

# Preface

This volume reviews the recent developments in the use of molecular rare-earth metal compounds in catalysis. Most of the applications deal with homogenous catalysis but in some cases, heterogeneous systems are also mentioned. The rare-earth elements, which are the lanthanides and their close relatives – scandium and yttrium – have not been in the focus of molecular chemistry for a long time and therefore have also not been considered as homogenous catalysts. Although the first organometallic compounds of the lanthanides, which are tris(cyclopentadienyl) lanthanide complexes, were already prepared in the 1950s, it was only in the late 1970s and early 1980s when a number of research groups began to focus on this class of compounds. One reason for the development was the availability of single crystal X-ray diffraction techniques, which made it possible to characterize these compounds. Moreover, new laboratory techniques to handle highly air and moisture sensitive compounds were developed at the same time. Concomitant with the accessibility of this new class of compounds, the application in homogenous catalysis was investigated. One of the first applications in this field was the use of lanthanide metallocenes for the catalytic polymerization of ethylene in the early 1980s. In the last two or three decades, a huge number of inorganic and organometallic compounds of the rare-earth elements were synthesized and some of them were also used as catalysts. Although early work in homogenous catalysis basically focused only on the hydrogenation and polymerization of olefins, the scope for catalytic application today is much broader. Thus, a large number of catalytic  $\sigma$ -bond metathesis reactions, e.g. hydroamination, have been reported in the recent years.

This book contains four chapters in which part of the recent development of the use of molecular rare-earth metal compounds in catalysis is covered. To keep the book within the given page limit, not all aspects could be reviewed in detail. For example, the use of molecular rare-earth metal complexes as Lewis acidic catalysts is not discussed in this book. The first two chapters review different catalytic conversions, namely the catalytic  $\sigma$ -bond metathesis (Chapter by Reznichenko and Hultsch) and the polymerization of 1,3-conjugated dienes (Chapter by Zhang et al.). Within these chapters, different catalytic systems and applications are discussed. The final two chapters are more concentrated on recent developments of

catalysts synthesis; but of course catalytic aspects are also mentioned. Therefore, these two chapters are focused on homogeneous catalysis using lanthanide amidinates and guanidines (Chapter by Edelmann) and the synthesis of rare-earth metal post-metallocene catalysts with chelating amido ligands (Chapter by Li et al.). The organometallic lanthanide catalysts of the first generation, which are the metallocene catalysts of the general composition  $[(\eta^5\text{-C}_5\text{Me}_5)_2\text{LnR}]$  ( $\text{R} = \text{CH}(\text{SiMe}_3)_2$ ,  $\text{N}(\text{SiMe}_3)_2$ ,  $\text{H}$ ), are mentioned in the first two chapters, but are not covered in a separate synthetic contribution because a number of excellent reviews on this topic have been published over the recent years.

In summary, the present volume of *Structure and Bonding* shows the substantial activity carried out in recent years in the field of synthesis of inorganic and organometallic rare-earth metal compounds and their use as catalysts for a number of different transformations. The future holds great promise for the rapid growth of this field of chemistry and for new spectacular results.

Karlsruhe  
June 2010

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Molecular Catalysis of Rare-Earth Elements

Roesky, P.W. (Ed.)

2010, XIII, 250 p. 48 illus., Hardcover

ISBN: 978-3-642-12810-3