

## Book Reviews

**Green Catalysis.** Edited by Paul T. Anastas. Wiley-VCH: Weinheim. Three volumes. 2009. 1082 pp. €499. ISBN 978-3-52731577-2.

Green Chemistry is seen as an important subject area for the future, particularly when it can be applied in manufacture. Wiley-VCH have therefore initiated a 12-volume Handbook of Green Chemistry, of which the first 3 volumes are on *Green Catalysis*. Volume 1 is on *Homogeneous Catalysis*, Volume 2 on *Heterogeneous Catalysis* and Volume 3 on *Biocatalysis*.

For such an important series of books, I would have anticipated that the editors could have contributed an opening chapter giving their philosophy behind the creation of the 12-volume handbook and establishing the objectives which the chapter authors were given. There is nothing, not even a preface. Instead, the first volume of *Green Catalysis* opens with a short chapter on atom economy, written from an academic viewpoint; no discussion of other metrics and no industrial examples, although there is a brief discussion of the impact of atom economy on the chemical industry.

The opening volume, *Homogeneous Catalysis*, contains some well-written chapters on Fluorous Phase Catalysts, Green Oxidation Processes Based on Hydrogen Peroxide, Microwave-Accelerated Reactions, Immobilization and Compartmentalization of Catalysts, etc. Industrial chemists will be more interested in the outstanding chapter from Solvias chemists Blaser, Hoge, Pugin and Spindler on Industrial Applications of Homogeneous Enantioselective Catalysis. This 50-page chapter is an excellent up-to-date summary of the field and should be read by all process chemists interested in designing catalytic processes. In contrast to many of the other chapters, the review discusses catalytic efficiency and process economics, important issues if we are to get green processes in manufacture. The chapter discusses more than 20 industrial processes in detail, including both oxidations, reductions, and C–X bond formation.

Other industrially focussed chapters are on the IFP biphasic Difasol process using ionic liquids, and the aerobic oxidation of xylene to terephthalic acid. In addition there are highly readable chapters on organocatalysis, hydrogenation for C–C bond formation (Krische chemistry), and palladacycles in catalysis.

Thus, Volume 1 is an excellent read for process chemists but lacks the green chemical discussion and focus that the series title would suggest.

Volume 2 on *Heterogeneous Catalysis* is less of interest to the practising process chemist, if only because the applications of green heterogeneous catalysts are likely to be in bulk chemistry, automotive emission control, solar cells, hydrogen production, and natural gas production.

Volume 3 on *Biocatalysis* could also have done with an overview on the role of biocatalysis in green chemistry but opens with a chapter on P450 monooxygenases, the focus being more on the enzymes than applications. Whilst there are some excellent chapters in the rest of this volume, there is no overall theme. So the book has chapters on nitrile hydrolysis, biocatalytic processes using ionic liquids/sCO<sub>2</sub>, thiamine-based enzymes, Bayer–Villager monooxygenases, bioreductions, hydrogenases and bioremediation—overall a bit of a hotch-potch.

However, there is one very industry-focussed chapter written by scientists from Lonza and Novartis on Biotransformations and the Pharma Industry. This chapter begins—as all the chapters in the series should—by discussing the relevance to green chemistry and then discusses each enzyme class with examples from industry where these have been applied. The 40-page chapter includes data such as turnover numbers and frequencies and overall tonnage made by the particular process.

Of the other chapters, the thiamine-based enzymes, useful in C–C bond formation, will be of most interest to organic process chemists, as will the chapter on bioreductions by microorganisms. In the latter chapter the focus is on asymmetric reduction of carbonyls, but the key (green) issues (re: use of expensive cofactors and cofactor recycling) are barely discussed. The important topic of olefin reduction using enzymes is not covered in this chapter, or in other chapters on hydrogenases.

In conclusion, the 3 volumes of *Green Catalysis* have some excellent chapters of interest to process chemists and engineers, but there is not enough focus on the green aspects of the subject in many sections of the book. An opportunity to produce the definitive work on green chemistry has been missed.

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