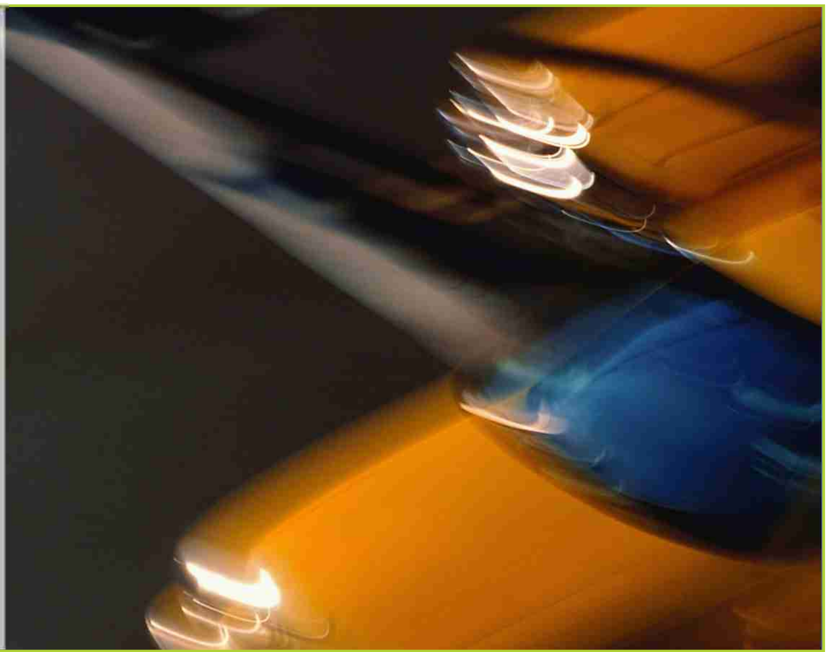
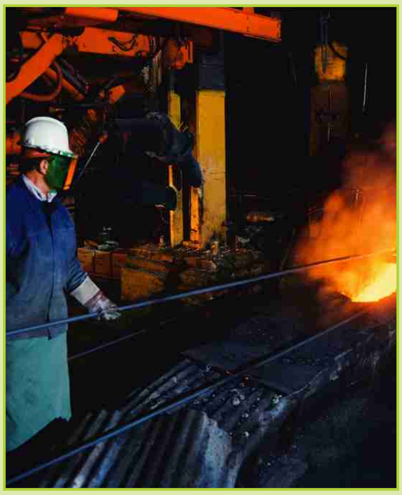
# More efficient reclamation of valuable platinum from automobile catalysts

## New understanding of recovery process offers major advantages to industry as growing numbers of catalysts reach the end of their service life





*'With the average catalyst lasting more than 50,000 miles, large quantities are now becoming available for recycling in the UK.'*

A new approach to recovering platinum group metals from automobile catalyst exhaust converters offers increased efficiency at a crucial time for the industry, it was announced today (25th March 2002). With the average catalyst lasting more than 50,000 miles, large quantities are now becoming available for recycling in the UK. But recovering the tiny amounts of platinum has proved difficult and expensive using conventional methods of dealing with bulk quantities of scrap.

New research as part of a major waste minimisation initiative backed by government and industry has changed ideas about how to recover the valuable metal. Knowing exactly how the microscopic particles behave in high temperature furnaces has made it possible to build commercial plants capable of continuous operation, high recovery rates and much lower energy consumption.

'This is a big step forward, coming at the right time in the UK market as large amounts of scrap catalysts become available,' says Dr John Harry of Loughborough University's Department of Electronic and Electrical Engineering. 'It's in the national interest to recover as much of this valuable strategic metal as possible. We now know how to do it and have all the information we need to go ahead with full-scale furnace designs.'

The process has been pioneered as part of the government's programme for Waste Minimisation through Recycling, Re-use and Recovery in Industry. The research team at Loughborough worked with the Centre for Numerical Modelling and Process Analysis at Greenwich University in the three-year programme. Funding worth approximately £250,000 was awarded by the Engineering and Physical Sciences Research Council, with support from industrial partners Engelhard Technologies, Inco and Johnson Matthey.

The main achievement of the research project is a much better understanding of how the platinum particles behave in high temperature furnaces. It had been assumed that they would settle out of the ceramic slag at high temperatures. But the particles are initially so small – between 1 and 20 nm – and in such low concentrations, it was discovered that gravity alone would not work.

'We were initially very surprised by this result,' says Dr Harry. 'It was quite different from our assumptions, and those made by commercial developers and operators of recycling plants. We found that the particles are pulled randomly in all directions by thermal diffusion and so in theory they would never drop out.'

The reason the particles are so small is the way platinum is deposited on the ceramic substrate of the catalyst as an organic compound just one molecule thick. The key to recovering them, according to the research, is to attract them by liquid droplets of another metal such as iron or copper. Using these droplets as a collector, it was found that all the platinum could be swept out of the molten slag and recovered. Tests showed that the particles attracted to the collector metal dropped out very quickly – in less than 10 minutes compared with the predicted 40 minutes or more.

**WMR3**

**(Waste Minimisation through Recycling, Re-use and Recovery in Industry) was a collaborative industrial research programme supported by £12m of funding from EPSRC and DTI during 1995 – 2003.**

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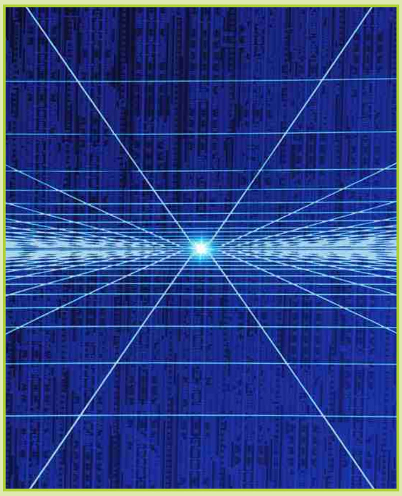

This means that the process will use much less energy than had been anticipated. Inert slag is all that is left, allowing safe disposal with no risk to the environment. At present, most spent catalysts in the UK are thrown into furnaces with other scrap material. There is no dedicated process for maximising what is potentially a valuable resource as the volume of scrap builds up. 'There could be a potential for two or three of these plants for automobile catalysts in the UK alone,' says Dr Harry. 'An industrial partner could now go ahead with construction based on the principles we have established.'

'Another exciting thing is that the same principles apply to retrieving fine dust particles in many other industrial processes. So there could be many more applications opening up in other areas.'

## Additional Project details and background

***Why is it difficult to recycle platinum from automobile catalysts?***

Automobile catalyst exhaust converters comprise a metal canister usually containing a metallic substrate coated with a wash containing platinum group metals (PGMs). The concentration of PGM by weight is extremely low, around 0.2%, so recovery rates must be very high to make the process economic. Contamination with lead, carbon and other materials passing through the car engine over its lifetime makes it difficult to recover the precious metals using aqueous solutions.

***What happens at the moment?***

At present most used catalysts in the UK are mixed with other scrap. There is no dedicated process for dealing with them. In the United States, where catalysts have been in use for a longer period, there is already a large-scale recycling plant but this operates as a batch process and is not available commercially.

***How does the new process work?***

The original idea was to start with a thin layer of slag rather like the float glass process allowing PGM particles to settle out by gravity. When the behaviour of the particles was properly understood, this was rejected in favour of a novel process combining an extended DC arc combined with electro-slag melting.

In the experimental equipment, crushed autocatalyst, collector metal and flux were initially heated in a crucible by the DC electric arc. Iron filings or powder were used as the collector metal, and the addition of a small amount of carbon was found to improve effectiveness.

During the initial heating and melting phase, agitation of the bath by the electric arc was found to help the liquid collector metal to sweep the slag for platinum.

Resistive electro-slag heating maintains the temperature during the next phase of the process, during which the collector metal, having absorbed the PGM droplets, settles out of the slag. The performance of this collector metal was found to be the key to achieving good rates of PGM recovery. Mathematical models were developed to maximise the rate at which the PGMs are absorbed by the collector metal.

***Test results***

The test results showed excellent physical separation of slag and bullion. Under optimum conditions, the level of PGM left in the slag is insignificant. Settling takes place rapidly, reducing energy consumption by minimising the period needed for resistive heating. The optimum temperature range was found to be 1500-1550°C.

Experimental results indicate that the same process could be applied to many other applications to treat feed or waste materials containing very fine particles.


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