Topics in Applied Physics Volume 22

Topics in Applied Physics Founded by Helmut K. V. Lotsch

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X-Ray Optics

Applications to Solids

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With 133 Figures

Springer-Verlag Berlin Heidelberg New York 1977

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ISBN 3-540-08462-2 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-08462-2 Springer-Verlag New York Heidelberg Berlin

Library of Congress Cataloging in Publication Data. Main entry under title: X-ray optics. (Topics in applied physics; v. 22). Bibliography: p. Includes index. 1. Solids Optical properties. 2. X-rays. 3. Solid state physics. I. Queisser, Hans-J., 1931-. II. Authier, A. QC 176.8.06X2 530.4'1 77-15086

Monophoto typesetting, offset printing, and bookbinding: Brühlsche Universitätsdruckerei, Lahn-Gießen
2153/3130-543210

Preface

Optics has been rejuvenated during the last few decades, mostly through the discovery of the laser. Most activity is, however, confined to the spectral regions of the visible radiation and adjoining regimes. The X-ray region, on the other hand, experienced a different development. Plasma diagnostics and the related field of X-ray astronomy provided many stimuli for improved instrumentation and novel experiments. Medical and materials-testing applications, of course, continued to provide strong motivation for the improvement of sources, detectors, and signal processing techniques in the X-ray region. The availability of synchrotrons and storage rings as powerful sources for X-rays also had a significant impact on utilization of X-ray photons for a variety of experiments in many fields.

This volume cannot cover all these aspects. The necessary restriction of topics therefore emphasizes those new developments in X-ray optics which are related to solid-state sciences and particularly to new solid-state technologies. The advancements of solid-state physics, the chemistry and crystallography of solids, and the understanding and control of X-radiation have always been closely intertwined and will continue to be intimately coupled to each other. One example is given by modern semiconductor technology with its achievement of highly perfect crystals and its requirements for extremely stringent control of crystalline perfection as well as with its need for geometry definition beyond that achievable with visible light. The contributions of this volume have been selected with this interrelation of X-ray optics and solid-state sciences in mind. The well-known techniques of crystallographic structure determinations are not covered here. Instead, it was attempted to accentuate new approaches, many of which we presume to emerge from the research laboratories into widespread applications for future fabrication of solid-state materials and devices in a similar fashion as numerous other applications of X-rays have done previously.

The modern status of high-power X-ray sources is covered first; synchrotron radiation is not treated in this book since an entire separate volume of the series "Topics in Current Physics" (Editor: C. Kunz) will later be devoted to this topic. Chapter 3 of the present volume covers in great detail the scientific principles and the practical applications of X-ray lithography, an extremely rapidly moving field of vital importance for the future of microminiaturization of semiconductor devices and other highly integrated solid-state structures. Chapter 4 reviews the present state of interferometry and includes the inseparable field of neutron interferometry as well. The two final chapters concern themselves with modern facets of the technique of X-ray topography, which is a large-area mapping of almost perfect single crystals in the light of specific Laue reflections. Section topography, treated in Chapter 5, is a particularly sensitive tool to use for revealing the fine structure of defects and obtaining information on depth distributions of such defects; live topography, as described in Chapter 6, is the attempt to avoid lengthy photographic exposure by using a direct display technique.

I hope to have chosen a coherent, closely interrelated set of subjects out of the vast field of modern X-ray techniques, which may be of use to those interested in applying and advancing both X-ray technology and solid-state sciences. I would like to thank all those who have helped me in the editing of this book—first all the authors for their cooperation in trying to present the most modern status of their subject fields; then the publisher for the speedy publication, W. Hagen for his help and advice, and Miss A. Vierhaus for her patience and skill in typing and handling.

Stuttgart, August 1977 *Hans-Joachim Queisser*

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