

Other Platinum Group Metals

Rhodium

Total demand for rhodium rose by just under 3 per cent to 596,000 oz in 2002. Use of rhodium on autocatalysts grew strongly, driven by an increase in average rhodium loading levels, and higher light vehicle production in the USA and Asia. However, automakers in the USA satisfied a proportion of their rhodium requirements by further drawing down inventories. Demand for rhodium from the chemical catalyst and glass manufacturing industries weakened slightly.

Autocatalyst

In 2000, a number of US and Japanese auto companies built up substantial inventories of rhodium. At that time, the stability of supplies from Russia was uncertain and many auto manufacturers were anticipating having to use greater concentrations of rhodium on autocatalysts in order to meet increasingly stringent emissions legislation. In 2001, however, several auto makers utilised a proportion of their stockpiled metal to supplement purchases. This trend continued in 2002, when use of stocks by US auto companies increased sharply. Consequently, although the underlying use of rhodium on autocatalysts grew by 15 per cent, purchases of the metal by the global autocatalyst sector expanded by just 6 per cent to 600,000 oz.

Average rhodium loading levels increased in the USA in 2002 as a result of efforts to reduce reliance on palladium. Auto companies were able to reduce palladium loadings on some catalyst systems by raising the concentration of rhodium used. In addition, rhodium was added to some palladium-only catalysts, again to reduce the intensity of palladium use. The overall increase in average rhodium loading levels was small in terms of grams per individual catalyst, but the cumulative effect across the US light vehicle fleet was significant.

Also contributing to greater rhodium use in 2002 was the 7.6 per cent increase in US light vehicle production, representing a rise of around 850,000 vehicles. However, greater use of rhodium inventories by some US-based manufacturers more than offset these positive factors and demand for the metal dropped by 13 per cent in North America.

US Federal Tier 2 emissions standards will be phased in from the 2004 model year onwards and will require a further considerable reduction in fleet average NOx emissions. A number of manufacturers

are likely to have to further increase rhodium loading levels on some of their catalyst systems in order to meet the Tier 2 requirements.

Japanese demand for rhodium in autocatalysts climbed noticeably in 2002. This was due in part to rising light vehicle production and exports – Japanese output of light vehicles increased by 4.7 per cent year-on-year. However, of greater significance for rhodium demand in Japan last year was an increase in average rhodium loading levels. This was primarily a result of the effect of tighter emissions regulations; both proposed in Japan and legislated in the European and North American export markets. A steadily increasing proportion of Japanese cars manufactured for the domestic market meet the published low emission vehicle guidelines, even though tighter standards are not likely to be enforced until 2005. To achieve the reduced level of NOx emissions that will be permissible in future, Japanese automakers increased average rhodium loading levels on autocatalyst systems on some of their models.

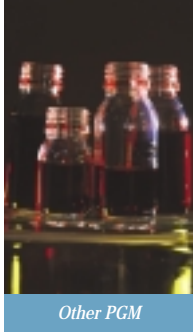
Autocatalyst demand for rhodium in Europe rose moderately in 2002, despite the almost 2 per cent fall in light vehicle production across Western Europe and a further increase in the market share taken by diesel cars (diesel autocatalysts do not contain rhodium). As in North America, the growth in rhodium consumption was due to a rise in the average rhodium loading per vehicle as some auto manufacturers thrifted palladium through more intensive use of rhodium.

In the Rest of the World, rhodium demand in 2002 increased by almost 8 per cent, reaching 95,000 oz. Light vehicle production strengthened across Asia, with the Chinese market in particular developing rapidly. Total passenger car production across the continent (excluding Japan) grew by 13.8 per cent, outweighing a 7 per cent fall in South America. Rhodium demand also continued to benefit from the spread of tougher emissions standards in countries such as China and South Korea.

The volume of rhodium recovered from scrapped autocatalysts climbed by 12.5 per cent to just less than 100,000 oz in 2002. Recovery rates in Europe continued to improve, although remained well below those in the USA. The European End of Life Vehicle Directive will further stimulate the dismantling and recovery of autocatalysts from scrapped vehicles from 2005 onwards. In North America, later model year cars now being scrapped contain higher loadings of rhodium

Rhodium Supply and Demand '000 oz		
	2001	2002
Supply		
South Africa	452	485
Russia	125	90
North America	23	28
Others	4	9
Total Supply	604	612
Demand		
Autocatalyst: gross	566	600
recovery	(88)	(99)
Chemical	44	42
Electrical	6	6
Glass	41	37
Other	10	11
Total Demand	579	596
Movements in Stocks	25	16





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Samples of rhodium nitrate, a key component of many gasoline autocatalysts.

than earlier models, reflecting the introduction of strict limits on NOx emissions from the mid-1990s onwards.

Other

Demand for rhodium in chemical, glass and other applications fell by 5 per cent in 2002 to 96,000 oz. Demand for chemical process catalysts containing rhodium slipped marginally to 42,000 oz, primarily a reflection of lower demand in Europe where economic growth was sluggish and most sectors of the chemical market were subdued. Rhodium-based catalysts are used in the production of chemicals such as acetic acid, silicones, oxo-alcohols and hydrogen cyanide. Rhodium is a constituent of platinum wire used to fabricate nitric acid catalysts – demand from this sector was flat in 2002.

Rhodium is also a component of platinum alloys used in glass manufacturing applications. Demand from this industry decreased slightly in 2002. Overcapacity and competition from imports resulted in low profitability in the TV glass and reinforcement fibre glass sectors in North America and Europe. This led to the closure of several glass furnaces in 2002. These closures were partly offset by continued construction of new plants in Asia, notably in China, but the rate of expansion was not as great as in 2001. Demand for

rhodium in thermocouples and other industrial applications in 2002 was broadly in line with the previous year.

Ruthenium & Iridium

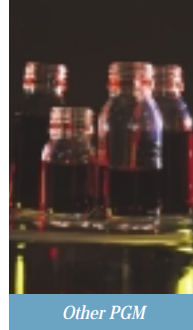
Ruthenium demand in 2002 recovered from the sharp fall of the previous year, as excess inventories were worked out of the electronics market and demand for ruthenium-based catalysts increased from the bulk chemicals industry. The result was an increase in ruthenium demand of nearly 18 per cent to 410,000 oz. In contrast, iridium demand fell further, slipping to 77,000 oz as the surplus of crystal manufacturing capacity persisted in the electronics sector.

Demand for ruthenium used in electronic components improved in 2002 to 145,000 oz – a rise of 11,000 oz from the weak level of demand the previous year when a substantial overhang of both finished electronic products and components reduced raw material purchases. Component inventories at manufacturers were still significant at the start of 2002 but as the year progressed stock levels were drawn down towards normal working levels. Demand for ruthenium pastes used in resistors and hybrid integrated circuits (HIC) consequently increased year-on-year.

Sales of ruthenium-based resistors were flat in 2002, reflecting the weak level of investment in telecommunications infrastructure and the softness of the global market for IT equipment. However, shipments of HIC containing ruthenium increased, propelled by continued growth in the automotive electronics sector.

Total electronics demand for ruthenium in 2002 included small volumes of metal used in computer hard disks and fuel cell catalysts. During the year, two of the leading hard disk manufacturers introduced products containing a very thin layer of ruthenium – this has the effect of substantially increasing data storage densities. Other manufacturers are expected to rapidly follow their lead. Ruthenium is also a constituent of some catalysts used in proton exchange membrane fuel cells. The addition of ruthenium to platinum-based catalysts can help to improve fuel cell performance.

Iridium's principal use in the electronics industry is in the form of crucibles used to grow high-purity crystals. Significant overcapacity has persisted in this



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sector following very strong sales of crucibles in 2000. Crystal manufacturers had ample capacity in 2002 to accommodate demand, which did not meet previous forecasts following the downturn in the mobile telecommunications industry.

The effect of this on iridium demand, however, was lessened somewhat by growth in demand for high purity crystals from medical equipment manufacturers. Materials manufactured in iridium crucibles are used in lasers and sophisticated medical scanners and sales of these products increased. Overall, demand for iridium in electronics applications slipped by 5,000 oz to 22,000 oz.

Demand for ruthenium used in chemical process catalysts was sharply higher in 2002, rising to 102,000 oz. Construction of new bulk and speciality chemicals manufacturing capacity, in particular for the production of acetic acid, boosted demand for ruthenium-based catalysts. The Cativa® acetic acid manufacturing technology utilises an iridium-ruthenium catalyst that offers the advantages of high selectivity, high reaction rates and reduced by-products over a wide operating range. Several new plants using the Cativa process were under construction in Asia in 2002.

Ruthenium and iridium are used to coat electrodes used in the manufacture of chlorine and caustic soda. The chloralkali industry is mature and there was little investment in new capacity in 2002. Chlorine demand,

which correlates closely with industrial output, was largely flat. North American demand for ruthenium increased year-on-year, as one major producer continued with a long-term anode re-coating programme and another increased the ruthenium loading on its electrodes. These factors were primarily responsible for an 8,000 oz rise in total ruthenium demand to 100,000 oz. Iridium demand from the chloralkali industry was marginally higher at 23,000 oz.

By the end of 2002 the use of iridium as a component of some autocatalyst formulations had been virtually eliminated. Stricter emissions legislation has resulted in the phasing out of technology utilising iridium in favour of platinum-based catalysts. Small volumes of iridium were used in high performance spark plugs but penetration of the market by these products remained low.

In other markets, the use of corrosion resistant ruthenium-titanium pipe in the oil and geothermal energy industries was stable in 2002. In North America, platinum jewellery alloys containing 3 to 5 per cent ruthenium are commonly used for the manufacture of wedding bands. Demand from this market increased in 2002 in line with improved retail sales of platinum jewellery. Both iridium and ruthenium are used to manufacture anodes to prevent corrosion of shipping vessels and underwater structures. This market consumes several thousand ounces of each metal annually and demand was stable last year.

Ruthenium Demand by Application '000 oz		
	2001	2002
Chemical	61	101
Electrochemical	92	100
Electronics	134	145
Other	61	64
Total Demand	348	410



Other PGM Supplies

Total rhodium supplies in 2002 grew slightly, rising to 612,000 oz. Lower sales of metal from Russia were offset by increased output in South Africa and Zimbabwe as platinum production expanded. The rising proportion of UG2 ore mined in South Africa is leading to greater rhodium output as the UG2 reef contains substantially higher concentrations of rhodium (as well as ruthenium and iridium) than the Merensky Reef. South African shipments of rhodium rose by 7.3 per cent during the year to 485,000 oz.

Russian exports of rhodium continued to ease back from the exceptional total in 2000, when large volumes were sold from state inventories to

western auto manufacturers. In 2002, Russian sales of rhodium totalled 90,000 oz, 35,000 oz less than the previous year. However, with several US automakers utilising greater volumes of rhodium from their inventories, total supply was sufficient to comfortably meet demand.

Output of ruthenium and iridium climbed significantly in 2002 and substantially exceeded demand. The price of both metals weakened throughout the year as a result and producer stocks of the metals are presumed to have increased. South African production of ruthenium and iridium is rising as expansions to platinum mining operations come on stream and the proportion of UG2 ore mined increases.

Iridium Demand by Application '000 oz		
	2001	2002
Automotive	8	5
Electrochemical	22	23
Electronics	28	22
Other	28	27
Total Demand	86	77

