

Studies in Surface Science and Catalysis

Vol. 20

METAL CLUSTERS IN CATALYSIS

Editors

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and

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Studies in Surface Science and Catalysis

Advisory Editors: B. Delmon and J.T. Yates

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METAL CLUSTERS IN CATALYSIS

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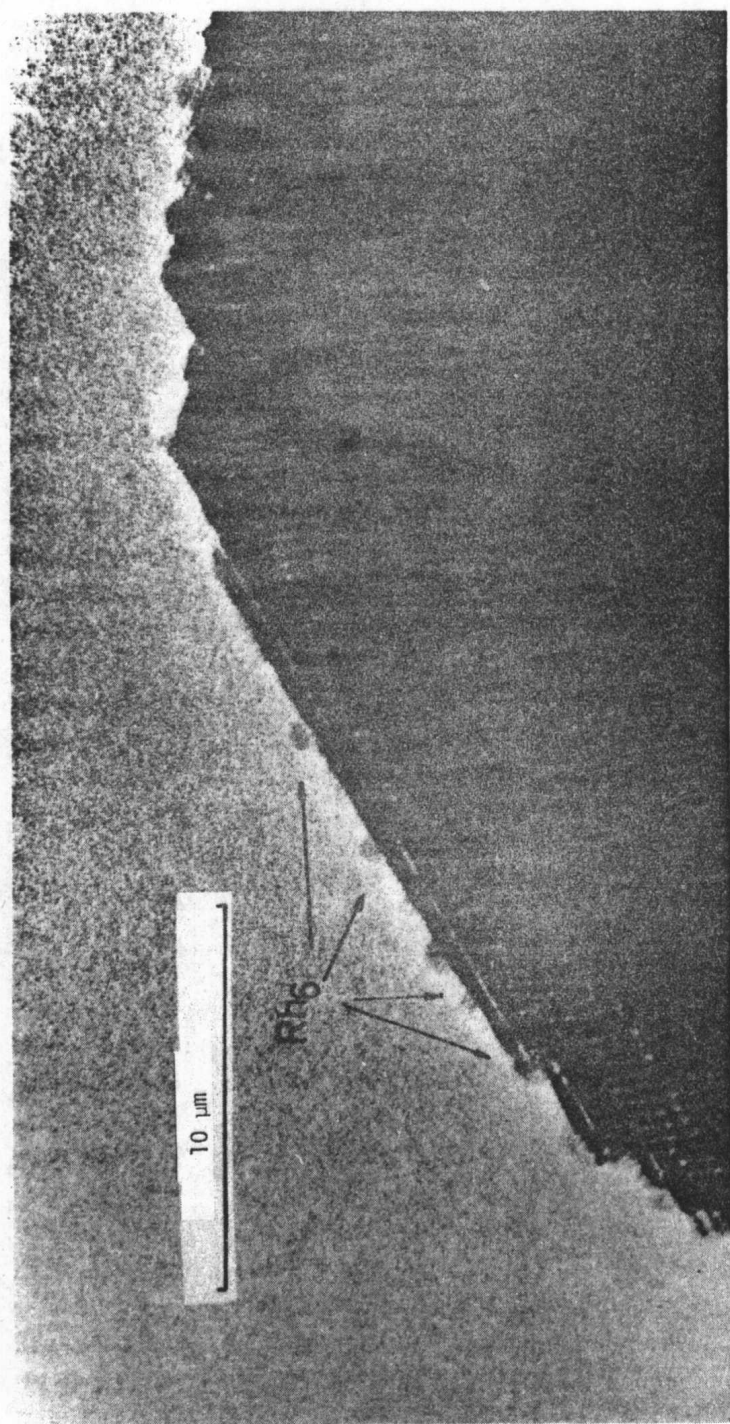
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High-resolution electron micrograph showing Rh₆ clusters on the (111) surface of $\gamma\text{-Al}_2\text{O}_3$ (courtesy of Professor M. Ichikawa and Dr. S. Iijima).

PREFACE

Metal cluster chemistry has entered a period of exponential growth in the preceding decade, and much of the driving force, at least nominally, is the prospect of application of metal clusters as catalysts. The goal of this monograph is a thorough and critical evaluation of the literature and prospects of metal clusters in catalysis.

Part I of the book is concerned with molecular chemistry and structures of metal clusters: synthesis, crystal and molecular structure, thermochemistry and bond energies, reactivity, and homogeneous catalysis.

Part II, the largest section of the book, is concerned with metal clusters in and on solid supports, ranging from polymers and oxides functionalized with groups analogous to the ligands in molecular metal clusters to metal oxides such as silica, alumina, and magnesia, and to zeolites, with their molecular-scale cages. The emphasis is on supported metal species with structures analogous to those of molecular species. We restrict the term "cluster" to these "molecular" species; to avoid confusion, the terms "aggregate", "crystallite", and "particle" are used to denote the typical, usually nonuniform, supported metals not having molecular structures (although these are commonly referred to as clusters in the catalysis literature).

Even though they are not the primary focus of the book, the metal aggregates are too interesting and too closely related to the clusters to ignore. The metal aggregates are important subjects of several chapters, including Chapter 8, concerned with metals in zeolites, and parts of Chapter 9 (9.4 and 9.5), concerned with metal-oxide-supported catalysts derived from molecular metal clusters.

Characterization of supported metal clusters is developing rapidly, made possible by the emergence and rapid development of instrumental techniques for surface spectroscopy. A detailed introduction (Chapter 6) summarizing classical and modern methods is included; it is our intent that this section be broadly applicable and of value to researchers characterizing a range of supported structures in addition to metal clusters.

Part III is a single chapter (11) addressing the relations between metal clusters and metal surfaces. Compelling new ideas have arisen that, perhaps no less than the prospects of catalysts made from metal clusters, are driving organometallic chemistry and surface science into common territory.

The subject of metal clusters in catalysis is just emerging from its infancy; the growth is dramatic and exciting, and we believe that understanding of the clusters will propel the advance of fundamental understanding of catalysis, organometallic chemistry, and surface science. These ideas are elaborated in a short summary chapter concluding the book.

We thank the authors for their excellent efforts and their willingness to mold their contributions to our conception of the book. We are grateful to Jeanne Grill, Dale Meyer, and Cecilia Viering, who entered the manuscripts into the word processor at the University of Delaware, and to Venerando Sciuto of the University of Munich, who prepared many of the drawings in final form. We gratefully acknowledge the financial support for our continuing research in this field, provided by the Deutsche Forschungsgemeinschaft (Knözinger), the Hungarian Academy of Science (Guczi), and the National Science Foundation (Gates). Much of the editorial work was done at the University of Munich; B. C. Gates was supported there by grants from the Deutsche Forschungsgemeinschaft, the Fulbright Commission in Bonn, and the National Science Foundation.

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