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## Preface

The science of heterogeneous catalysis has flourished for over more than a century. Its processes have contributed significantly to our modern way of life by enabling the production of indispensable commodities such as fuel and fertilizer as well as materials with previously unknown properties such as the polymers.

Both serendipity and empirical chemical discovery have played a part in the development of many of the catalytic systems now used in large chemical processes. The early observations of catalysis and their scientific formulation by Ostwald, Sabatier, and Haber provided the insights and tools necessary for later developments in this field.

While the nineteenth century was the century characterized by categorizing scientific phenomena, the twentieth century can be seen as the century of developing the physical sciences at the molecular level. The formulation of a molecular theory and the development of predictive tools for heterogeneous catalysis has been a long and tortuous process that is now reaching a critical level of completion.

This book provides an introduction and overview of the modern state of heterogeneous catalysis. It took almost an entire century to gain this understanding because heterogeneous catalytic systems are very complex. The two main theories advanced in the literature are the Langmuir-Hinshelwood and the Mars-van Krevelen mechanisms. The various currently used heterogeneous catalytic systems are discussed in terms of catalytic activity, selectivity, and stability.

The catalyst is, in itself, a complex material that can be a solid or a liquid. It is a solid composed of various components that are dispersed on a support. The particles over a heterogeneous surface are very small and they are very active because they have a high surface area. The reaction system is not homogeneous because the product is often a multi-component mixture that is difficult to separate. It is not easy to study because its performance depends on many reaction conditions and because catalytic activity may decrease over time. A catalyst may eventually deactivate during the reaction.

Clearly, catalyst research requires an interdisciplinary approach. Knowledge of applied inorganic chemistry is necessary to design a class of catalytic materials, training in spectroscopic measurements is essential for characterizing the catalyst as synthesized and at various stages of use, and reactor engineering