in free fall.

When layers of graphite flakes are forced apart in chromic acid, the result is expanded graphite which is used as packing or to make graphite foil. Consumption in 2001 in this complex end-use was up 5%-10% from 2000, depending on whether we consider expanded graphite, foil or natural graphite used directly as packing. The 2002 demand in this end-use has a decent outlook but, barring developments in certain kinds of fuel cells, growth is likely to be modest.

The circumscribed demand can be easily met by supply; Chinese graphite was easily available in 2001 and should continue to be available in similar quantities in 2002. This will put pressure on non-Chinese mines and force a number of closures. Perhaps even some Chinese mines will close. It is exceedingly unlikely that there will be a need to resort to the shuttered operations in Australia, Mozambique and even Tanzania.

Two continuing advances in graphite information availability were maintained this year. In one advance, the author of this article has expanded a website for graphite, [www.basicsmines.com/graphite](http://www.basicsmines.com/graphite), that is frequently updated with news, statistics, and the market outlook. In the other advance, heralded in last year's article, the US Geological Survey (USGS) published production statistics on synthetic graphite for 2000: the US produced a total of 290,000 t valued at US\$771 million.