

ruthenium particles (6). Electron microscopy and eventually X-ray diffraction analysis will allow us to confirm or reject the latter possibility.

- (ii) In a bimetallic catalyst, once the absence of any significant amount of pure particles of say ruthenium, has been established, it follows that all, or almost all, of the ruthenium is present as

(Pt, Ru) bimetallic aggregates. However, this does not necessarily mean that the bimetallic phase has a narrow particle composition distribution. We are now working on methods which could give further insight into the (in)homogeneity in composition from one particle to another, in very small (Pt, MeII) aggregates.

References

- 1 R. Burch, *Platinum Metals Rev.*, 1978, **22**, (2), 57
- 2 C. Bolivar, H. Charcosset, R. Frety, M. Primet, L. Tournayan, C. Betizeau, G. Leclercq and R. Maurel, *J. Catalysis*, 1975, **39**, (2), 249
- 3 C. Bolivar, H. Charcosset, R. Frety, M. Primet, L. Tournayan, C. Betizeau, G. Leclercq and R. Maurel, *J. Catalysis*, 1976, **45**, (2), 163
- 4 C. Betizeau, G. Leclercq, R. Maurel, C. Bolivar, H. Charcosset, R. Frety and L. Tournayan, *J. Catalysis*, 1976, **45**, (2), 179
- 5 L. Tournayan, J. Barbier, H. Charcosset, R. Frety, C. Leclercq and P. Turlier, *Thermo-chim. Acta*, in press
- 6 G. Blanchard, H. Charcosset, M. T. Chenebaux and M. Primet, Second Intern. Symposium: Scientific Bases for the Preparation of Heterogeneous Catalysts, Sept. 4-6, 1978, Louvain-la-Neuve, Belgium, Paper B8
- 7 Z. A. Furhman and G. Parravano, *Proc. of the Sixth Int. Congr. on Catalysis*, London, July 1976, Chem. Soc., London, 1977, 686
- 8 H. Kubicka, *Roczniki Chemii*, 1973, **47**, (3), 599
- 9 For review articles on hydrogen spillover, see P. A. Sermon and G. C. Bond, *Catalysis Rev.*, 1973, **8**, 211; H. Charcosset and B. Delmon, *Ind. Chim. Belge*, 1973, **38**, (5), 481

New Platinum Cluster Catalysts

A new way of preparing platinum cluster catalysts using a photocatalytic deposition method has been described recently by Bernhard Kraeutler and Allen J. Bard of the University of Texas (*J. Am. Chem. Soc.*, 1978, **100**, (13), 4317-4318).

A semiconducting lightly doped anatase phase of TiO_2 was suspended under nitrogen in 0.1M $\text{H}_2\text{PtCl}_6/0.1\text{M}$ HCl which had been treated successively with sodium carbonate and acetic acid to give a pH of 4; and then irradiated with a mercury-xenon lamp. Carbon dioxide is evolved and is carried away in the nitrogen stream. Chemical analysis by electron spectroscopy showed that the dark deposits on the TiO_2 powder were entirely Pt(0); and this platinum was fairly uniform—no agglomerates were detected by scanning electron microscopy.

The procedure also works with undoped TiO_2 , and platinum deposits from homogeneous solution when irradiated in this way, but these processes are not as efficient as on the semiconducting oxide. The proposed mechanism involves the oxidation of acetate via a photogenerated hole while the photogenerated electron leads to reduction of the platinum complex. The oxidative decarboxy-

lation is irreversible and this prevents any back reaction between the reduced metal species and the oxidation product. This suggests that carboxylic acids are ideal choices as electron donors for heterogeneous photo-reductions.

The method described thus enables the preparation of a catalyst with a high dispersion of small clusters of platinum atoms on the support surface. Metal deposition probably only occurs near sites where photons strike the surface and the light flux can be made very small. The low temperature of the photo-decomposition (55°C) also minimises surface diffusion of metal atoms and prevents the formation of large aggregates. The extent to which a range of metals may be photo-deposited on to semiconducting powders is now being investigated.

Both platinised TiO_2 and WO_3 powders have shown high activity in the catalytic hydrogenation of both neat benzene and cyclohexene to cyclohexane at temperatures of 80°C and below. Similarly, the platinised anatase powders promoted the efficient photocatalytic decarboxylation of saturated carboxylic acids.

D. T. F.