

# Palladium

## Autocatalyst

Demand for palladium in autocatalysts is forecast to fall by 720,000 oz in 2000, the first decline for more than a decade, to 5.16 million oz. In 1998 and 1999, several auto makers built substantial stocks of palladium, but this year some have drawn from these stockpiles, especially at times of highest prices. Despite the fall in purchases by the auto industry, the amount of palladium used in catalysts this year will increase by just over 20 per cent as more cars are manufactured to meet tighter emission standards in the USA, Europe and Japan.

### Europe

Demand for palladium in Europe is expected to increase by 19 per cent this year to 1.82 million oz, largely in response to the introduction of Euro Stage III legislation from January 2000. Most auto makers are using palladium-rich catalysts to meet these stricter limits for gasoline models, resulting in a further move away from platinum technology. At the same time, average pgm loadings have increased to meet the new standards. These factors have substantially outweighed a slight decline in sales of gasoline cars, caused by a shift in consumer preferences towards more fuel-efficient diesel vehicles.

### Japan

Some Japanese auto makers added to their stocks of palladium in 1999 but we do not expect them to do so again in 2000 and, as a consequence, demand is expected to fall by 18 per cent to 490,000 oz. In October this year, Japan introduced new,

stricter emissions legislation (JLEV) and this has resulted in heavier loadings of palladium in catalysts on cars for the domestic market, although the full impact will not be felt until next year. More palladium has also been used in catalysts fitted to cars exported to the USA to meet the LEV regulations there: exports to North America in the first six months of 2000 were up 14 per cent on last year.

The longer term outlook for palladium use in autocatalysts in Japan is not clear. The requirement to produce low emissions vehicles to comply with JLEV and overseas regulations would seem to favour palladium. However, there are signs that some Japanese auto companies, driven by concerns about the future price and availability of palladium, will add platinum to catalyst systems fitted to new models.

### Palladium Demand: Autocatalyst

'000 oz

	1999	2000
Europe	1,530	1,820
Japan	600	490
North America	3,490	2,430
Rest of the World	260	420
<b>Total</b>	<b>5,880</b>	<b>5,160</b>
<b>Autocatalyst recovery</b>	<b>(195)</b>	<b>(230)</b>



### North America

In North America, demand for palladium by the auto industry in 2000 is forecast to decline by 30 per cent to 2.43 million oz.

In recent years, in anticipation of substantially increased use of palladium,



most auto makers built up stocks of the metal, in order to protect against price rises and uncertainty about the future availability of palladium. Significant additions were made in 1999, but this year we have seen a significant reversal of this policy, with manufacturers drawing substantially from these stocks, especially at times of the highest prices for palladium.

Despite the fall in purchases by auto makers, the actual use of the metal in catalyst systems fitted to cars and trucks in North America in 2000 will increase by around 450,000 oz, in order to meet the tighter standards now in place. During the year, several of the major US auto companies have indicated that they wish to reduce their dependence on palladium and it seems likely there will be moves to try to bring overall pgm use in autocatalysts closer to mine mix. However, even if such moves are successful, the ever tightening regulations on hydrocarbon control in the USA will almost certainly ensure that palladium continues to be an essential component of most auto-catalyst systems.

## Rest of the World

Demand for palladium in the Rest of the World is expected to increase by 160,000 oz this year to 420,000 oz. Production of cars is significantly higher than last year in many countries in Asia that have catalyst enforcing legislation, with particularly strong gains in Malaysia, India and China. In addition, growth in production of trucks in Mexico has led to increased demand for palladium in catalysts.

## Autocatalyst recovery

Recovery of palladium from scrapped autocatalysts is expected to rise by 35,000 oz in 2000 to reach 230,000 oz. The dramatic increase in the use of palladium in autocatalysts did not begin until the middle 1990s and therefore it

will be at least a further 2-3 years before this change is reflected in significant increases in the amount of metal recovered from spent catalysts.

## Electronics

Demand for palladium in electronics is expected to grow by 5 per cent to reach 2.07 million oz in 2000. This increase is somewhat surprising given that the high price of palladium might have been expected to accelerate its substitution by lower cost materials. However, much greater production of the electronic components in which palladium is used and a reduction in the amount of scrap being recovered are forecast to result in an increase in demand of 90,000 oz.

Worldwide production of multi-layer ceramic capacitors (MLCC) is forecast to grow by 50 per cent to 630 billion in 2000. This massive growth in output has outweighed a further increase in the substitution of palladium by nickel in the electrode layers of these capacitors.

Japan accounts for just over half of global MLCC production and has traditionally used high palladium content pastes to manufacture electrodes. Substitution with nickel has advanced strongly and is expected to exceed 60 per cent in Japan this year. Despite this change, demand for palladium in Japan is expected to remain virtually unaltered from that of 1999, due to the increase in MLCC production.

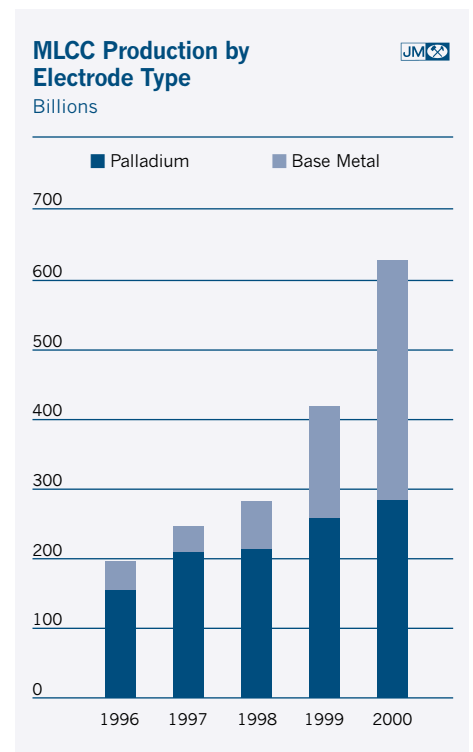
In the countries of South East Asia, which together now comprise the second largest producing area for MLCC, similar rates of substitution of palladium by base metal have been achieved to those in Japan. However, a near 70 per cent increase in output of MLCC in the region has resulted in demand for palladium increasing significantly in 2000.

The growth of MLCC production in North America this year will be lower

	1999	2000
Europe	255	260
Japan	980	975
North America	395	415
Rest of the World	350	420
<b>Total</b>	<b>1,980</b>	<b>2,070</b>

than in other regions, at around 20 per cent. Manufacturers here have traditionally used silver-palladium pastes with a higher silver content to make MLCC electrodes: as a result, cost pressures have been less intense in this region and substitution of palladium by base metals has progressed more slowly.

The use of palladium pastes for the conductive elements of hybrid integrated circuits (HIC) has also been affected by the higher price of the metal and demand has declined by about 10 per cent this year as manufacturers have moved to silver-palladium pastes with higher silver



contents. In other electronic applications of palladium, such as the plating of connectors and lead frames, price is also an issue but demand has changed little.

Some further substitution of palladium by gold in the plating of connectors has been encouraged by the widening of the price differential between the two metals, but increases in production of these components have more than compensated for the lower intensity of palladium use. Palladium is also still preferred where high reliability is essential.

The high price of palladium is discouraging lead-frame manufacturers seeking an alternative to tin-lead solders from switching to palladium. However, those that have already made the change have continued to use palladium and demand this year is virtually unaltered.

A consequence of the efforts to miniaturise, and minimise the cost of, electronic goods in recent years has been the gradual thrifting of precious metals from electronic components. One result of this is that the content of palladium in manufacturing scrap and old scrap is steadily diminishing. Thus, although the substantial increase in the price of the metal, and the growth of component production, has resulted in increased volumes of scrap being collected for refining, we believe that the amount of palladium that will be recovered will fall by around 20 per cent this year.

## Dental

The use of palladium in dental alloys has been severely affected by the rising price of the metal. Although the impact of price has not been uniform across the main consuming countries, overall demand is expected to fall by 22 per cent to 870,000 oz in 2000. In both Europe and North America there has been a significant shift away from high-palladium alloys in dental

Palladium Demand: Dental '000 oz		
	1999	2000
Europe	180	110
Japan	545	510
North America	350	230
Rest of the World	35	20
<b>Total</b>	<b>1,110</b>	<b>870</b>

treatment, with substitution by either gold alloys or base metals. In Europe demand is expected to fall by 39 per cent in 2000 to 110,000 oz, and in North America the decline is predicted to be 34 per cent to 230,000 oz.

In Japan, the largest market, the situation is different: demand has fallen this year, but only by 6 per cent to 510,000 oz. In April, the Japanese government introduced a new system for the compensation of patients under the state insurance scheme. The cost of the components of the standard gold: palladium alloy used for dental restorations covered by this system is now monitored and the payment made is adjusted every six months in line with the cost of these materials. It therefore seems likely that the use of palladium in dental alloys will remain firmer in Japan than in other countries.

## Other

Demand for palladium in other applications will decline by 55,000 oz this year to 530,000 oz. Although purchases by the chemical industry have increased marginally, there have been substantial falls in consumption in other sectors in response to higher palladium prices. The use of palladium as a minor alloy component in platinum jewellery alloys has been subject to conflicting pressures. Increased demand for platinum in

jewellery is positive for palladium demand, but the continuing high price of the metal is encouraging some jewellery makers, notably in China, to seek alternatives to palladium as an alloy component. In some instances this has been achieved by increasing the platinum content of the alloys, but for the most part, palladium has been substituted by other metals such as copper or cobalt.

Palladium is widely used as a whitening agent in white gold jewellery alloys. However, as white gold is often regarded as a cheaper alternative to platinum, manufacturers are naturally reluctant to include a metal that is currently more expensive than platinum, and are seeking less expensive substitutes for palladium.

Demand for palladium in the chemical sector is expected to grow by 20,000 oz this year to reach 260,000 oz. During 2000 there has been a significant investment in new plant to produce vinyl acetate monomer using palladium catalysts.

In contrast, demand for other minor applications is forecast to fall by 50,000 oz, mainly due to the replacement of palladium by base metals in some hydrocracking catalysts used in petroleum refining. The reasons for this are mixed, with some oil companies aiming to produce different refined products in response to market changes, and others indicating that the higher palladium price has been a factor.

Palladium Demand: Other '000 oz		
	1999	2000
Chemical	240	260
Jewellery	235	210
Other	110	60
<b>Total</b>	<b>585</b>	<b>530</b>