been compared with that of a conventional CRT™ and with a catalysed filter. The regeneration efficiency of the CCRT™ has been found to be better than that of a CRT™, which in turn is significantly better than only a catalysed filter. The CCRT™ operates well in problematic situations where CRT™ performance is marginal. This is probably due to reoxidation in the filter of NO, formed from PM oxidation by NO_2. Each NO molecule is therefore used several times in PM oxidation via reaction with NO_2.

In situations where the exhaust gas temperature is too low for the PM/NO_2 reaction to be effective or where the NOx:PM ratio is too low for the reaction involving NO_2 to remove all of the PM, it is necessary to provide a means of increasing the temperature to 550°C or higher to initiate PM combustion with oxygen. In cars with diesel engines this can be achieved by having a flexible fuelling system that enables injection of fuel into the cylinders during exhaust strokes, or perhaps injection of fuel directly into the exhaust gas. Partially burnt fuel in the exhaust gas is then oxidised over the Pt catalyst in front of the filter, and the exotherm produced is sufficient to raise the gas temperature to the point where the PM burns. However, it is important to control the rate of PM combustion in the filter to limit excessively high exotherm temperatures, particularly when the exhaust gas flow rate is low. Ford (2002-01-0427) have highlighted the practical control parameters that could be used to do this and have concluded that it is best to restrict the amount of oxygen present during combustion. This can be done reliably by combining exhaust gas recirculation (EGR) with an inlet air throttle. A strategy that can deal with transient response needs combined with as much forward control as possible is deemed to be necessary for overall successful operation.

Conclusions

Significant advances in the exhaust emissions control areas are taking place, and in many of them pgm-based catalysts play vital roles. Over recent months in Europe the demand for diesel powered cars has been growing. Some of the emissions control systems described here will help towards achieving future emissions legislation requirements. If these systems show good in-field durability this could further increase the interest in diesel light-duty applications in North America, which would result in lower CO_2 emissions and significant fuel savings. At the next Detroit SAE World Congress we can confidently expect that further innovative and exciting developments in emissions control technology will be reported.

References

1 For a review of previous years' emissions control papers at the Detroit SAE see: *Platinum Metals Rev.*, 2001, 45, (2), 71; *ibid*, 2000, 44, (2), 67

2 Cobo Center, Detroit, Michigan, 4–7th March, 2002

3 Most papers are available in electronic format on two CD-ROMs ('New Emission Technology from the SAE 2002 World Congress', SP-1703CD, and 'Direct Injection SI Engine Technology 2002', SP-1693CD). Copies of these and individual papers are available from: SAE, 400 Commonwealth Drive, Warrendale, PA 15096, U.S.A. See also www.sae.org

4 For a description of the principles of operation of the NOx sensor see: M. V. Twigg, *Platinum Metals Rev.*, 1996, 40, (3), 111

The Author

Martyn Twigg is the European Technical Director of Johnson Matthey Catalytic Systems Division. His main interests are in applying advanced chemical concepts to highly efficient emissions control systems. He is the author of numerous research papers in this area and is the editor of the book series "Fundamental and Applied Catalysis".

Ruthenium Light-Switch Effects

Scientists at the University of North Carolina at Chapel Hill, U.S.A., report temperature-dependent excited-state lifetime measurements, in protic and aprotic solvents (MeOH, BuCN, MeCN) on $[Ru(bpy)_2dppz]^{2+}$ which suggest that the light-switch effect is competitive (M. K. Brennaman, J. H. Alstrum-Acevedo, C. N. Fleming, P. Jang, T. J. Meyer and J. M. Papanikolas, *J. Am. Chem. Soc.*, 2002, 124, (50), 15094–15098).

The dppz ligand has bpy-like and phz-like states. The bpy is associated with the bright state and phz with the dark state. The bpy-like state is similar in size to the corresponding orbital in the ^{3}MLCT state in $[Ru(bpy)_3]^{2+}$; it is entropically favoured and populated at high temperatures. The dark state is lowest in energy and is populated at low temperatures. The switch effect results from competition between the energetic and entropic factors, not from state reversal.