hydrogen peroxide) on surface composition indicates that there could be a distortion in measurement during chemical analysis, and even when preparing samples for analysis.

• The most exact measurements of reaction surfaces can be obtained, after surface preparation, by using an ion beam at a small angle of incidence and following AES measurements.

• Comparing the surface composition before and after ion etching provides information about structural particles of different elements.

• The composition of the preliminary etched surface best represents the composition of the active surface and gives the most accurate measure of catalyst activity for nitric oxide formation.

References

1 M. M. Karavaev, A. P. Zasorin and N. F. Kleshchev, "Catalytic Ammonia Oxidation", ed. M. M. Karavaev, Khimiya, Moscow, 1983

2 S. Savenkov and V. S. Beskov, in "The Kinetics and Catalysis of Heterogeneous Pressure Processes", Vishcha Shkola, Kharkov, 1974

3 M. Bonne, N. D. Zaichko, M. M. Karavaev *et al.*, "Nitric Acid Production in Large-Scale Single Units", ed. V. M. Olevsky, Khimiya, Moscow, 1985

4 Y. Ning and Z.Yang, *Platinum Metals Rev.*, 1999, 43, (2), 62

5 V. I. Atroshchenko and S. I. Kargin, "Nitric Acid Engineering", Khimiya, Moscow, 1970

6 B. T. Horner, *Platinum Metals Rev.*, 1993, 37, (2), 76

7 S. V. Zyuzin, V. V. Barelko, V. I. Chernyshov *et al.*, *Russian Patent* 1,573,594; 1988

8 E. A. Brustian, S. Y. Vasina, I. V. Lazaricheva *et al.*, *Russian Patent* 1,807,608; 1991

9 O. Ya. Loboyko, G. I Gryn, N. V. Trusov and I. I. Goncharov, 'Regeneration of Catalysts on the Basis of Platinum and its Alloys', Report of Int. Meeting "Rare and Precious Metals", Donetsk, 1994, Part III, pp. 40–41

10 G. I. Gryn, N. V. Trusov and O. Ya. Loboyko, 'Activation and regeneration of the catalyst on the basis of platinum and its alloys during oxidation of ammonia and oxidizing ammonolysis of methane', Section 9 in: "Catalytic and Mass Transfer Processes under Pressure in Inorganic Substances Technology", Kharkov, "Osnova", 1993

11 "Sputtering by Particle Bombardment. I", ed. by R. Behrisch, Springer-Verlag, New York, 1981

The Authors

Paul A. Kozub is a senior researcher and lecturer in the Faculty of Inorganic Chemistry at Kharkiv State Polytechnic University. His interests include experimental data processing, kinetics and chemistry of catalytic reactions on platinum, and kinetics and equilibrium in multi-component solutions (in particular with reference to platinum metals recovery).

Grygoriy I. Gryn is a Professor in the the Faculty of Inorganic Chemistry at Kharkiv State Polytechnic University. His main interests are heterogeneous catalytic processes on platinum (ammonia oxidation, HCN synthesis), modification of platinum surfaces and loss prevention, and the development of oxide-catching composites.

Igor I. Goncharov is an Assistant Professor in the the Faculty of Inorganic Chemistry at Kharkiv State Polytechnic University. His interests include the electrochemical treatment of platinum surfaces and electron microscopy.

Palladium-Based Catalysts for Nitrate Reduction

Nitrogen is essential for plant growth and, in the form of nitrates, is their primary source of nitrogen. Nitrates occur naturally in soil and water, but extensive farming can deplete the soil of its natural nitrogen, so nitrogen-containing fertilisers are often added. However, when more nitrogen is added to the soil than plants can use, excess nitrate can leach into groundwater supplies and could become a potential health risk.

Technologies for the removal of nitrate from drinking water and waste water are therefore of great importance. Palladium-based catalysts for the hydrogenation of nitrates to nitrogen represent one of the most promising approaches.

Now, an Italian research group has investigated palladium-copper and palladium-tin supported on zirconia and titania catalysts for the hydrogenation of nitrate in drinking water (G. Strukul, R. Gavagnin, F. Pinna, E. Modaferri, S. Perathoner, G. Centi, M. Marella and M. Tomaselli, *Catal. Today*, 2000, 55, (1–2), 139–149). Catalysts were prepared either as microspheres or in the form of membranes deposited on alumina tubes. The use of catalysts under diffusion control conditions reduced the amount of the byproduct ammonia formed while retaining a high catalytic activity.

Researchers in Germany, however, used palladium-tin and palladium-indium catalysts for the nitrate reduction (U. Prüsse, M. Hähnlein, J. Daum and K.-D. Vorlop, *Catal. Today*, 2000, 55, (1–2), 79–90). *In situ* buffering with formic acid as a reductant instead of hydrogen and polyvinyl alcohol-encapsulated catalysts with superior diffusional properties have both been demonstrated. The above Pd-Sn and Pd-In catalysts are reported to be more efficient than prior palladium-copper regarding the nitrogen formation activity, the selectivity and the long-term stability.

As the removal of nitrates from drinking water and waste water is becoming more necessary, these concepts may lead to the establishment of a technical-scale nitrate reduction process.