Scanning Electron Microscopy and X-Ray Microanalysis

A Text for Biologists, Materials Scientists, and Geologists

SECOND EDITION

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Preface

In the last decade, since the publication of the first edition of *Scanning Electron Microscopy and X-ray Microanalysis,* there has been a great expansion in the capabilities of the basic SEM and EPMA. High-resolution imaging has been developed with the aid of an extensive range of field emission gun (FEG) microscopes. The magnification ranges of these instruments now overlap those of the transmission electron microscope. Low-voltage microscopy using the FEG now allows for the observation of noncoated samples. In addition, advances in the development of x-ray wavelength and energy dispersive spectrometers allow for the measurement of low-energy x-rays, particularly from the light elements (B, C, N, O). In the area of x-ray microanalysis, great advances have been made, particularly with the "phi rho z" [$\phi(\rho z)$] technique for solid samples, and with other quantitation methods for thin films, particles, rough surfaces, and the light elements. In addition, x-ray imaging has advanced from the conventional technique of "dot mapping" to the method of quantitative compositional imaging. Beyond this, new software has allowed the development of much more meaningful displays for both imaging and quantitative analysis results and the capability for integrating the data to obtain specific information such as precipitate size, chemical analysis in designated areas or along specific directions, and local chemical inhomogeneities.

During these 10 years we have taught over 1500 students in our Lehigh SEM short course in basic SEM and x-ray microanalysis and have updated our notes to the point that the instructors felt that a completely rewritten book was necessary. In this book we have incorporated information about the new capabilities listed above and added new material on specimen preparation for polymers, a growing area for the use of the SEM. On the other hand, we have retained the features of the First Edition, including the same general chapter headings that have been so well accepted. The authors have noticed that there are generally two groups of students who use this textbook and who attend our course, the real introductory or novice student and the experienced student who is looking to sharpen his or her basic skills and to delve into the newer

techniques. Therefore, we have decided to highlight in the left margin the material which is essentially basic and should be read by every student who is a novice in the field. We have also added a new introductory chapter on quantitative x-ray microanalysis of bulk samples which will serve as a beginning for those readers interested in quantitation but overwhelmed at first by the physics and the mathematical expressions. This introductory chapter is descriptive in nature with a minimum of equations and should help those readers who want to understand the basic features of the quantitative analysis approach.

The authors wish to thank their many colleagues who have contributed to this volume by allowing us to use material from their research, by their criticism of drafts of the chapters, and by their general support. One of the authors (J. I. G.) wishes to acknowledge the research support and encouragement from the Extraterrestrial Materials Program of the National Aeronautics and Space Administration. Special thanks go to Ms. Sharon Coe for her efforts with the manuscript, to Dr. John Friel of Princeton Gamma Tech and Dr. Bill Bastin of the Technical University of Eindhoven for their contributions to the chapters on quantitative x-ray microanalysis, and to Dr. David Williams of Lehigh University for continuous and helpful advice as the textbook was developed.

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