"Design and Applications of Single-Site Heterogeneous Catalysts: Contributions to Green Chemistry, Clean Technology and Sustainability"

By Sir John Meurig Thomas (University of Cambridge, UK), Imperial College Press, London, UK, 2012, 293 pages, ISBN: 978-1-84816-909-8 (Hardcover), £79.00, ISBN: 978-84816-910-4 (Softcover), £38.00

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Introduction

In 2010 Sir John Meurig Thomas was awarded the Gerhard Ertl Lecture award by the Max Planck Institutes of Berlin. As a result of the lecture he has subsequently written the book entitled "Design and Applications of Single-Site Heterogeneous Catalysts: Contributions to Green Chemistry, Clean Technology and Sustainability". The work is as expected rather eloquently written by a leader in the field and successfully attempts to summarise the huge volume of work published over the last decades. The book is split into three sections: firstly the reader is introduced to the concept of single-site heterogeneous catalysis with emphasis placed on the difference between materials such as aluminosilicates and immobilised homogeneous catalysts and the similarities between single-site heterogeneous catalysts and enzymes. The second and third sections are then divided between the use of microporous and mesoporous materials as single-site heterogeneous catalysts and how such materials can be used to eradicate the need for either hazardous or stoichiometric reagents. There are numerous examples of high quality work utilising single-site materials to modernise and improve the green credentials of reactions of industrial and academic interest, and two chapters deal with catalysis involving platinum group metals (pgms).

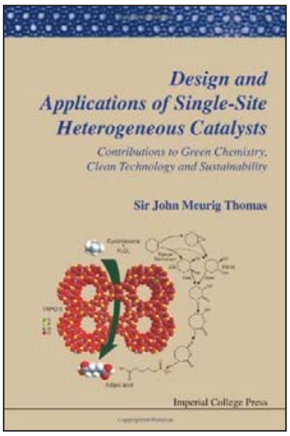
Catalyst Design

Chapter 7 discusses the possibilities of exploiting the space contained within nano sized pores for asymmetric reactions, with palladium and rhodium often being the metals of choice. It has been shown that the enantioselectivity of such metal complexes can be enhanced when confined within pores of a similar size to that of the complex and this raises interesting questions which should be considered during catalyst design. For example, can the enantioselectivity of a reaction be routinely improved beyond what is achievable under homogeneous conditions by the selection of a material with appropriately sized pores? The text describes a particularly striking example where the enantioselectivity of a rhodium-based complex increases from less than 20% to greater than 95%, for the asymmetric hydrogenation of methyl benzoylformate to methyl mandelate, by immobilising the complex in a suitably sized porous silica. However, whilst beneficial effects in terms of enantioselectivity may be observed, one must also consider what effect the support of choice will have on complex accessibility/activity.

The pgms feature more heavily in Chapter 8 under the title of 'Multinuclear, Bimetallic Nanocluster Catalysts'. Here the author describes some of the benefits which can be obtained from using clusters such as Ru_6Pd_6 supported on mesoporous silica. Such a cluster has been shown to be more active (by an order of magnitude) compared with a nanoparticle equivalent for the hydrogenation of 1-hexene. In addition, changing from a bimetallic cluster (Ru_6Pd_6) to a monometallic cluster (Ru_6) results in the reaction selectivity changing from favouring hydrogenation to isomerisation. A variety of other bimetallic (ruthenium-tin, ruthenium-platinum, ruthenium-copper and rhodium-tin) and trimetallic (ruthenium-platinum-tin and ruthenium-platinum-germanium) pgm-containing clusters are also discussed.

Conclusion

This well-written book is a thoroughly enjoyable read at a reasonable price. It comes highly recommended for anyone with an interest in single-site heterogeneous catalysts and would serve as a helpful and stimulating introduction to someone new to the field.



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The Reviewers

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