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"Green Chemistry and Catalysis"

BY ROGER A. SHELDON, ISABEL ARENDS and ULF HANEFELD (Delft University of Technology, The Netherlands), Wiley-VCH, Weinheim, Germany, 2007, 448 pages, ISBN 978-3-527-30715-9, £95.00, €142.50, U.S.$190.00

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Catalysis is behind virtually every chemical we use today, and is involved in some way in virtually every consumer product on the market. This has been true for a century or more, and will continue to be true for the foreseeable future. The last century saw catalyst scientists and technologists master the conversion of crude oil into an enormous array of chemicals, using solid-phase acids such as zeolites to convert the original oil into a range of more useful products. These could then be elaborated using systems such as redox catalysts, metal-centred coupling catalysts or enzymes, all of which provide excellent control over reactivity and selectivity.

As a consequence of the uncertainties over crude oil supply, this century is likely to see a focus on converting renewables, for example biopolymers such as starch and cellulose, into more sophisticated molecules. The C:O ratio of these molecules is typically 1 (compare with crude oil, where it is > 100), and that of the desired products is typically between 3 and 10. This means that the processes required to convert these feedstocks will involve different blends of chemistries, with reduction perhaps becoming more central than oxidation as a conversion technology. Reduction catalysis will be expected to play a very prominent role, with the outlook for palladium, platinum and related reduction catalysts in deoxygenation type chemistry being very interesting. Catalysis will certainly retain its central importance to chemistry.

Additionally, the role of chemistry in 'greening' existing processes will drive the development of more efficient and selective catalysts, and their more effective use. Improved processing, separation and recovery are key concepts, and reduced energy costs will also be vital.

For these reasons, this book is very valuable, as it pulls together all the main catalytic technologies, with a focus on green chemistry and processing. The book is structured to cover the key areas of catalysis, with chapters on solid acids and bases, oxidation (including ruthenium catalysts), reduction, C–C bond forming (including palladium and ruthenium catalysts) and hydrolysis. Other important aspects are also covered; for example, the chapter on alternative reaction media covers developments in solvent choice. In recent years, many new solvent types have been developed in order to improve the environmental impact of processes, since solvents are typically by far the largest components of a reaction mixture and, given their volatility, are one of the hardest parts to control. The newer solvents include 'typical' organic solvents with lower toxicity, plus novel systems such as fluorous solvents, supercritical media and ionic liquids. Biphasic catalysis is also covered here. These newer solvents are the focus of intense research activity and are likely to find uses in industry; a few processes already use them.

Biocatalysis is also an emerging theme, and may find itself more suited to transformations of biomolecules (which are given a chapter) than petrochemicals. Process design and integration is also given a chapter, as it can produce significant improvements by intelligent combination of two catalytic steps.

The book deals with chemical catalysis and biocatalysis as two parts of the same whole, something which is pleasing to see. The two parts are often seen as competing, whereas they can be combined to great effect. The coverage of the area is well rounded and the chapters are up to date, well written and referenced. Overall, this is an impressive book, and a valuable addition to the field.