



Palladium

# Palladium

## Autocatalyst

Purchases of palladium by auto manufacturers slumped to 3.08 million oz in 2002, a fall of almost 40 per cent from demand of 5.09 million oz in 2001. Actual use of palladium in autocatalysts, however, declined by a less dramatic 13 per cent. The difference was a result of the very considerable use of stocks of palladium by auto manufacturers in the USA and, to a much lesser extent, Japan. The fall in the underlying use of the metal was largely a reaction to the high and volatile palladium price of 2000 and early 2001. Auto companies were successful in reducing average palladium loading levels and some made greater use of platinum-based autocatalysts. A major contributory factor in Europe was the drop in gasoline car production as diesels gained further market share.

### Europe

Demand for palladium in autocatalysts in Europe slid by 17 per cent to 1.43 million oz in 2002, a four-year low. The drop reflected a fall in sales of gasoline cars, programmes instigated by some auto manufacturers over the last two years to reduce their use of palladium-based catalysts, and the development of catalysts with lower palladium loadings.

Production and sales of diesel cars (which use platinum-based catalysts) continued to grow at the expense of gasoline vehicles. Production of the latter fell by 9.5 per cent, or around 900,000 cars, to 8.59 million cars as the penetration of diesels across Western Europe climbed to 40 per cent. With average loadings of between 3 and 4 grams of palladium per gasoline car, this had a significant impact on palladium demand. Diesel powered cars are expected to gain further market share in 2003.

Those auto manufacturers in Europe who had moved in favour of palladium-rich autocatalyst formulations during the 1990s instigated programmes to reduce their reliance on the metal in 2000 and 2001, when Russian supplies were interrupted and the price rose rapidly. As a result, a number of European car companies switched towards greater use of platinum-based catalysts on a proportion of their models. Because of the time taken to design, calibrate and certify new emissions control systems, the effect of these programmes to change pgm ratios reduced palladium demand in 2002.

The majority of catalyst systems used on European gasoline vehicles, however, still contain a substantial proportion of palladium. Auto manufacturers have been able to reduce average palladium loadings through the development of improved emissions systems and advances in engine design and control. This contributed to lower palladium demand in 2002.

### Japan

Consumption of palladium by the Japanese auto industry increased by 8 per cent in 2002 as light vehicle output grew and tighter emissions standards resulted in higher average pgm loadings. However, purchases of palladium by Japanese auto companies improved by just 2 per cent or 10,000 oz as inventories of metal were drawn down. Certain Japanese manufacturers accumulated stocks of palladium in the late 1990s and reduced these during 2002. Japanese auto companies moved to thrift their use of palladium from 2000 onwards as the price started to rise, in part by moving to greater use of platinum-based catalysts. By 2002, most of these programmes had taken effect and there was little further impact on palladium demand.

A primary cause of the rise in the underlying use of palladium in autocatalysts was the 6.2 per cent increase in Japanese car production to 8.62 million vehicles. This was driven by both improved domestic sales and strong exports. Japanese exports of light vehicles climbed by 12.4 per cent to 4.65 million, with deliveries to the USA leading the rise.

Tighter vehicle emissions standards in Japan and abroad also contributed to the growth in palladium consumption. Japanese car companies are already producing vehicles that meet proposed stricter emissions standards, which are likely to be introduced before the end of 2005. This voluntary improvement in emissions levels by auto manufacturers is, to a certain extent, a reflection of the fact that environmental considerations can be significant in the purchasing decisions of Japanese consumers.

With exports accounting for around 46 per cent of Japanese car production, tightening emissions legislation in North America and Western Europe also had an impact on Japanese autocatalyst pgm demand in 2002. Reduced emissions levels of both domestic and export vehicles were achieved in some instances through increased average pgm loadings, boosting palladium usage.

Palladium Demand: Autocatalyst '000 oz		
	2001	2002
Europe	1,730	1,430
Japan	505	515
North America	2,375	635
Rest of the World	480	500
<b>Total</b>	<b>5,090</b>	<b>3,080</b>
Autocatalyst recovery	(280)	(370)





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## North America

Consumption of palladium in autocatalysts in North America dropped by 21 per cent in 2002 as the switch towards greater use of platinum continued, and manufacturers successfully reduced palladium loadings. Despite this, consumption of palladium remained in excess of 2 million oz. Purchases of the metal, however, crashed to just 635,000 oz as large US-based auto companies drew very heavily on palladium inventories that they had accumulated in prior years.

This use of stocks in preference to purchasing palladium was a consequence of several factors, not least of which was the desire of auto makers to minimise raw material costs and expenditure, in part to support the large incentive packages offered to new car buyers. Several US auto makers had substantial palladium inventories at the start of the year – the imperative to reduce costs outweighed the strategic value of holding these stocks. The perceived necessity of holding large pgm inventories declined as higher volumes of metal were produced in North America and South Africa.

The net result of these elements was that the major US auto makers purchased very little palladium by recent historical standards during 2002; the majority of the 635,000 oz of demand came from the US subsidiaries of European and Japanese manufacturers.

The 21 per cent fall in the underlying palladium use in autocatalysts in 2002 can, to a large extent, be directly attributed to the jump in the palladium price from under \$450 at the start of 2000 to over \$1,000 in January 2001, plus previous disruptions in palladium supply from Russia. US car companies, some of whom had tended to use quite heavily loaded palladium-based catalysts, initiated programmes to reduce their reliance on the metal, adopting a twin strategy of switching to greater use of platinum-based catalysts and reducing average palladium loadings across certain model ranges. Many of these initiatives bore fruit in 2002, cutting palladium demand.

## Rest of the World

Demand for palladium in autocatalysts in the Rest of the World grew by 4 per cent or 20,000 oz to reach 500,000 oz in 2002. Light-duty vehicle production across Asia expanded by 7.7 per cent, powering the increase in palladium purchases. The actual and imminent tightening of emissions regulations in countries such as China and South Korea also

increased pgm use. However, palladium demand grew at a slower rate than platinum demand; the difference was primarily a result of greater use of platinum-based catalysts at the expense of palladium-rich systems.

## Autocatalyst Recovery

The volume of palladium recovered from the recycling of scrapped autocatalysts increased by nearly one-third in 2002, rising by 90,000 oz to an estimated 370,000 oz. The high palladium price of 2000 and 2001 intensified interest in the collection of scrapped catalytic converters, while the average palladium content of catalysts recovered increased.

Much of the increase in the total volume of palladium recovered was due to a 30 per cent rise in metal recovery in North America, where there is a well-developed and extensive collection and recycling network. Recovery rates also increased in Europe, where impending legislation has increased the emphasis on automobile recycling. In Japan recovery was flat, while elsewhere the volumes of metal recovered increased but remained relatively small.

In the USA and Europe in particular, the average palladium content of recovered autocatalysts increased. Catalytic converters fitted to cars manufactured from the mid-1990s onwards contained significant loadings of palladium and the number of these vehicles now being scrapped is rising.

## Chemical

Chemical industry demand for palladium was broadly stable in 2002, the total edging up by just 5,000 oz to 255,000 oz. This reflected the soft rate of economic growth in North America, Europe and Japan. Demand for both palladium-based process catalysts and for catchment gauze from the nitric acid industry showed little change from the previous year. Construction of new purified terephthalic acid capacity in China was the sole stimulus to demand.

Palladium catalysts are widely used in the production of the bulk intermediate chemical vinyl acetate monomer (VAM). Structural overcapacity in VAM manufacturing persisted in 2002 and there was little capital investment to boost palladium catalyst demand. The main uses of VAM are in the manufacture of polyvinyl acetate and polyvinyl alcohol – the former has numerous applications in paints, adhesives, fibres

**Palladium Demand: Chemical**  
'000 oz

	2001	2002
Europe	65	70
Japan	20	20
North America	75	75
Rest of the World	90	90
<b>Total</b>	<b>250</b>	<b>255</b>



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and coatings, while the latter is used in packaging film and glass laminates. These are generally mature markets and demand was subdued.

The other major bulk chemical application of palladium catalysts is in the production of purified terephthalic acid (PTA). This is a precursor to polyesters and to polyethylene terephthalate (PET), a plastic resin used in packaging – demand for both is growing in Asia. Construction of new capacity provided a small boost to palladium PTA catalyst demand in China but there was little investment elsewhere as the market in general was oversupplied.

The fall in the price of palladium throughout 2002 and the rise in the price of platinum improved the cost-effectiveness of palladium catchment gauze used in the production of nitric acid. However, the great majority of nitric acid is used in the manufacture of nitrogen fertilisers and depressed fertiliser prices meant margins and cash flow in the industry were squeezed last year. Consequently there was little net change in demand for palladium gauze.

## Dental

The fall in the price of palladium throughout much of 2002, combined with the rise in the gold price, made palladium-based alloys more attractive to dental practices. A moderate recovery in demand resulted and purchases of metal increased by 3.4 per cent (25,000 oz) to 750,000 oz. The improvement, however, was restricted to Japan and North America; in Europe the substitution of palladium seen over the last three years appears to be permanent.

In Japan, the cost of dental treatment using a 20 per cent palladium alloy ('kinpala') is partly underwritten by a state-backed health insurance scheme. When palladium peaked at almost \$1,100 per oz in 2001, the rising cost of treatment to patients and the time lag between treatment and the reimbursement of dental practices' costs by the state deterred the use of the kinpala alloy. However, the fall in the price of palladium resulted in a resumption of growth in 2002. Demand grew by a modest 10,000 oz to 485,000 oz.

The North American market also experienced an increase in palladium demand, with purchases of metal rising by 8 per cent to 205,000 oz. The fall in the price of palladium compared with the rising and increasingly volatile price of gold during the year reversed the move from palladium-based alloys to

high-gold alloys. To put this in context, however, demand for palladium in this sector in 2002 was approximately half of the level it was five years previously.

Most European dental practices moved away from the use of palladium alloys between 1999 and 2001 in reaction to the metal's rising and volatile price. Preferences for alternative dental compounds in Europe vary from country to country and so the effect of the reversal of palladium prices in 2002 was mixed.

In Germany, cheaper base-metal alloys have become widely accepted and continued to take market share from precious metal alloys. The Italian market, however, remains heavily biased in favour of precious metal alloys and here the drop in the palladium price stimulated an increase in demand for palladium-based products at the expense of high-gold alloys. Across Europe as a whole, dental demand for palladium flattened out at 50,000 oz.

## Electronics

Use of palladium in electronic applications continued to fall in 2002, dropping by 18 per cent compared to the previous year. Other than in China, spending on information technology was generally weak, and palladium-based capacitors lost further market share to nickel products. However, purchases of palladium staged a moderate recovery, climbing 6 per cent to 710,000 oz. Although manufacturers continued to run down excess metal and component inventories, the effect of this on palladium purchasing was lower than in 2001. In addition, the volume of palladium recovered from scrapped electronic circuitry declined.

Electronic component manufacturers were faced with substantial inventories of palladium pastes and finished components in 2001, when demand for electronic goods dropped much further and faster than expected. With electronics demand still fragile, the effect of this stock overhang continued to be felt during 2002. However, the impact on palladium demand was not as severe as the previous year. The lower proportion of inventory use meant that overall purchases of palladium increased by 40,000 oz.

Corporate IT spending and PC sales in Europe, Japan and North America were weak in 2002, reflecting sluggish economic growth and widespread reluctance to invest in new goods and technology.

Palladium Demand: Dental '000 oz		
	2001	2002
Europe	50	50
Japan	475	485
North America	190	205
Rest of the World	10	10
<b>Total</b>	<b>725</b>	<b>750</b>



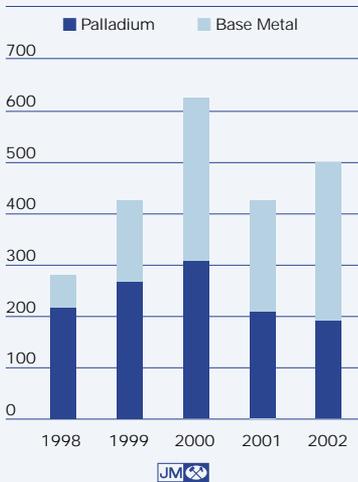
Palladium Demand: Electronics '000 oz		
	2001	2002
Europe	35	80
Japan	260	155
North America	250	250
Rest of the World	125	225
<b>Total</b>	<b>670</b>	<b>710</b>





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MLCC Production by Electrode Type  
1998-2002  
Billions



Global sales of mobile phones, however, grew by up to 5 per cent according to manufacturer estimates, helped by the introduction of new 3G products and by strong sales in China. Automobile demand for electronics also continued to expand as global light vehicle production recovered by around 3 per cent, and the electronics content of automobiles maintained its long-term growth trend.

These factors produced a rebound in multi-layer ceramic capacitor (MLCC) shipments, which rose by 16.5 per cent to 500 billion. Production of palladium-based MLCC, however, dropped as the market share of nickel products jumped from 52 per cent to 63 per cent. The switch in favour of nickel is a result of the substantial investment made by manufacturers in base metal capacitor fabrication plants between 1999 and 2001 in response to palladium's rising price.

After collapsing by 50 per cent in 2001, demand for palladium in plating applications stabilised in 2002. The price of palladium fell throughout the year, both in absolute terms and in relation to gold. After starting the year at a premium to gold of around \$160, the palladium price fell to reach parity by the end of June. At this point palladium was significantly cheaper to use than gold in plating applications, as less metal is required to achieve the same performance of coating. The cost advantage of palladium widened during the final two months of the year as the metal's spot price dropped steeply and gold climbed. This helped to slow the substitution of palladium, although users remained wary of its price volatility. In addition, component manufacturers continued to make efforts to thrift their overall use of precious metals in the plating of lead frames and connectors.

Demand for palladium conductive pastes used in hybrid integrated circuits (HIC) was flat in 2002 – lower sales of HIC to the telecommunications market were offset by greater use in automobile electronic circuitry. In the resistor sector, demand for palladium pastes for chip and network components grew but that for surge resistors (used primarily in the telecommunications infrastructure) fell due to over-investment made in the late 1990s. Overall, net palladium demand for resistors was static.

Despite the increased attention being paid to recycling of old electronic scrap, the volume of palladium recovered in 2002 fell for the second year in succession to an estimated 240,000 oz. With spending on new IT equipment constrained, the number of

obsolete products entering the recycling chain fell. The average precious metal content of scrapped components continued to decline, reflecting the previous success of manufacturers in thrifting pgm use.

## Other

Palladium demand from the jewellery sector and other markets increased by 60,000 oz (20 per cent) to 355,000 oz in 2002. In Japan, higher production of white gold and a fall in the recycling of jewellery stock resulted in greater palladium demand. In North America, the drop in the price of palladium halted the trend to substitute some palladium-based petroleum cracking catalysts with base metal alternatives.

Demand for palladium in jewellery alloys increased by 13 per cent in 2002 to 260,000 oz, primarily due to increased purchases by the Japanese jewellery trade. Palladium is a constituent of many platinum jewellery alloys (typically from 5 to 10 per cent) and is commonly used as the whitening agent in white gold alloys (from less than 5 per cent to over 15 per cent palladium). Japanese sales of white gold articles jumped by 16 per cent in 2002, taking market share from both the lowest priced platinum jewellery and from yellow gold jewellery.

Demand for palladium was also assisted by the lower use of inventories of platinum jewellery in Japan compared to the year before. After cutting back stock levels heavily in 2001, there was much less slack in the fabrication and retail pipeline in 2002. As a result purchases of platinum jewellery alloys containing palladium rose, even though retail sales of platinum jewellery declined.

In China, the strength of the platinum jewellery market and rising white gold sales gave some impetus to demand for palladium as an alloying agent. However, only a minority of platinum and white gold alloys made in China contain palladium – a number of other metals such as nickel are also used – and so growth in palladium demand was not as strong as growth in the overall precious metal jewellery market.

In the industrial sector, the fall in the palladium price during 2002 reduced the economic incentive for petroleum companies to substitute palladium-based hydrocracking catalysts with base metal products. In 2001 this substitution caused net sales of palladium back to the market from refineries in North America but in 2002 demand across the industry was positive.

Palladium Demand: Jewellery & Other  
'000 oz

	2001	2002
Europe	55	55
Japan	150	175
North America	15	45
Rest of the World	75	80
<b>Total</b>	<b>295</b>	<b>355</b>

