

Palladium

Autocatalyst

Sales of palladium to auto makers are forecast to fall by 14 per cent to 4.84 million oz in 2001. Consumption in North America and Europe will decline sharply, with some car companies increasing their use of other pgm in order to thrift palladium. In addition, we believe that the US auto industry will draw upon strategic stocks, thereby reducing fresh purchases of metal in 2001.

Europe

After reaching 1.9 million oz in 2000, the use of palladium by the European auto industry is expected to decline by 8 per cent to 1.74 million oz this year. Consumption will be hit by lower sales of gasoline cars, combined with a shift back to platinum technology by some auto makers.

Between 1995 and 2000, European car companies switched to palladium-rich catalysts on a large majority of their gasoline models, and most initially selected this technology to meet the European Stage III legislation which came into effect from January 2000.

Palladium Demand: Autocatalyst '000 oz

	2000	2001
Europe	1,900	1,740
Japan	510	540
North America	2,805	2,020
Rest of the World	425	540
Total	5,640	4,840
Autocatalyst recovery	(230)	(290)



However, high and volatile palladium prices, combined with concerns about the metal's availability, have led some car companies to move back towards platinum technology on gasoline vehicles. This will have a modest impact on palladium demand in 2001, and a more significant effect next year.

Japan

In Japan, autocatalyst demand for palladium is forecast to rise by 6 per cent to 540,000 oz in 2001. Tighter emissions standards came into effect for new domestic models in October 2000, and will apply to all new vehicles (including imports) by September 2002. Most Japanese car companies have opted to comply with the new standards in advance of their full implementation, and are voluntarily meeting even stricter limits on some models. This has resulted in a significant increase in pgm loadings on catalysts. The increase in palladium consumption is less than that of platinum as some Japanese car companies have reduced the proportion of palladium in the pgm mix on vehicles sold in their domestic market.

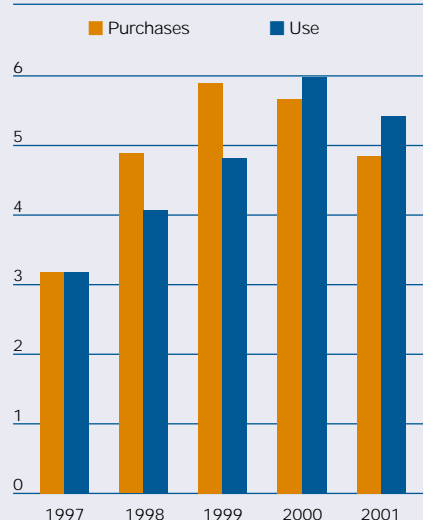
Palladium-rich technology continues to dominate on export models, especially those sold in Europe and North America. However, a contraction in the auto market in both these regions resulted in a 9 per cent fall in total vehicle shipments from Japan during the first six months of 2001. We therefore expect the amount of palladium used on export models to decline slightly this year.

North America

Sales of palladium to North American auto makers are forecast to be 2.02

Palladium Autocatalyst Demand 1997-2001

Million oz



million oz in 2001, down 28 per cent compared with last year and nearly 1.5 million oz lower than the peak recorded in 1999. This year's decline reflects a combination of lower consumption in catalysts, and the use of metal from stocks purchased in previous years.

There are two main factors behind the fall in actual usage on catalysts: a sharp drop in vehicle production, which was down 13 per cent in the first eight months of the year, and thrifting of palladium in response to concerns about price and availability. A reduction in average palladium loadings has been achieved through a combination of improved engine management, advanced catalyst technology, and increased use of the other autocatalyst pgm. Nevertheless, palladium remains a vital ingredient of emission control systems in the USA: it is the most effective catalyst for HC, and emissions limits for this pollutant continue to tighten.

During 1998 and 1999, the US auto industry made substantial additions to strategic stocks of palladium. High prices and increasingly difficult business conditions have encouraged some companies to draw upon inventories this year, with the result that fresh sales of palladium to car companies will be significantly below the level of actual consumption.

Rest of the World

In the Rest of the World, the use of palladium in autocatalysts continues to rise rapidly, with the enforcement of stricter emissions standards outweighing declines in vehicle production in most countries. We forecast that demand will rise by 27 per cent to reach 540,000 oz in 2001.

The most significant increase will occur in Korea, where LEV standards were introduced in January 2001. In order to comply with strict new HC emissions limits, there has been a significant increase in palladium loadings on domestic models. However, this has been partly offset by a decline in vehicle production, which is expected to be down at least 6 per cent this year.

China has also seen a rise in the use of palladium in autocatalysts. European Stage I legislation has been imposed on all new vehicles since January 2001, and some vehicles meeting Stage II standards are being offered in response to fiscal

incentives. Palladium technology is being used on some models in order to meet the new limits.

In Latin America, a decline in auto production in Argentina and Mexico has been outweighed by significant expansion of the Brazilian market. We expect palladium demand to increase modestly in 2001, reflecting higher vehicle output and rising loadings.

Autocatalyst Recovery

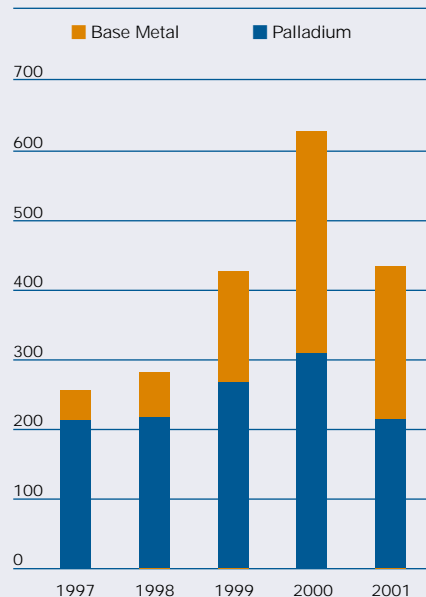
The recovery of palladium from autocatalyst scrap is expected to rise by 26 per cent to 290,000 oz in 2001. Higher palladium prices encouraged an increase in collection rates during the first half of the year. In addition, palladium catalysts were widely adopted by the European and US auto industry during the second half of the 1990s and these vehicles are now starting to enter the scrap network in greater numbers.

Dental

Dental demand is forecast to fall by 16 per cent to 690,000 oz in 2001. However, following a drop in the palladium price to two year lows of under \$400, there are signs that demand has stabilised and may begin to recover next year.

In both Europe and North America, there has been a move away from palladium-based dental alloys over the last two to three years. This trend accelerated in late 2000 and early 2001, with huge rises in metal costs precipitating a widespread movement to high gold alloys and, especially in Europe, base metal formulations. European palladium demand is forecast to fall by 40 per cent this year, and this decline is unlikely to be reversed: many alloy manufacturers have now ceased production of high palladium compositions. The downturn has been less severe in North America, with demand 17 per cent lower than last year. Here, weaker palladium prices have already encouraged some return to

MLCC Production by Electrode Type 1997-2001
Billions



palladium alloys and, if the price remains near current levels, it is likely that the use of palladium will stabilise or even increase slightly in 2002.

In Japan, the fall in palladium usage has been more moderate, with consumption down 9 per cent to 430,000 oz. Demand in this region tends to be less sensitive to changes in metal prices, as the use of an alloy containing 20 per cent palladium is subsidised by the state health insurance scheme. The main factor behind the fall in palladium consumption this year is the weak Japanese economy, which is deterring patients from spending money on dental treatments.

Electronics

Sales of palladium to the electronics industry are expected to fall by over 50 per cent to 1.05 million oz this year. There has been a sharp decline in production of multi-layer ceramic capacitors, due to weakness in sales of electronic devices. In addition, MLCC manufacturers have used large amounts of palladium from stocks.

Palladium Demand: Dental '000 oz

	2000	2001
Europe	100	60
Japan	470	430
North America	230	190
Rest of the World	20	10
Total	820	690



Output of multi-layer ceramic capacitors (MLCC) has been severely affected by a reversal of fortunes in the electronics market, which had been growing at rapid rates for several years. As a result of an unexpectedly sharp downturn during the final months of 2000, electronic device manufacturers began this year with unsold stocks of finished products and large inventories of components such as MLCC. The electronics market has continued to weaken this year, with sales of computers forecast to fall by about 10 per cent and those of mobile phones by around 5 per cent. As a result, worldwide production of MLCC is expected to plummet by a third, to just over 420 billion units.

Technical developments have had little impact on palladium demand this year. Since the mid 1990s, MLCC manufacturers have adopted nickel pastes for the conductive layers in an increasing percentage of their capacitor output. In consequence, the proportion of capacitor production using palladium diminished from around 85 per cent in 1997 to under 50 per cent in 2000. This year, poor profitability has led manufacturers to freeze investment in new furnaces for nickel MLCC, with the result that palladium's share of the market is not expected to change significantly. The move to base metal technology will resume once conditions in the industry improve, though

Palladium Demand: Electronics '000 oz		
	2000	2001
Europe	265	180
Japan	990	330
North America	485	240
Rest of the World	420	300
Total	2,160	1,050

palladium will continue to be used in certain high-specification MLCC.

Production of palladium-based capacitors is expected to be down 30 per cent this year, and underlying consumption of the metal will fall by a similar percentage. However, sales of palladium to MLCC makers will see a much more drastic decline. Japanese manufacturers in particular held substantial stocks which we believe have been consumed when palladium prices were high during the first half of 2001.

Demand has also fallen in palladium's other electronic applications. Weakness in the telecommunications market has led to lower use of palladium pastes in hybrid integrated circuits (HIC). In the connector market, there has been a move back to gold coatings, although palladium is still required for high-end products. The adoption of palladium for plating leadframes has been halted by high prices, while there has been thrifting by manufacturers already using this technology.

Other

High palladium prices have generally had less impact on consumption of palladium in its smaller industrial applications, but jewellery demand has been affected by lower sales of platinum-palladium alloys in Japan. Total demand for palladium in other sectors is forecast to fall by 4 per cent to 550,000 oz in 2001.

Demand for palladium in jewellery alloys is expected to fall slightly this year, with its increasing use as a whitening agent in white gold offset by a large fall in consumption in platinum jewellery alloys in Japan.

Platinum jewellery alloys used in Japan typically contain between 5 and 15 per cent palladium, and sharp falls in the fabrication of platinum jewellery will therefore have a negative impact on palladium demand. In contrast, consump-

Palladium Demand: Other '000 oz		
	2000	2001
Chemical	255	245
Jewellery	255	240
Other	60	65
Total	570	550

tion of similar alloys in China continues to increase, although the rate of growth in palladium usage has been tempered by a move towards alloys with a higher platinum content.

The use of palladium in white gold has increased sharply in the last two years. In Japan in particular, high platinum prices have encouraged manufacturers to adopt white gold for inexpensive fashion jewellery, with the result that sales of white gold items were up by a third during the first half of 2001. However, this gain was partly offset by the development of white gold alloys with a lower palladium content.

The use of palladium in the chemical industry is expected to weaken slightly to 245,000 oz to this year. This is primarily due to lower sales of palladium catalysts to producers of vinyl acetate monomer. However, demand for palladium in the manufacture of pharmaceutical and speciality products remains strong.

Other applications will consume 65,000 oz of palladium in 2001, up slightly on last year. In the petroleum sector, the replacement of some palladium hydrocracking catalysts with base metal formulations has continued, but at a lower rate than in 2000. This will result in a reduction in sales of palladium back to the market this year. There will be little change in demand in smaller applications, such as oxygen sensors, brazing alloys and catalysts for pollution control from stationary sources.