

Book review

Applied Homogeneous Catalysis with Organometallic Compounds. A Comprehensive Handbook, Volume 1 Applications; Volume 2 Developments

B. Cornils and W. A. Herrmann (eds)

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This substantial two-volume work has been edited jointly by an industrial chemist, B. Cornils, and another chemist, W. A. Herrmann, based in a university. They begin with the bold claim that homogeneous catalysis is the success story of organometallic chemistry and back this up with a series of authoritative detailed surveys commissioned from some of the world's leading practitioners in the area. Homogeneously catalysed reactions are defined as those which are (a) molecularly dispersed, (b) unequivocally characterized chemically and spectroscopically and synthesized by simple and reproducible processes, (c) tailor-made according to known principles and rational design and (d) such that unequivocal kinetics may be determined. These restrictive conditions ensure that the only reactions included are those where the detailed chemistry is reasonably well understood.

Volume 1 covers 'Applications', by which the editors mean those reactions which have already been successfully used in industrial processes. There are chapters entitled 'Carbon monoxide and synthesis gas chemistry', 'Hydrogenations', 'Reactions of unsaturated compounds', 'Oxidations', 'Reactions with hydrogen cyanide (hydrocyanation)', 'Hydrosilylation and related reactions of silicon compounds', 'Reactions with nitrogen compounds (hydroamination)', 'Reactions of hydrocarbons' and 'Asymmetric syntheses'.

Reactions which have not yet been exploited commercially but which have the potential to be exploited in the future are referred to as 'Developments' and grouped together in three chapters in Volume 2 under the headings 'Development of methods', 'Special catalysts and processes', and 'Special products'. The chapter on 'Development of methods' covers topics such as heterogenization and immobilization, molecularly defined catalysts on surfaces, molecular modelling, *in situ* NMR techniques, chemical engineering aspects, carbon–carbon coupling by palladium, catalytic cyclopropanation, arene coupling and the Fischer–Tropsch reaction. The section on 'Special catalysts and processes' includes discussion of biocatalysis, template reactions, membrane reactors, phase-transfer catalysts, rare-earth metals in homogeneous catalysis, homogeneous electrocatalysis and photocatalysis, olefin reactions, the water-gas shift reaction and hydrosulfurization. In the chapter on 'Special products' there is discussion of enantioselective synthesis, catalytic dihydroxylation, hydrovinylation, carbon dioxide as a

building block, carbon–hydrogen activation, cyclo-oligomerization, and carbonylation of alkynes. The book concludes with a short epilogue suggesting general directions in which homogeneous catalysis could develop and problems still to be solved.

It will be clear that in some parts of the book the boundary between homogeneous and heterogeneous catalysis has become blurred. Immobilized catalysts are heterogeneous but in their development the chemistry is often worked out under homogeneous conditions where all the analytical techniques of organometallic chemistry can be applied. Similarly, powerful insight into the chemistry of classical heterogeneous processes such as the Fischer–Tropsch reaction can be obtained from studies in homogeneous media. Though about 85% of catalytic processes are currently heterogeneous, it can be argued that homogeneous processes have the higher potential for step-by-step improvement based on examining and understanding reaction mechanisms. In developing homogeneous catalysts in industrial processes enormous technical problems have been overcome, e.g. in the prevention of catalyst loss so that the more expensive rhodium could be substituted for the cheaper cobalt without jeopardizing the financial viability of the methanol carbonylation process. It is however suggested here that, with the introduction of ever more sophisticated homogeneous catalysts, the main cost in future will not be in the metal at all but in the synthesis of the ligand.

The amount of published information on homogeneous catalysis is considerably less than that available in the chemical industry as a whole. There is much more protected by commercial secrecy or obscured by patents. Nevertheless, by bringing together such a powerful group of experts from both industry and academic institutions, the editors have produced a handbook which will be essential reading for both sides, with clear summaries and presentation and many thousands of references, some as late as 1996. In these days of Foresight and targeted research programmes worked out by governments or bodies such as the European Commission, the dialogue between industrial and academic chemists is increasingly important. This book provides an excellent example of what can be done.

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