Other Platinum Group Metals

Rhodium

Supplies of rhodium fell sharply in 2001: Russian exports were less than half the previous year's level, while South African shipments also decreased slightly. However, demand declined even more steeply, as auto makers – who had added significantly to strategic stocks in 2000 – drew upon inventories to meet their rhodium requirements. As a result, the market moved into surplus after two years of deficits. Improved availability was reflected in a retreat in the price, from $2,300 in February to a low of $675 in November.

Autocatalyst

Changes in strategic stocks held by auto makers have led to sharp swings in autocatalyst demand for rhodium over the last two years, at a time when underlying consumption on catalysts has remained virtually unchanged. During 2000, we believe that US and Japanese car companies bought substantial quantities of rhodium for inventory; this was partly reversed last year, with metal being withdrawn from stockpiles for use on catalysts. As a result, sales of rhodium to the auto industry fell by 29 per cent to 566,000 oz in 2001.

In contrast, actual use of rhodium on catalysts was stable last year, as modest increases in loadings were offset by lower production of gasoline vehicles in most markets. In North America, output of light vehicles fell by 10 per cent, reflecting a modest decline in sales combined with a substantial reduction in inventories of finished vehicles. Rhodium consumption also fell, though by a smaller percentage: some auto makers have raised the rhodium content of their catalysts as part of their palladium thrifting programmes. However, it appears that improvements in catalyst design are likely to limit further increases in rhodium loadings. Although not the main incentive behind last year's reductions in strategic stocks, this may have been a factor, since inventory levels are partly related to expectations of future demand.

Despite a slight increase in domestic car sales, auto production in Japan fell by 3 per cent last year, affected by a sharp reduction in exports to North America and Europe. This decline was largely offset by a rise in average rhodium loadings in order to meet tighter emissions legislation. As a result, consumption of rhodium on catalysts was virtually unchanged, but fresh sales of metal to auto makers were much lower than the previous year due to inventory adjustments.

In Europe, vehicle production was virtually unchanged in 2001. However, gasoline cars continued to lose market share to diesel models, which carry platinum-only catalysts. Manufacturing of gasoline vehicles actually contracted last year, largely cancelling out a slight increase in average rhodium loadings. As a result, rhodium demand rose only marginally compared with 2000.

Consumption growth in the Rest of the World region was mainly due to higher sales to auto makers in Latin America: demand in Mexico was lifted by further increases in rhodium loadings on models for export to the USA, while the Brazilian market continued to benefit from growth in car production and sales.

Rhodium Supply and Demand
'000 oz

	2000	2001
Supply		
South Africa	457	452
Russia	290	125
North America	17	23
Others	3	4
Total Supply	**767**	**604**
Demand		
Autocatalyst: gross	793	566
recovery	(79)	(92)
Chemical	39	44
Electrical	7	6
Glass	42	39
Other	10	11
Total Demand	**812**	**574**
Movements in Stocks	(45)	30

These gains were partly offset by a plunge in vehicle output in Argentina, where economic and political crisis has resulted in a sharp decline in consumer spending. In Asia, there was some increase in rhodium usage in smaller markets such as India, Malaysia and Thailand, but demand in the largest market, Korea, was flat. Following a series of difficult years for the Korean auto industry, the introduction of local LEV regulations has been postponed until 2003, although some car companies are already selling vehicles meeting the new limits.

The amount of rhodium recovered from scrapped catalysts rose by 16 per cent to 92,000 oz last year. In North America, higher pgm prices during early

2001 provided an incentive for growth in the collection and processing of spent autocatalysts. Recoveries in this region were also boosted by further increases in the average rhodium content of scrapped catalysts, reflecting stricter legislation which entered force in the early 1990s.

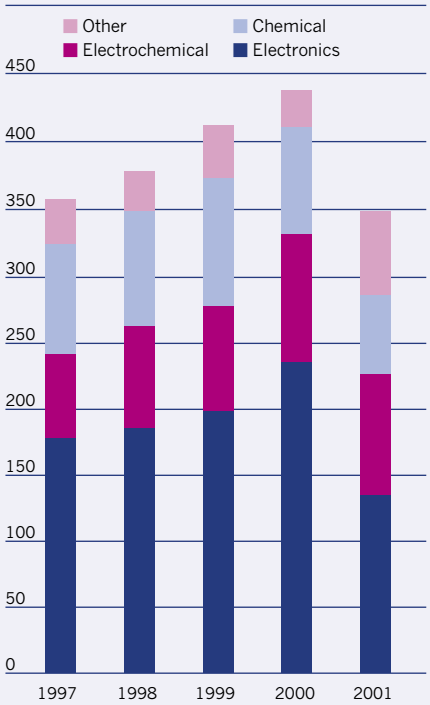
The amount of rhodium recovered in Europe also continued to expand, though from a very low level. This was largely due to a gradual improvement in collection of catalyst scrap. In addition, an increasing proportion of vehicles scrapped last year were manufactured after 1993, when EU emissions legislation first led to the universal use of catalysts on gasoline cars.

Other

Demand for rhodium in other applications rose by 2 per cent to 100,000 oz in 2001. In the chemicals sector, investment in new production capacity for oxo-alcohols and other speciality chemicals resulted in an increase in sales of rhodium process catalysts, especially in the Rest of the World region. However, this was partly offset by a downturn in demand from the glass industry.

Oversupply in the LCD glass market resulted in less additional manufacturing capacity being constructed than in 2000, and hence in a reduction in purchases of rhodium. The impact on demand was moderated by construction of new cathode ray tube glass capacity in China and India.

Demand for Ruthenium 1997-2001
'000 oz



Ruthenium & Iridium

A plunge in demand from the electronics industry was the principal factor behind last year's fall in consumption of both ruthenium and iridium. Use of ruthenium declined by 22 per cent to 349,000 oz in 2001, while demand for iridium was 31 per cent lower than the previous year, at 86,000 oz.

Last year was difficult for the electronics industry. Many device manufacturers, anticipating continued strong growth in retail sales, entered the year with a large overhang of both finished products and components. When consumer demand proved less robust than expected, these companies cut production and began to work off inventories. As a result, there was a collapse in demand for components such as resistors, which are ruthenium's principal application in the electronics sector.

With industry stocks of components much reduced, demand for resistor chips – and hence for ruthenium – is expected to recover in 2002. There will also be a modest addition to electronics demand for ruthenium from a new application: hard disks. It has been reported that the addition of a microscopic layer of ruthenium between two magnetic layers on a hard disk results in a large increase in the density at which data can be stored. This technology should enable disk manufacturers to overcome what were previously believed to be the physical limits of data density, and to develop hard disks with data storage capacities four or more times those of current products. Manufacturing of ruthenium-containing disks started in 2001, and the technology is expected to be applied to the majority of hard disks within a few years.

Iridium is also used in the electronics sector, principally in the form of crucibles for the growth of high-purity crystals. In recent years, there has been a huge expansion in demand for lithium-based crystals used in surface acoustic wave (SAW) filters, which prevent interference between individual mobile phones. Manufacturers made significant additions to crystal-growing capacity during 2000, and this was reflected in strong demand for iridium crucibles. The industry now has sufficient capacity to meet crystal demand for the foreseeable future, and as a result, there has been a

Ruthenium Demand by Application
'000 oz

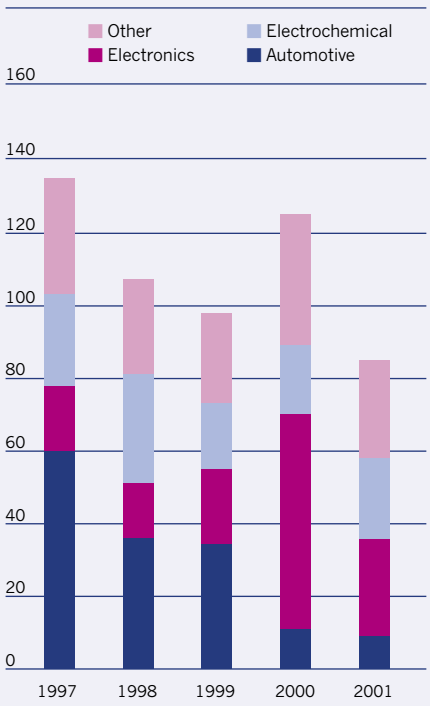
	2000	2001
Chemical	79	61
Electrochemical	97	92
Electronics	233	134
Other	36	62
Total Demand	**445**	**349**

Iridium Demand by Application
'000 oz

	2000	2001
Automotive	11	9
Electrochemical	19	22
Electronics	59	27
Other	36	28
Total Demand	**125**	**86**

Demand for Iridium 1997-2001

'000 oz



sharp downturn in crucible sales. Demand for iridium in this sector halved in 2001 and is expected to fall again this year.

The electrochemical industry is also a significant consumer of both ruthenium and iridium. Both metals are required in coatings for electrodes used in the chloralkali process, which involves the electrolysis of brine to produce chlorine and caustic soda. During 2001, there was a small decline in demand for ruthenium, and a slight increase in consumption of iridium. This was largely due to a continued switch away from older mercury and diaphragm cells, which are associated with environmental problems, towards newer membrane technology. The latter type of plant uses electrodes with a lower ruthenium content but higher iridium loadings.

In recent years, demand for ruthenium and iridium in process catalysts has been enhanced by investment in plants using two new processes: the Kellogg Advanced Ammonia Process (KAAP), which produces ammonia using a ruthenium-based catalyst, and the Cativa process for the production of acetic acid using an iridium-ruthenium catalyst. However, there were no new Cativa or KAAP plants in 2001, although top-up metal was required for existing operations. This contributed to a decline in demand for both iridium and ruthenium from the process catalyst sector.

Both iridium and ruthenium are used in the auto sector. Ruthenium consumption is small, being confined to a limited number of spark plugs where it is used as a component of platinum alloys; this is expected to remain a very minor application. In contrast, demand for iridium in spark plugs is expanding; it has been used for some time by Japanese manufacturers, and iridium-tipped plugs are now also being fitted to some premium European and US models. It is claimed that iridium plugs show improved performance and durability compared with platinum based products, but their higher cost is likely to limit market penetration.

In recent years, substantial quantities of iridium have been used in autocatalysts for some gasoline direct injection models in Japan and Europe. However, the enforcement of stricter emissions limits in both regions is resulting in the phasing-out of this technology in favour of conventional platinum-based catalysts. Demand has fallen sharply and is expected eventually to disappear completely, although in the short term some iridium may continue to be used on models for sale in Asian markets with less stringent emissions legislation.

The jewellery sector consumes small amounts of iridium and ruthenium as components of platinum alloys. The use of such alloys is largely confined to the USA and Europe, with the two largest platinum jewellery markets, Japan and China, traditionally favouring palladium-containing alloys instead (see the special feature on page 28). Demand for iridium and ruthenium declined in 2001, in line with lower fabrication levels of platinum based jewellery in Western Europe and North America.

Among ruthenium's other applications, the most substantial is in ruthenium-titanium piping for offshore drilling and geothermal projects. There was a sharp increase in demand in 2001, and further growth is expected; most new projects of this type are expected to use ruthenium-containing alloys, which are more corrosion resistant and hence have a longer life than conventional steel-clad piping.

Other PGM Supplies

Supplies of rhodium fell by 21 per cent to 604,000 oz in 2001. There was a sharp dip in exports from Russia, which had made unusually heavy shipments in early 2000. Sales by Almaz in 2001 totalled 125,000 oz, less than half the previous year's level, with most of this metal being imported by the USA. Shipments from South Africa were also down slightly, at 452,000 oz. Although production increased, there was no repeat of the sales from producer stocks which added to supplies in 2000.

Supplies of ruthenium and iridium were reduced sharply in 2001, reflecting lower demand and prices. Although there was an increase in the output of both metals in South Africa, we believe that stocks of unsold metal grew.

Production of rhodium, ruthenium and iridium is expected to increase steadily over the next few years, principally due to the expansion of platinum mining in South Africa. Most new projects will exploit the UG2 reef, which contains higher concentrations of these metals than the Merensky Reef.