JOURNAL OF CATALYSIS 136, 281 (1992)

BOOK REVIEWS

Studies in Surface Science and Catalysis 57: Spectroscopic Characterization of Heterogeneous Catalysts, Part A, **Methods of Surface Analysis** and Part B, **Chemisorption of Probe Molecules.** Edited by J. L. G. FIERRO. Elsevier, Amsterdam, 1990.

Meeting the challenges of chemical and fuel production, while at the same time protecting the environment, will require new catalytic materials and reaction pathways as well as fine tuning of existing processes. Catalyst characterization is a key component of the vision that will guide these technological developments. It is timely, then, to take stock of the spectroscopic "eyes" with which we can view catalytic chemistry. This two-volume work divides the task into methods aimed primarily at direct views of surfaces and those that use molecular messengers. The editor sets the tone for Part A with an excellent tour of the Probst diagram, defining more than 60 surface characterization methods and providing the physical origins and references for all and examples for many. In the four remaining chapters of this volume, depth is provided in electron spectroscopy; surface groups on oxides, primarily by IR, Raman, and NMR; EXAFS; and Mössbauer spectroscopy. Chapter 2 emphasizes theory and experimental details for Auger electron spectroscopy, XPS, and UPS with examples ranging from film growth to CO adsorption. Chapter 3 integrates the spectroscopic results in an informative discussion of SiO_2, Al_2O_3, TiO_2, MgO, other oxides, and zeolites. The EXAFS chapter follows a clear discussion of the physical phenomena and usual approximations made with a detailed analysis of supported metal and other catalysts by XANES as well as EXAFS. The final chapter of volume A amply demonstrates the power of the Mössbauer effect to document changes in catalyst chemistry during sequential treatments. Examples of support, alloying, and particle size on iron chemistry are augmented by studies of other nuclei such as ^{57}Co, ^{193}Ir, and ^{119}Sn.

The editor opens Part B with an overview of chemisorption that includes classification of probe molecules, discussion of quantitative chemisorption and spectroscopic analysis methods, and applications to a variety of catalyst systems. The five chapters that follow give depth on both the spectroscopic method and the use of IR, electron vibrational spectroscopy, NMR, EPR, and thermal desorption for extracting catalytic chemistry from probe molecules. After a brief introduction of the method, Chapter 2 emphasizes transmission IR applications to transient kinetics, metal carbonyls adsorbed on surfaces, and detailed study of the surface chemistry of a variety of metal oxides. Chapter 3 follows with a clear discussion of electron scattering mechanisms with examples of how this knowledge can be used in electron energy loss spectroscopy to yield structure and chemistry of atoms and molecules adsorbed on single crystal surfaces. The NMR chapter summarizes the important interactions and techniques and demonstrates the power of this method with unique studies of surface acidity and hydrogen adsorption on metals and a detailed discussion on the use of ^{129}Xe to examine catalyst structure and chemistry as well as the spatial distribution of adsorbates. Chapter 5 presents the physics of electron paramagnetic resonance and then shows how various techniques, including spectrum simulation, can be used to unravel the complexities of this method. The discussion of the elucidation of catalyst chemistry through the use of probe molecules shows the power of EPR to determine surface crystal fields, redox chemistry, catalytic sites, the coordination of surface metal ions, and the mobility of adsorbed species. The final chapter of this volume is the most heavily weighted toward the technique itself. Its emphasis is on the accurate extraction of kinetic parameters from temperature-programmed desorption curves.

The organization and emphasis of the specific technique chapters that follow the opening chapter in each volume are not uniform, but each chapter presents its technique in quantitative detail. While the chapters are not intended as complete literature surveys, a great strength of the presentation is in the thorough discussion of examples. Some chapters are organized by surface chemistry and some by catalytic material, but all demonstrate the richness of information available from the method. Typographical errors and a few omissions detract from the impact, but overall this is a valuable addition to the catalysis literature. Experts in specific characterization methods will find new insights and opportunities in complementary techniques. Those less experienced will find both a background for understanding the current literature and strong inducement, through the description of past successes, to consider specific spectroscopic measurements on new systems.

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0021-9517/92 $5.00