

Preface

Calorimetry and other thermal methods play an increasingly important role as tools for the study of catalysts, supports, adsorbents, and for the characterization of their surfaces. This makes it particularly timely to collect in a single volume a set of texts on the fundamentals of adsorption and the bases of thermal analysis techniques such as microcalorimetry, differential scanning calorimetry, thermogravimetry, temperature-programmed desorption, temperature-programmed reduction/oxidation, inverse gas chromatography, etc. The use of many of these techniques is now fairly routine, but their application in the domain of catalysis often requires coupling them to other methods such as volumetry, gas chromatography, mass spectrometry, infrared spectroscopy, etc., in order to allow for an in-depth study of the successive stages of the life cycle of a catalyst, from its preparation to its use in the catalytic reaction and finally its regeneration. Tools that allow the measurement of the heats evolved during the various steps of a chemical reaction are particularly useful given the current emphasis on energy efficiency. However, among the various techniques mentioned above, used alone, or in couplings, each have their own strengths and weaknesses that need to be carefully discussed.

This book, based on a series of summer schools held in Lyon every year since 2007, aims to provide students, engineers, and confirmed researchers alike with an introduction to the major thermal analysis techniques used to characterize solid materials and investigate their surface reactivity, including both physical and chemical processes occurring at gas–solid or liquid–solid interfaces. The main topics covered include:

- the basic phenomena (adsorption, competitive adsorption, desorption, thermodynamics, and kinetics) involved at the solid–gas and solid–liquid interfaces;
- the main thermal analysis and calorimetry techniques used to investigate catalytic materials, alone or linked to other techniques, and their relative advantages; including the main types of calorimetric techniques (adsorption calorimetry, flow calorimetry, titration calorimetry, immersion calorimetry, etc.), as well as temperature-programmed desorption, reduction and oxidation, along with a number of examples and a discussion of experimental considerations and constraints;

- applications of these techniques, such as the study of competitive or selective adsorption processes, the characterization of acid/base sites in oxides and zeolites, the adsorption or capture of gas or liquid pollutants (CO, CO₂, VOCs, nicotine, phenol, etc.), and processes for new energies (biodiesel production, hydrogen production and storage, etc.).

We hope that this book will thus serve as a practical guide to end users about selecting and implementing the most appropriate thermal analysis techniques for solving a specific problem.

In closing, I would like to express my sincere gratitude to my colleagues who kindly agreed to write up the various lecture notes and contributions that make up this volume, as well as to all those who helped with the design, redaction, and editing of this book.

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