

# Preface

Catalysts are crucial, not only for the production of many thousands of materials and products, including fuels required by modern society, but also for the reduction of water and air pollution, as well as to minimize the waste of natural resources and energy. Recent advances in green and sustainable science and technology demand more powerful and sophisticated catalysts, which have a tunable function. Much efforts have been paid to the development of well-defined bifunctional molecular catalysts based on the combination of Lewis acid and basic sites working in concert to attain highly efficient molecular transformation for organic synthesis. Bifunctional catalysts contain two or more sites for the activation of electrophiles and nucleophiles, and consequently these catalysts can efficiently promote a wide range of molecular transformation by effective accumulation and cooperative activation of reacting substrates on the neighboring active centers in the same molecules. Careful and precise tuning of the structures of the molecular catalysts, as well as the spatial organization of the functionality, is required to achieve the best catalysis performance.

Metal–ligand cooperating bifunctional molecular catalysts are also recognized as an alternative and indispensable strategy to realize highly effective molecular transformation. The non-innocent ligand therein directly participates in the substrate activation and subsequent reactions through various secondary interactions including hydrogen bonding. Therefore, the catalyst deactivation due to the acid–base neutralization or destructive aggregation can be minimized. Indeed, a number of biological catalyses in nature have been performed in a sophisticated manner on such bifunctional and even multifunctional systems with ligated peptide residues and prosthetic groups.

This unique concept of the recently developed bifunctional metal-based molecular catalysts leads to high reaction rates and excellent stereochemical outcome because the reactions proceed through a closed assembly of reactants and catalysts, providing a wide substrate scope and applicability in organic synthetic chemistry. This volume is intended to highlight the recent exciting advances in bifunctional catalysis with well-designed multimetallic systems, dinuclear, mononuclear

transition metal-based molecular catalysts, and Lewis acid catalysts. All chapters have been written with a brief introduction on the definition and concept of bifunctionality by leading chemists in the corresponding research area. We wish to express our sincere thanks to them for their contributions and fruitful and exciting collaboration in publishing a book dealing with the most recent achievement in this field: Motomu Kanai, Shigeki Matsunaga, Naoya Kumagai, Madeleine C. Warner, Charles P. Casey, Jan-E. Bäckvall, Chidambaram Gunanathan, David Milstein, Noritaka Mizuno, Keigo Kamata, Kazuya Yamaguchi, Pingfan Li, Hisashi Yamamoto, Jun-ichi Ito, Hisao Nishiyama. We are also grateful for all help and supports from Springer, in particular, from Drs. Elizabeth Hawkins and Jutta Lindenborn.

We hope not only that this book will be useful to researchers and students already involved in organic synthesis and molecular catalysis, but also that it will attract scientists working in various field of chemistry.

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