

Preface

Carbon dioxide is one of the green house gases and the emission and accumulation of a huge amount of CO₂ causes significant and negative effects on the global environment. It is crucial, therefore, to take effective measures to reduce CO₂ emission and treat the CO₂ emitted. Carbon dioxide is a safe and abundant resource of C and O and the production of useful chemicals from CO₂ conforms to the Green Chemistry principles. Carbon dioxide may replace harmful reactants like CO and phosgene currently used in chemical reaction processes. Carbon dioxide is a stable and less reactive molecule and, hence, the CO₂ activation has been investigated so far by using various catalysts and processes. The practical use of CO₂ as a reactant could also have a contribution to the reduction of the undesired CO₂ in the environment.

This book is dedicated to a wide-angle review of chemical transformation and utilization of CO₂ in 14 chapters. It is composed of four parts, which are chemical (organic and inorganic), electro- and photo-chemical, and biochemical transformation of CO₂ to a number of organic and inorganic, small- and large-scale products. The last two chapters deal with the application of CO₂ as a promoter as well as a reactant in organic synthetic reactions.

Part I, consisting of seven chapters, deals with the use of CO₂ in chemical reactions. In Chap. 1, Prof. Kühn and coworkers describe valorization of CO₂ to organic products using organocatalysts. Chapters 2 and 3 give several examples of direct and indirect utilization of CO₂ to valuable products using heterogeneous catalysts. In Chap. 4, Prof. Beller and coworker review hydrogenation and related reduction of CO₂ using molecular catalysts. Professor Arena and coworkers describe hydrogenation of CO₂ to bulk chemicals like methanol and dimethyl ether in Chap. 5. Professor Ross describes fundamentals and perspectives of syngas production using CO₂ reforming in Chap. 6. In Chap. 7, Prof. Rieger and coworkers explain utilization of CO₂ as a C-1 block for the synthesis of polycarbonates. These chapters demonstrate the usefulness and potential of CO₂ as a reactant.

Part II consists of four chapters dedicated to photocatalytic, electrochemical, and inorganic reactions of CO₂. Professor Krebs and coworker explore the possibilities of using flexible substrates as basis for CO₂ fixation and photocatalytic reduction in

Chap. 8. Chapter 9, contributed by Prof. Yamashita and co-workers, describes reductive conversion of CO₂ by using various photocatalyst materials. In Chap. 10, Prof. Senboku explains electrochemical fixation of CO₂. Chapter 11 of Prof. Baciocchi and co-workers describes accelerated carbonation processes for CO₂ capture, storage, and utilization.

Part III is directed to biological reactions of CO₂, consisting of Chap. 12 of Prof. Das and coworker. This chapter summarizes the role of various biological processes available for CO₂ mitigation and discusses the use of terrestrial plants, algae, cyanobacteria, carbonic anhydrase enzyme, and various other bacteria in CO₂ sequestration.

Part IV deals with the reactions in/under dense phase CO₂ in two chapters. In Chap. 13, Prof. He and co-workers describe homogeneous catalysis promoted by CO₂. Chapter 14 explains the potential of multiphase catalytic reactions in/under dense phase CO₂, in which CO₂ is utilized as a reaction promoter.

We believe/hope that this book will be useful to readers in various fields who take practical and scientific interests in the current and future *Transformation and Utilization of Carbon Dioxide*. All these chapters have been written by overseas experts in the related fields. We would like to express our sincere thanks to the authors for their excellent contributions to this book and their names are listed on separate pages. We are also thankful to Springer for their support in publishing this book.

Sapporo, Japan
Mumbai, India

Masahiko Arai
Bhalchandra M. Bhanage

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Bhanage, B.M.; Arai, M. (Eds.)

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