

- 19 W. R. Schutt, Paper 267, "Steel-in-Concrete Cathodic Protection, Results of a 10-Year Experience", NACE Meeting, Corrosion/85, Boston, Massachusetts
- 20 *British Patent* 1,457,511; 1973
- 21 *British Appl.* 2,140,456A; 1984
- 22 *British Patent* 1,351,741; 1970
- 23 *European Patent* 47,595; 1982
- 24 *European Appl.* 186,334A; 1986
- 25 R. F. Stratful, *op. cit.*, Ref. 13, p. 66
- 26 *European Appl.* 147,977A; 1985, *British Patent* 2,100,290; 1982
- 27 Proposed NACE Standard, Recommended Practice for "Cathodic Protection of Reinforcing Steel in Concrete Structures", 1986
- 28 U.K. Dept of Transport Press Notice, "Trial to Prevent Steel Corrosion on Midland Link Motorways to Start Soon", 10 July 1986, Andy Hopkinson, Central Office of Information, Birmingham

Some Platinum Group Metals Cluster Catalysts

Contribution of Clusters Physics to Materials Science and Technology

EDITED BY J. DAVENAS AND P. M. RABETTE, Martinus Nijhoff, Dordrecht, 1986, 646 pages, Dfl. 250,000/£69.25

Clusters and small particles have a large area to volume ratio and can therefore be considered as an intermediate state of matter at the interface between atomic or molecular chemistry and the physics of condensed matter. Discussion at the NATO Advanced Study Institute held in France in 1982, where the papers in this book were given, centred on the critical size at which the change to bulk properties occurs.

The book includes a chapter on catalysis by molecular clusters and many of the examples given contain platinum group metal systems. Following a description of the reactivity of molecular clusters, the reactions catalysed by these systems are described. The rhodium and ruthenium catalysed synthesis of ethylene glycol from carbon monoxide and hydrogen under high pressure conditions has been studied in detail by workers at Union Carbide and has been shown to involve anionic clusters such as $[\text{Rh}_3(\text{CO})_9]^-$, and $[\text{HRu}_3(\text{CO})_{11}]^-$ and $[\text{Ru}(\text{CO})_3\text{I}_3]^-$; but other examples showing unambiguous catalysis by clusters are still rare. Two examples of homogeneous catalysis given are the isomerisation of olefins catalysed by $\text{H}_2\text{Os}_3(\text{CO})_{10}$ and catalysis of the water gas shift reaction by $\text{Ru}_2(\text{CO})_{12}$. Olefin hydrogenation has been shown to be catalysed by silica supported $\text{HOs}_3(\text{CO})_{10}$, and the water gas shift reaction is catalysed by $\text{Rh}_6(\text{CO})_{16}$ on alumina.

Molecular clusters can be used as starting materials for the preparation of heterogeneous catalysts, and for ruthenium systems cluster derived catalysts display enhanced activity for the hydrogenation of straight chain aliphatic hydrocarbons. The increased activity superficially correlates with the smaller metal crystallite sizes reproducibly obtained with metal cluster compounds as catalyst precursors.

The study of the organometallic chemistry of

surfaces could prove to be a significant area for future investigations. For example, the oxidative addition of hydrogen onto a coordinately unsaturated rhodium atom on the surface of alumina has been described.

The book gives many examples of the surface characterisation of supported platinum metals catalysts and, for example, links product selectivity in catalysis to platinum particle size in platinum on alumina catalysts produced by the evaporation of a range of platinum film thicknesses followed by various treatments in hydrogen and oxygen. There are many surface methods available for the characterisation of metal supported catalysts and examples of the use of ESCA, EXAFS, EELS and other techniques are given throughout the book.

Cluster science has relevance to a large number of solid state sciences including metallurgy, magnetism, and defects in solids and alloys, in addition to inorganic chemistry and catalysis. Interrelating results from all these fields is still in its infancy, but this book has helped to focus attention on the value of considering the relevance of cluster phenomena to them all.

D.T.T.

Commodity Meeting on Platinum

The Institution of Mining and Metallurgy is to hold its Annual Commodity Meeting on December 4th, 1986 at The Geological Society, Burlington House, London. The programme will include presentations on platinum as a strategic metal, exploration targets and guidelines, the UG2 platinum reef, processing of platinum metals, developments in the platinum market, trends in industrial applications, and its use in the control of gaseous environmental pollutants.