Nanomaterials in Catalysis

Catalysis is part of the myriad chemical processes that provide essential products for society. Their production would not be feasible without catalysts. In particular, homogeneous catalysis is known to be one of the most active and selective catalytic tools, and is widely used. However, the difficulty of isolating and separating these catalysts from the final product restricted broadening their use. This separation problem was then overcome by converting active homogeneous catalysts into a heterogeneous form. Heterogeneous catalyst systems are currently the most widely utilized types of catalysts in industry.

Many industrial heterogeneous catalysts are solids of large surface area on which active sites are generated. However, the active sites on these solid supports are not always accessible for reactions, and this reduces the overall process efficiency. To overcome this challenge there is a need for a new branch of catalysis, which can bridge the gap between homogeneous and heterogeneous catalysis. This new branch of catalysis is nanocatalysis. Although the use of nanosize materials as catalysts (nanocatalysts) has been known for many decades, it is only in the last two decades that the field of nanocatalysis has attracted intense interest. Therefore, the book Nanomaterials in Catalysis is perfectly timed by editors Philippe Serp and Karine Philippot, who are both well-known researchers in this field. It comprises 12 chapters, authored by world-class researchers.

The book aims to provide an introduction to nanocatalysis, followed by a description of the main achievements in this field. Chapter 1 discusses fundamental concepts of nanocatalysis in detail, including synthesis techniques and the effects of particle size, shape, and morphology, and briefly describes applications of nanocatalysts in various areas. The next two chapters cover the use of metal nanoparticles (MNPs) in the green solvent water, and dendrimer-stabilized MNPs for various reactions, such as hydrogenation and carbon–carbon coupling reactions. Chapter 4 reviews the use of nanocatalysis in what is currently one of the most important areas—energy. The authors start the chapter by discussing the synthesis of nanocatalysts, followed by various energy-related applications, such as in Fischer–Tropsch (FT) and partial methane oxidation processes, and their use in fuel cells, solar cells, and the production and storage of hydrogen.

The next three chapters are devoted to the subject of nanoparticles in unconventional solvents, such as ionic liquids and supercritical fluids. The authors describe several different synthetic approaches, including various stabilization techniques. They then review applications in a variety of catalytic reactions and organic transformations. Chapter 8 addresses one of the most crucial aspects of catalysis, the recovery of the catalyst. The author nicely describes various techniques that are available for the isolation and recovery of catalysts. However, to improve the flow of the book, this chapter could have been placed after Chapter 1.

Chapter 9 reviews carbon nanotubes (CNTs), their synthesis, purification, and functionalization. The authors then discuss CNT-supported metal nanocatalysts, and especially selective metal coating on the internal or external surfaces of CNTs, for various catalytic reactions. At the end of the chapter, the authors also discuss the significance of a newly emerging form of carbon: graphene. This is followed by a chapter on nanooxides and their synthesis and applications in catalysis. Although the author discusses the effects of the size and shape of nanooxide particles on their catalytic activity, recent exciting results, especially regarding the effects of shape and morphology, could have been discussed in more depth. Chapter 11 deals with the interesting confinement effect observed with some nanosupports, mainly CNTs. Finally, in the last chapter the author reviews the use of theoretical calculations and modeling to design and understand nanocatalysts. This chapter is one of the best in the book, with a very useful discussion, as this sub-topic is not reviewed in depth in any other book.

Altogether, this is an excellent book, bringing together various protocols of nanocatalysis, with individual chapters concentrating on the synthesis, characterization, and catalytic performance of particular nanocatalysts. However, only a very limited number of catalytic processes are discussed, which makes this book less comprehensive than needed. I also felt that overlapping between chapters and repetition of some catalytic reactions could have been avoided by having the chapters focus on catalytic reactions rather than on catalysts.

In conclusion, I enjoyed reading this book and recommend it to researchers who already have experience in the field of nanocatalysis and want to develop efficient, sustainable nanocatalytic processes.

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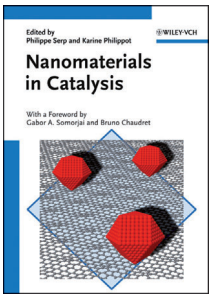

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