

# PALLADIUM

## AUTOCATALYST

*Demand for palladium is expected to increase sharply again in 1999, rising by 500,000 oz to reach 4.89 million oz. The largest increases will occur in North America and Europe, where palladium loadings are being increased to meet tougher hydrocarbon emission standards.*

### Europe

European demand for palladium for autocatalysts is expected to increase by 140,000 oz to 1.51 million oz in 1999. The steady substitution of palladium for platinum in catalysts fitted to gasoline cars has been well documented in our recent reports and is continuing this year. Palladium demand has also been enhanced by fiscal incentives that encourage the early introduction of cars meeting Euro Stage III emissions legislation. These standards are due to be effective for new models from January 2000 and for all new cars from January 2001. From these dates a new set of incentives will come into effect that will apply to cars meeting the Stage IV regulations that are planned for 2005; there are already indications that some auto makers are planning to switch directly to Stage IV technology. These

### Palladium Demand: Autocatalyst



'000 oz	1998	1999
Europe	1,370	1,510
Japan	330	350
North America	2,470	2,810
Rest of the World	220	220
<b>Total</b>	<b>4,390</b>	<b>4,890</b>
<i>Autocatalyst recovery</i>	<i>(175)</i>	<i>(200)</i>

developments are expected to boost pgm demand in autocatalysts, with palladium loadings rising most strongly.

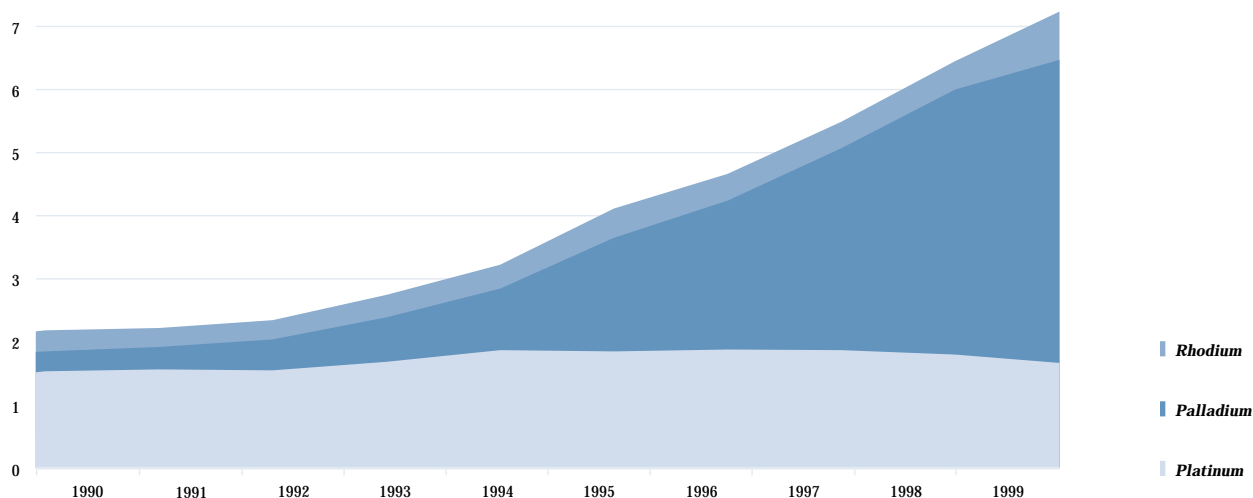
### Japan

In Japan, demand for palladium for autocatalysts is forecast to increase by 20,000 oz in 1999, to reach 350,000 oz. This is partly a result of this year's recovery in passenger car sales, up 3 per cent in the first eight months over the same period in 1998. Another reason for the increase in demand is that exports to North America have risen, and these cars are increasingly being fitted with heavily loaded palladium-rich catalysts to meet LEV standards.

### Demand for PGM in Autocatalysts 1990-1999



Million oz



## North America

North American demand for palladium in autocatalysts is expected to grow sharply once again in 1999, rising by 340,000 oz to 2.81 million oz. A major factor in the increase in palladium demand is higher sales of cars and sports utility vehicles, with the large engines of the latter requiring correspondingly larger catalyst volumes to control emissions.

In addition, the proportion of cars that meet LEV standards has increased, with most manufacturers raising the loadings of palladium in catalysts used to meet these standards. Auto makers appear to be accelerating the production of LEV vehicles, both as a marketing tactic and to gain credits against future legislation. From the middle of 2000, virtually all light duty vehicles sold in the USA will meet the LEV standard.

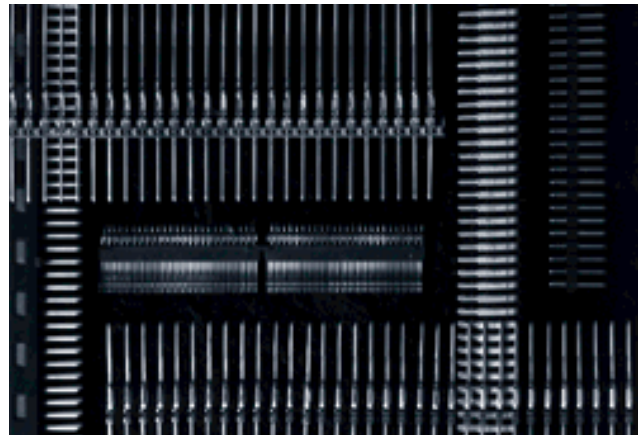
## Rest of the World

Demand for platinum for autocatalysts in the Rest of the World is expected to be unchanged at 220,000 oz in 1999. Demand in Korea will increase due to a recovery in domestic car sales. In India, demand for pgm in catalysts is expected to rise this year and next. The Indian Supreme Court has ruled that from 1 April 2000, all new cars sold in Delhi will have to comply with Euro II emission standards; this will affect some 15 per cent of cars sold in India. The catalysts used on most of these cars will contain palladium and rhodium.

Demand for palladium will fall in South America, where car sales have been in decline since November 1997, when the Brazilian Government raised interest rates in an attempt to minimise any knock-on effect from the Asian financial crisis. As a result, car sales in Brazil fell by 23 per cent in 1998, and they have continued to decline in 1999. Argentina, the third largest car producer in Latin America, exports about 45 per cent of its output to Brazil and has therefore also suffered.

## Autocatalyst Recovery

The amount of palladium recovered from scrapped autocatalysts continues to climb gradually and is expected to reach 200,000 oz in 1999. The rapid growth in the use of palladium in autocatalysts did not begin until 1995. Therefore, the recovery of this metal from catalytic converters removed from scrapped cars will not accelerate for another 3-4 years. Most of this growth will come from the USA where the recovery infrastructure is much better developed than in Europe, the other region which has seen a dramatic increase in the use of palladium in autocatalysts in recent years.

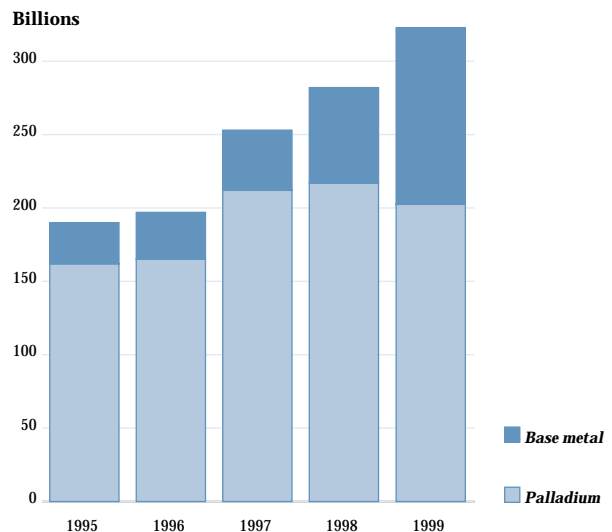


## ELECTRONICS

*Palladium demand for electronics is expected to decline by 230,000 oz in 1999 to 1.84 million oz due to a combination of substitution by base metals and further miniaturisation of electronics goods.*


The principal use for palladium in electronics is in the electrode layers of multi-layer ceramic capacitors (MLCC). Production of these components, which are widely used in mobile phones, auto and consumer electronics, has risen by 18 per cent in 1999, but higher palladium prices have led to an expansion in the use of base metal electrodes - usually nickel - and this is eating into palladium's market share. Base metals are expected to account for almost one third of the MLCC manufactured in 1999, up from around a quarter in 1998. The changeover has occurred most rapidly in Japan, where manufacturers have traditionally used electrodes with a high palladium content, making substitution

MLCC Production by Electrode Type



by base metals very attractive. Even in other regions of the world, where the use of palladium is less intensive, MLCC makers are investing steadily in the new production lines that are necessary to utilise base-metal technology.

In addition to substitution, palladium demand in MLCC is being negatively affected by continued miniaturisation of many electronic devices, as typified by the ever-reducing size of mobile phones. Despite these changes, palladium is expected to be retained in high-reliability and other specialised MLCC, where the technical demands are greatest. Therefore, although base metals will account for much of the forecast growth in the production of MLCC in future years, the use of palladium is likely to remain significant.


<b>Palladium Demand: Electronics</b>		
		
'000 oz		
	<u>1998</u>	<u>1999</u>
Europe	270	240
Japan	1,080	925
North America	480	450
Rest of the World	240	225
<b>Total</b>	<b>2,070</b>	<b>1,840</b>

The high price of palladium, and its volatility over the past two years, has also impacted other uses in the electronics sector. When the price of palladium was below that of gold it was increasingly being used as an alternative to gold for plating connectors, but the current differential in price between the two metals - a premium of \$78 for palladium at the end of September 1999 - makes any further switch from gold unlikely. For the plating of lead frames used to mount semiconductor chips, palladium has an advantage over the traditional tin-lead solders on health and environmental grounds, and some switching to palladium has taken place. However, the high price of palladium is encouraging manufacturers to seek alternative solutions for the replacement of tin-lead.

## OTHER

*Demand for palladium in other applications will decline marginally this year, from 1.81 million oz in 1998 to 1.77 million oz. Although there has been a reduction in the use of palladium in dental alloys, increased demand in jewellery alloys and process catalysts has largely offset this decline.*

In 1998 there was a significant drop in demand for palladium from European dental alloy manufacturers, but this was related

<b>Palladium Demand: Other</b>		
		
'000 oz		
	<u>1998</u>	<u>1999</u>
Chemical	230	245
Dental	1,230	1,160
Jewellery	235	255
Other	115	110
<b>Total</b>	<b>1,810</b>	<b>1,770</b>

more to changes in the method of reimbursing dental patients in the largest dental alloy market - Germany - than to the increase in the price of palladium. The new German government, elected in September 1998, has reversed these changes, but during the current year both the new and old systems of dental remuneration have been operating simultaneously in different parts of the country. As a result, a clear picture of the German dental market is not likely to emerge until well into 2000.

It is plain, however, that some sensitivity to the price of palladium has emerged in the dental sector. This is not surprising because the growth in the use of palladium-based alloys during the 1990s was due to their low price compared with gold alternatives. Although technical factors also play a role in the choice of alloy used by the dentist, the current differential in price between gold and palladium is a disincentive to the use of the latter. This price sensitivity has been seen most sharply in the USA and in some European markets. Demand in Japan has been less affected due to the widespread use of an alloy containing 12 per cent gold and 20 per cent palladium that is covered by the state insurance scheme. Overall, demand for palladium in dental alloys is expected to fall by 6 per cent to 1.16 million oz.

Palladium is used as a component of both platinum and white gold jewellery alloys. The steadily rising price of palladium has led some manufacturers to substitute it with cheaper metals in these alloys. However, any such substitution this year has been outweighed, for platinum jewellery, by the rise in demand in China and, for white gold, by the trend towards white metal jewellery in other parts of the world. We therefore expect palladium demand for jewellery to increase by 20,000 oz in 1999 to reach a total of 255,000 oz.

Demand for palladium in the chemical sector is expected to grow by 15,000 oz this year, to reach 245,000 oz. There has been significant investment in catalysts used in the production of tetrahydrofuran, a chemical used in the production of synthetic fibres, and acetaldehyde, used in the production of acetic acid.