SECOND EDITION

Introduction to TEXTURE ANALYSIS

Macrotexture, Microtexture, and Orientation Mapping

OLAF ENGLER
VALERIE RANDLE

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Part III Microtexture Analysis

Preface

Most solid-state materials, including metals, ceramics, and minerals, have a polycrystalline structure in that they are composed of a multitude of individual crystallites or "grains." This book is concerned with a specific aspect of such materials—the crystallographic orientation of its components or the crystallographic texture, or simply *texture*, of the polycrystalline compound. The significance of texture lies in the anisotropy of many material properties; that is, the value of this property depends on the crystallographic direction in which it is measured. In most cases grain orientations in polycrystals, whether naturally occurring or technologically fabricated, are not randomly distributed and the preference of certain orientations may indeed affect material properties by as much as 20%–50% of the property value. Therefore, the determination and interpretation of texture are of fundamental importance in materials technology. Furthermore, analysis of the texture changes during the thermomechanical treatment of materials yields valuable information about the underlying mechanisms, including deformation, recrystallization, or phase transformations. In geology, texture analysis can provide insight into the geological processes that led to rock formations millions of years ago.

Nowadays there is a selection of techniques available to analyze the texture of materials. The well-established methods of x-ray or neutron diffraction, known as macrotexture techniques, are now supplemented by methods whereby individual orientations are measured in transmission or scanning electron microscopes and directly related to the microstructure, which has given rise to the term *microtexture*. Microtexture practice has grown principally through the application of electron backscatter diffraction, and it is now possible to measure orientations automatically from predetermined coordinates in the microstructure, which is known generically as *orientation mapping*. From the full range of texture techniques now available, insights can be gained into material processing, corrosion, cracking, fatigue, grain boundary properties, and other phenomena with a crystallographic component.

Over the past 70 years, a large number of publications on texture analysis have appeared in the literature. However, there are only a few monographs on the subject, many of which are highly specialized with a strong focus on the mathematical aspects of texture. We have written the second edition of *Introduction to Texture Analysis* to provide comprehensive coverage of the range of concepts, practices, and applications of the techniques for determining and representing texture. The mathematics of the subject has been kept to the minimum necessary to understand the scientific principles. For a more complete treatment, a comprehensive bibliography directs the reader to more specialized texts. The text is inclined toward microtexture

analysis, reflecting both the growing emphasis on this modern approach to texture analysis and the greater requirement for detailed explanation of the philosophy, practice, and analysis associated with microtexture. The book is intended for materials scientists, physicists, and geologists—both nonspecialists, including students, and those with more experience—who wish to learn about the approaches to orientation measurement and interpretation, or to understand the fundamental principles on which measurements are based to gain a working understanding of the practice and applications of texture.

The sequence of the book is as follows. Part I, Fundamental Issues, addresses the descriptors and terminology associated with orientations and texture and their representation in general. This part concludes with an introduction to the diffraction of radiation, since this phenomenon forms the basis of almost all texture analysis. Part II, Macrotexture Analysis, covers both data acquisition and representation. Part III, Microtexture Analysis, provides experimental details of the transmission or scanning electron microscope-based techniques for microtexture analysis, followed by a description of how microtexture data are evaluated and represented. The innovative topics of orientation microscopy and orientation mapping are introduced, and more advanced issues concerning crystallographic aspects of interfaces and connectivity are treated.

We are indebted to a large number of colleagues from whom we have learned, with whom we have discussed and interacted, or who have provided thoughtful comments on parts of this book. In particular, we would like to acknowledge Michael Dahms, Austin Day, Günter Gottstein, Jürgen Hirsch, Martin Hölscher, Dorte Juul Jensen, Jerzy Jura, Fred Kocks, Ingo Lischewski, Kurt Lücke, Jan Pospiech, Dierk Raabe, Robert Schwarzer, Steve Vale, Hasso Weiland, Rudy Wenk, and Stefan Zaefferer.

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Authors

Olaf Engler is senior scientist of metallurgy at the Research and Development Center of Hydro Aluminium in Bonn, Germany. Prior to that, he was at the University of Technology in Aachen, Germany, and the Materials Science and Technology Division of Los Alamos National Laboratory in the United States. Since 2004, he has also been an adjunct professor for texture and crystal plasticity at the NTNU Trondheim, Norway, and a member of the international committee of the International Conference on Texture of Materials (ICOTOM).

Engler has more than 20 years of experience in analysis, interpretation, and modeling of the development of microstructure and texture during the thermomechanical processing of metallic materials and control of the resulting materials properties.

Valerie Randle has been eminent in the field of electron backscatter diffraction for more than 20 years. Her other main research interest is grain boundary engineering in metals and alloys. She has written more than 300 scientific publications on these research topics, including five textbooks.

Randle is a past Welsh Woman of the Year and recipient of the Institute of Materials' Rosenhain Medal. Currently, she heads the Materials Research Centre at Swansea University in Wales, United Kingdom.

Part I

Fundamental Issues

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