MATERIALS CHARACTERIZATION SERIES

SERIES EDITORS: C. Richard Brundle and Charles A. Evans, Jr.

材料表征原版系列丛书

有机薄膜的表征

CHARACTERIZATION OF Organic Thin Films

Abraham Ulman

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黑版贸审字08-2013-085号

Abraham Ulman
Characterization of Organic Thin Films
9781606500446

Originally published by Momentum Press, LLC
English reprint rights arranged with Momentum Press, LLC through McGraw-Hill Education (Asia)

图书在版编目（CIP）数据

有机薄膜的表征：英文/（美）布伦德尔（Brundle C. R.），（美）埃文斯（Evans C. A.），（美）乌尔曼（Ulman A.）主编. —哈尔滨：哈尔滨工业大学出版社，2014.1
（材料表征原版系列丛书）
ISBN 978-7-5603-4287-0

Ⅰ. ①有… Ⅱ. ①布…②埃…③乌… Ⅲ. ①薄膜技术-英文 Ⅳ. ①TB43
中国版本图书馆CIP数据核字（2013）第264466号

材料科学与工程
图书工作室

责任编辑 许雅莹 张秀华 杨 桦
出版发行 哈尔滨工业大学出版社
社 址 哈尔滨市南岗区复华四道街10号 邮编 150006
传 真 0451-86414749
网 址 http://hitpress.hit.edu.cn
印 刷 哈尔滨市石桥印务有限公司
开 本 660mm × 980mm 1/16 印张 18.5
版 次 2014年1月第1版 2014年1月第1次印刷
书 号 ISBN 978-7-5603-4287-0
定 价 98.00元

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MOMENTUM PRESS

MOMENTUM PRESS, LLC., NEW YORK

MATERIALS CHARACTERIZATION SERIES
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Preface to the Reissue of the Materials Characterization Series

The 11 volumes in the *Materials Characterization Series* were originally published between 1993 and 1996. They were intended to be complemented by the *Encyclopedia of Materials Characterization*, which provided a description of the analytical techniques most widely referred to in the individual volumes of the series. The individual materials characterization volumes are no longer in print, so we are reissuing them under this new imprint.

The idea of approaching materials characterization from the material user's perspective rather than the analytical expert's perspective still has great value, and though there have been advances in the materials discussed in each volume, the basic issues involved in their characterization have remained largely the same. The intent with this reissue is, first, to make the original information available once more, and then to gradually update each volume, releasing the changes as they occur by on-line subscription.

C. R. Brundle and C. A. Evans, October 2009

Preface to Series

This Materials Characterization Series attempts to address the needs of the practical materials user, with an emphasis on the newer areas of surface, interface, and thin film microcharacterization. The Series is composed of the leading volume, *Encyclopedia of Materials Characterization*, and a set of about 10 subsequent volumes concentrating on characterization of individual materials classes.

In the *Encyclopedia*, 50 brief articles (each 10 to 18 pages in length) are presented in a standard format designed for ease of reader access, with straightforward technique descriptions and examples of their practical use. In addition to the articles, there are one-page summaries for every technique, introductory summaries to groupings of related techniques, a complete glossary of acronyms, and a tabular comparison of the major features of all 50 techniques.

The 10 volumes in the Series on characterization of particular materials classes include volumes on silicon processing, metals and alloys, catalytic materials, integrated circuit packaging, etc. Characterization is approached from the materials user's point of view. Thus, in general, the format is based on properties, processing steps, materials classification, etc., rather than on a technique. The emphasis of all volumes is on surfaces, interfaces, and thin films, but the emphasis varies depending on the relative importance of these areas for the materials class concerned. Appendixes in each volume reproduce the relevant one-page summaries from the *Encyclopedia* and provide longer summaries for any techniques referred to that are not covered in the *Encyclopedia*.

The concept for the Series came from discussion with Marjan Bace of Manning Publications Company. A gap exists between the way materials characterization is often presented and the needs of a large segment of the audience—the materials user, process engineer, manager, or student. In our experience, when, at the end of talks or courses on analytical techniques, a question is asked on how a particular material (or processing) characterization problem can be addressed the answer often is that the speaker is "an expert on the technique, not the materials aspects, and does not have experience with that particular situation." This Series is an attempt to bridge this gap by approaching characterization problems from the side of the materials user rather than from that of the analytical techniques expert.

We would like to thank Marjan Bace for putting forward the original concept, Shaun Wilson of Charles Evans and Associates and Yale Strausser of Surface Science Laboratories for help in further defining the Series, and the Editors of all the individual volumes for their efforts to produce practical, materials user based volumes.

C. R. Brundle *C. A. Evans, Jr.*

Preface to the Reissue of *Characterization of Organic Thin Films*

There have been many advances in both the characterization and the processing of thin organic films since the original release of this volume. The basic understanding of Langmuir–Blodgett films and self assembled monolayers, as discussed in the first two chapters, has not changed, however. Also, though there have been advances in both instrumentation and theoretical modeling, the basic description and understanding of the nine different techniques discussed in detail here, for characterizing organic films, has not changed. After the re-release of this volume in a form close to the original, it is our intention that updates, covering the advances that have taken place, will be released as downloads as they become available.

C. R. Brundle and C. A. Evans, November 2009

Preface

Materials science is at the center of academic and industrial research today. In the past ten years, it has become apparent that the way materials scientists operate should change, and that a design approach must be used in the preparation of new materials. This is best represented by the research done in the area of organic thin films, where a useful property is identified a priori, an appropriate molecule designed and synthesized, and the corresponding film prepared.

Materials scientists, physicists, chemists, and even biologists are interested in both amorphous (spin-coated polymer) and highly organized (Langmuir–Blodgett and self-assembled) organic films because of their relevance to science and technology For example, spin-coated polymer films that contain polar aromatic molecules may have applications in electro-optic devices. Monolayers on piezoelectric crystals may serve as chemical and biological sensors, and sell-assembled monolayers, due to their dense and stable structure, have potential application in corrosion prevention, wear protection, and more. The ability to tailor both head and tail groups of the constituent molecules makes self-assembled monolayers ideally suited for a more fundamental understanding of phenomena affected by competing intermolecular, molecular—substrate, and molecule—solvent interactions, such as ordering and growth, wetting, adhesion, lubrication, and corrosion.

While scientists and engineers typically have the background needed to understand the subtleties of the molecular material important for their applications, they may not have the training to extract all the information from the analysis of organic thin films. Often, analysts have the opposite strengths and weaknesses. This volume, *Characterization of Organic Thin Films*, together with the others in the Characterization Series published by Manning Publications and Butterworth-Heinemann, are intended to rectify this situation. This volume does not emphasize the characteristics of the different techniques—that is accomplished in the lead volume in the Series, *Encyclopedia of Materials Characterization*. Instead, a case study approach is used in most chapters to illustrate how important problems in organic thin films can be resolved using a given analytical technique.

In arranging this volume, we have not followed the general pattern used in other volumes of the series. We have decided to organize it according to different analytical techniques for a couple of reasons. The first is that by writing a chapter on only a specific material, using different analytical techniques as examples, a serious discussion on any of the techniques cannot be developed, and an understanding of the uniqueness, strengths, and weaknesses of a particular technique cannot be achieved. Helping readers achieve such an understanding is my first goal. The second reason is that if the book is structured according to materials, readers will probably choose to read

the one or two chapters closely related to their work, and will not be introduced to other types of materials. By taking the analytical techniques approach, on the other hand, a range of important structural issues are presented, and at the same time the reader gains an understanding of interpretation schemes. The reader also is exposed to different types of materials through the examples used. The purpose of the book clearly is not to make readers experts, but to get them started should they desire to become experts, and to plant ideas so they can question an associate who is an expert analyst. Providing a broad perspective on organic thin films is my second goal.

We begin this volume with introductory chapters on Langmuir–Blodgett and self-assembled films. We then turn to discussions of both their surface (interfacial) and bulk properties, as studied using different analytical techniques. The techniques discussed arc ellipsometry, Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy, surface potential measurements, X-ray diffraction measurements, high resolution electron energy loss spectroscopy (HREELS), wetting and surface energy, secondary ion mass spectrometry (SIMS), X-ray photoelectron (XPS) and Auger electron spectroscopies, and optical second harmonic generation (SHG).

A number of techniques have not been included in this volume, and the reader is referred to the complementary volume *Encyclopedia of Materials Characterization*. The development of analytical tools for the study of organic thin films has been dramatic in the past decade. Using such tools it has become possible to get structural information at the molecular level and thus relate structure to properties. The fundamental understanding of structure—properties relationships makes molecular engineering of advanced materials possible and opens new opportunities in material science and molecular manufacturing.

Abraham Ulman

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Self-Assembled Monolayers; X-Ray Photoclectron Spectroscopy of Organic Thin Films

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