

Preface

This book contains 37 subjects and topics in 5 chapters based on recent developments in the XAFS approach to science and technology, describing the theories, calculation methods, computer programs, advanced methodologies and techniques, experiments, and applications to catalysts, nanoparticles, and surfaces. The book details advanced XAFS techniques and their applications, which enable high-quality research in various areas such as physics, chemistry, materials science, bioscience, engineering, energy science, environmental science, geoscience, metallurgy, and mineralogy. Fundamental characterization of catalysts, nanomaterials, and surfaces is an essential and important area of academic and industrial material development and important to addressing many of today's big global challenges.

The XAFS science and technology has significantly progressed in the past 50 years in association with developments of synchrotron radiation sources and storage rings with lower beam emittance and higher brilliance. In this book we concentrate on the distinct progress, advantage, and merit of the XAFS techniques in conducting fundamental and practical studies on a variety of advanced catalysts, nanomaterials, and surfaces with definite purposes and goals. We also describe recent important issues as examples and future prospects, while also providing the basic theory, principle, and analysis of XAFS and a systematic presentation of relevant data.

Powerful, unique, and versatile, XAFS techniques have provided in situ approaches under working/operando conditions for more realistic molecular-level understanding of catalysis mechanisms and dynamic functions of nanomaterials and surfaces. Recently, XAFS has developed by significant progress in real-time and spatially imaging XAFS measurements. These techniques have provided new pieces of information on real-time structural kinetics and dynamics by real-time characterization and on two- and three-dimensional mapping and visualization of catalyst layers, even a single nanoparticle, sensors, fuel cell electrode catalysts, batteries, biological assemblies, and so on. XAFS analysis methodology has also made progress in applications to more precise characterization of important

catalysts, nanomaterials, and surfaces, which cannot be obtained from other analysis techniques.

This book is written for not only students and academic researchers, but also for people involved in industrial research, in an effort to create synergy between academia, research institutions, and industry. This book is a comprehensive, theoretical, practical, and thorough guide to current XAFS spectroscopy and modern applications involving social needs research. Assuming only undergraduate-level physics, mathematics, and chemistry, the book is ideally suited for graduate students, young scientists, and senior scientists in any disciplines including XAFS-based research. The book also provides guidance to senior undergraduate students for their future research directions and interests.

We were happy to have excellent contributions of many world-class scientists from the USA, the UK, Germany, France, Japan, Italy, the Netherlands, Switzerland, Norway, Brazil, and Russia, reflecting the real international dimension of the book and broad interests and significance of XAFS-based researches. We are pleased to sincerely thank all of them. We thank all Springer staff for continuous encouragement, useful suggestions, and careful production throughout the XAFS book project. We believe that this book can contribute toward present and future fundamental and practical research of the related fields and will satisfy the widest range of researchers and students working in the domain or related topics.

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