Springer Series in Optical Sciences

Volume 190

Springer Series in Optical Sciences

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X-Ray Absorption Spectroscopy of Semiconductors

Springer

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ISSN 0342-4111 ISSN 1556-1534 (electronic)
ISBN 978-3-662-44361-3 ISBN 978-3-662-44362-0 (eBook)
DOI 10.1007/978-3-662-44362-0

Library of Congress Control Number: 2014951156

Springer Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

X-ray Absorption Spectroscopy (XAS) is a powerful technique with which to probe the properties of matter, equally applicable to the solid, liquid and gas phases. Its unique characteristics, including element-specificity and nanometer range, make it a versatile probe that provides structural information distinctly different and complementary to that obtained by other common techniques such as X-ray diffraction or electron microscopy. Since the pioneering works in the early 1970s, XAS has progressed tremendously with respect to both experimental techniques and theoretical understanding. Modern synchrotron lightsources not only enable standard XAS measurements with extremely high data quality, they also facilitate studies on the subsecond or nanometer scale. This provides a large variety of new applications such as time-resolved measurements of dynamic processes or structural characterization of single nanostructures. The theoretical understanding of XAS has progressed at a similar pace and several computer codes capable of calculating the X-ray absorption fine structure to within the experimental uncertainty are now readily available. It therefore seems a mere consequence that XAS is these days widely used in a large number of fields including physics, chemistry, material science, geology, biology and environmental science.

Semiconductors form the basis of an ever-growing variety of electronic and photonic devices that permeate almost every aspect of today's society. From mobile phones to cars, from washing machines to artificial light, semiconductor technology is at the bottom of nearly all modern appliances. Advanced telecommunications, the key to a global world, is utterly unthinkable without the achievements made in the semiconductor industry over the last decades. These developments, however, are far from completed. Currently, the whole new world of nanomaterials is being explored extensively and first concepts to utilize the unique properties thus discovered are being implemented. Semiconductor materials also play a vital role in the quest for a sustainable energy supply, one of the big global challenges of the twenty-first century. By directly converting sunlight to electricity, photovoltaic devices such as solar cells provide a versatile and renewable energy source. The growing and changing demands of future technology in nearly all aspects of modern life therefore continuously require improving current and developing new semiconductor devices.

The most effective utilization of these materials, today and tomorrow, necessitates a detailed knowledge of their structural properties as they determine other electrical, optical or magnetic properties crucial for device performance. XAS has provided unique and valuable insight into these relations for a large number of semiconductor systems. It is therefore the aim of this book to present a comprehensive overview of past and present research activities in this ever growing field.

Chapter 1 is dedicated to a short introduction to XAS and is aimed primarily at newcomers to the technique. It presents all the basic information necessary to follow the subsequent chapters and provides references for further reading. The following chapters are dedicated to XAS research of distinct groups of materials. Part I comprises Chaps. 2–6 and is dedicated to crystalline semiconductors spanning topics such as alloying, wide band gap materials, dopants and clusters and vibrational properties. Part II presents research on disordered semiconductors with amorphous materials covered in Chaps. 7 and 8 while phase changes due to extreme conditions such as high temperature and high pressure are discussed in Chap. 9. Part III consists of Chaps. 10–13 and is dedicated to semiconductor nanostructures such as quantum dots, nanoparticles and nanowires of various group IV, III–V and II–VI materials. The last section, Part IV, concerns the investigation of magnetic ions such as Mn, Co and Fe incorporated in different group IV, III–V and II–VI semiconductors discussed in Chaps. 14–16, respectively.

Each chapter summarizes the research activities of the respective field and highlights important experimental results thus demonstrating the capabilities and applications of the XAS technique. As such, this book provides a comprehensive review and valuable reference guide for both XAS newcomers and experts involved in semiconductor materials research.

Jena, Canberra

Claudia S. Schnohr
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Part III Semiconductor Nanostructures

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