HANDBOOK ON PHYSICAL PROPERTIES OF SEMICONDUCTORS

VOLUME 3

II-VI Compound Semiconductors

HANDBOOK ON PHYSICAL PROPERTIES OF SEMICONDUCTORS

VOLUME 3

II-VI Compound Semiconductors

Sadao Adachi
Department of Electronic Engineering
Gunma University
Kiryu-shi, Gunma 376-8515
Japan

KLUWER ACADEMIC PUBLISHERS
NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW

eBook ISBN: 1-4020-7821-8
Print ISBN: 1-4020-7820-X

Created in the United States of America

Visit Kluwer Online at: http://kluweronline.com
and Kluwer's eBookstore at: http://ebooks.kluweronline.com

To

Kōya

CONTENTS

PREFACE

The progress made in physics and technology of semiconductors depends mainly on three families of materials: the group-IV elemental, III–V, and II–VI compound semiconductors. Almost all II–VI compound semiconductors crystallize either in the zincblende or wurtzite structure. The first research papers on II–VI compound semiconductors date back to the middle of the nineteenth century. In the ensuring hundred years extensive literature has been accumulated as much research and development works are being carried out on these compound semiconductors. At present, the II–VI compound semiconductors are widely used as photodetectors, x-ray sensors and scintillators, phosphors in lighting, displays, etc. New applications are continuously being proposed. Thus, it seems to timely bring together the most up-to-date information on the material and semiconducting properties of II–VI compound semiconductors.

The aim throughout has been to present in convenient form as large amount of accurate, reliable, and up-to-date information on the physical properties of II-VI compound semiconductors for a variety of basic research and device applications. The data on the physical properties of each semiconductor are organized in the same way in order to facilitate searching for information. The physical properties considered in this book can be classified into 12 groups: (1) structural properties; (2) thermal properties; (3) elastic properties; (4) phonons and lattice vibronic properties; (5) collective effects and related properties; (6) energy-band structure:

energy-band gaps; (7) energy-band structure: electron and hole effective mass; (8) electronic deformation potential; (9) electron affinity and Schottky barrier height; (10) optical properties; (11) elastooptic, electrooptic, and nonlinear optical properties; and (12) carrier transport properties.

The extensive bibliography is included for those who wish to find additional information if required. I hope that the book will aid many who want to know various properties of those semiconductor materials in the course of their work. The reader will also find the series books "Group-IV Semiconductors" and "III–V Compound Semiconductors" useful in order to find the needed information quickly on these practically important semiconductors.

ACKNOWLEDGMENTS

The author wishes to thank the editors and authors of the following journals, symposium papers, and books for permission to reproduce previously published figures: *Academic Press* for Figs. 14.12.1 and 16.12.2; *Appl. Phys. Lett.* for Figs.5.10.7, 5.11.3, 6.12.1, 8.10.3, 8.12.3, 8.12.6, 8.12.7, 14.10.3, and 14.12.4; *Brit. J. Appl. Phys.* for Figs. 6.12.4, 7.12.5, 11.12.7, and 11.12.8; *Can. J. Phys.* for Fig. 7.10.4; *Eur. Phys. J.* for Fig. 8.10.11; *INSPEC* (*IEE*) for Figs. 8.10.8, 11.10.8, 11.10.9, and 12.10.3; *Int. J. Electron.* for Fig. 11.12.6; *J. Appl. Phys.* for Figs. 6.11.1, 6.12.3, 7.6.3, 7.11.2, 7.12.1, 7.12.4, 8.6.3, 8.10.4, 8.12.1, 8.12.5, 9.6.3, 9.11.3, 11.6.3, 11.10.5, 14.4.1, 14.4.2, 16.7.1, 17.4.1, and 17.4.2; *J. Chem. Phys.* for Figs. 7.4.1, 7.4.2, 9.4.1, and 9.4.2; *J. Cryst. Growth* for Fig. 15.4.1; *J. Opt. Soc. Am.* for Figs. 7.10.6, 8.10.6, and 14.10.5; *J. Phys. Chem. Solids* for Figs. 1.4.1, 1.4.2, 5.12.1, 5.12.2, 8.1.1, 9.6.2, 14.11.1, and 17.12.1; *J. Phys.: Condens. Matter* for Fig. 4.6.1; *J. Phys. D: Appl. Phys.* for Fig. 9.12.1; *J. Phys. Soc. Jpn* for Figs. 7.11.1, 9.11.1, 9.11.2, 11.11.1, 11.11.3, 11.12.1, 11.12.3, and 14.12.2; *Jpn. J. Appl. Phys.* for Figs. 7.11.3 and 8.11.3; *North-Holland Publishing Company* for Figs. 8.2.1, 9.2.1, 10.2.1, 11.2.1, 11.12.4, 12.2.1, 13.2.1, 14.2.1, 16.2.1, and 17.2.1; *Opt. Mater.* for Figs. 11.10.10 and 14.10.8; *Phys. Rev.* for Figs. 1.2.1, 1.6.1, 1.6.2, 5.1.1, 5.6.1, 5.6.2, 5.10.5, 5.11.1, 5.11.2, 6.6.1, 6.6.2, 6.10.4, 7.1.1, 7.2.2, 7.6.2, 7.6.4, 7.10.3, 7.10.7, 7.10.8, 7.11.4, 8.2.3, 8.6.1, 8.6.2, 8.10.7, 8.11.1, 8.11.2, 8.11.4, 9.1.1, 9.2.3, 9.6.1, 9.10.3, 9.10.5, 9.10.6, 9.10.8, 9.11.4, 9.11.5, 10.6.1, 10.6.2,

10.10.4, 11.6.1, 11.6.2, 11.10.4, 12.1.1, 12.4.1, 12.6.1, 12.6.2, 13.6.1–13.6.3, 13.10.8, 14.4.3, 14.6.1, 14.6.2, 14.10.6, 14.10.9, 14.12.3, 15.10.3, 16.6.4, 16.6.5, 16.10.4–16.10.6, 16.12.1, 17.10.3, 17.10.4, and 17.10.8; *Phys. Scripta* for Figs. 1.10.3, 16.4.1, and 16.4.2; *Phys. Status Solidi* for Figs. 8.4.1–8.4.3, 8.12.9, 9.12.3, 11.10.7, 13.10.5, 14.1.1, 15.7.1, 15.10.1, 15.10.2, 15.12.1, 16.2.4, 16.6.1, 16.10.3, 17.2.3, 17.6.1, 17.10.5, 17.10.6, and 17.12.3; *Physica* for Fig. 11.7.1; *Proc. Phys. Soc.* for Fig. 11.12.5; *Proc. Roy. Soc.* for Fig. 13.10.6; *Semicond. Sci. Technol.* for Figs. 2.6.1, 3.6.1, 3.10.1, and 9.12.5; *Solid State Commun.* for Figs. 5.4.1, 5.6.3, 8.6.4, 8.10.9, 8.11.5, 9.6.4, 11.4.1, and 13.12.3; *Sov. Phys. Semicond.* for Figs. 13.12.1 and 17.12.2; *Sov. Phys. Solid State* for Fig. 13.11.1; and *W. A. Benjamin Inc.* for Fig. 11.12.2.

CONTENTS OF OTHER VOLUMES

HANDBOOK ON PHYSICAL PROPERTIES OF SEMICONDUCTORS I
Group-IV Semiconductors

Sadao Adachi, Author

HANDBOOK ON PHYSICAL PROPERTIES OF SEMICONDUCTORS II
III–V Compound Semiconductors

Sadao Adachi, Author