DOI: 10.1595/147106707X235133

"Metal-catalysis in Industrial Organic Processes"

EDITED BY G. P. CHIUSOLI (University of Parma, Italy) and P. M. MAITLIS (The University of Sheffield, U.K.), RSC Publishing, Cambridge, U.K., 2006, 290 pages, ISBN 978-0-85404-862-5, £99.95, U.S.$189.00

Reviewed by Robin B. Bedford

School of Chemistry, University of Bristol, Cantock's Close, Bristol BS8 1TS, U.K.; E-mail: r.bedford@bristol.ac.uk

"Metal-catalysis in Industrial Organic Processes" fills the gap in the market between textbooks on homogeneous or heterogeneous catalysis and treatises on particular processes, typically available in the form of specialist reviews. It is pitched as an "advanced general textbook for chemistry students and their teachers; it will also be welcomed by researchers in industrial and Government laboratories". In my opinion these target audiences are very well catered for by this excellent textbook. The field of industrial catalysis is obviously enormous and yet has been well covered here in fewer than 300 pages. This makes the book an accessible work that describes many of the more important processes in sufficient depth, rather than an unwieldy tome.

The introduction (P. Howard, G. Morris and G. Sunley) gives a good overview of the general principles of catalysis in the industrial sector. These include the scales of various processes and factors that affect process development, such as economics, feedstock availability, safety and environmental considerations. Chapter 2 (M. G. Clerici, M. Ricci and G. Strukul) covers the formation of carbon–oxygen bonds by oxidation, beginning with the basic interactions of oxygen with transition metal centres. It then focuses on large-scale commercial applications such as the formation of adipic acid, terephthalic acid, ethylene oxide and phenols. Asymmetric epoxidation and dihydroxylation reactions are explored with regard to their application to the synthesis of fine chemical and pharmaceutical intermediates.

Chapter 3 (L. A. Oro, D. Carmona and J. M. Fraile) covers hydrogenation reactions, beginning with an overview of homogeneous and heterogeneous reaction pathways. The industrial application of heterogeneous catalysis focuses on the hydrotreating of petrochemicals, the hydrogenation of fats and the reduction of adiponitrile. Asymmetric homogeneous hydrogenation is covered in depth. Specific industrially important examples are given, including the syntheses of L-DOPA, (*S*)-metolachlor and (–)-menthol, all using rhodium-based catalysis. The next chapter (P. Maitlis and A. Haynes) describes industrial processes based on carbon monoxide. The first of the three main areas covered is the synthesis of acids and anhydrides from alcohol carbonylation reactions. The historical development of acetic acid synthesis leads on to the growth of the Monsanto (1) and BP Cativa™ (2) processes using rhodium and iridium respectively. Similarly, the section on hydroformylation covers the development of the cobalt-catalysed process through to the use of rhodium-based systems, with a concise description of asymmetric hydroformylation. The final part of the chapter focuses on the Fischer-Tropsch reaction.

Chapter 5 (F. Calderazzo, M. Catellani and G. P. Chiusoli) describes C–C bond-forming reactions. This starts with the use of Lewis acid catalysis in the alkylation of aromatic compounds and then progresses to palladium-catalysed coupling reactions. Industrially significant examples are given, including the synthesis of sartans for the pharmaceutical industry and the fungicide boscalid, this is followed by a particularly informative discussion on why palladium-catalysed cross-coupling reactions have not made the inroads into the industrial sector that might be expected. The next section of the chapter details the use of allylic substrates in industrial catalysis. This chapter also includes the oligomerisation of alkenes, for instance in the synthesis of alkenes

for the Shell Higher Olefins Process (SHOP), as opposed to olefin polymerisation which is covered in depth in a later chapter (Chapter 7) by G. Fink and H.-H. Brintzinger. The SHOP process itself is covered in Chapter 6 (C. L. Dwyer) which details the metathesis of olefins, with ruthenium catalysis prominent. This chapter also describes emerging technologies that are likely to impact on future applications of metathesis in the commercial sector.

Concluding Remarks

Given that most readers' interests will tend to lie either with homogeneous or heterogeneous catalysis, the provision of two appendices on organometallic chemistry and catalysis, and on basic concepts of surface science related to heterogeneous catalysis, is invaluable. An appendix on the kinetics of catalysis would have been useful as this is an area that is unfortunately not addressed to any great extent in the book.

In general the text is liberally supported by the use of 'boxes' and annexes that detail interesting asides, important concepts or emergent technologies. A particularly appealing aspect of the book is the inclusion of 'discussion points' throughout the text. These would be useful, for instance, as themes for round-table discussions with advanced level undergraduate and postgraduate students, indeed I have used some of them for precisely this purpose. In some of the chapters these are supplemented with invaluable extra 'hints' to help get the ball rolling. In summary I wholeheartedly recommend this excellent textbook to anybody with an interest in catalysis, either from an industrial or academic perspective.

References

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The Reviewer

Having graduated in biochemistry from the University of Sussex, U.K., Robin Bedford undertook a D.Phil. in organometallic catalysis with Penny Chaloner (also at Sussex). He then held a postdoctoral research associateship with Anthony Hill at Imperial College London and lectureships in inorganic chemistry at Trinity College, Dublin and the University of Exeter, where he was promoted to Reader in Catalysis. He moved to the University of Bristol in a similar role in 2005. He currently holds an EPSRC Advanced Research Fellowship and the Royal Society of Chemistry's Sir Edward Frankland Fellowship (Dalton Division) for 2006/7.