DEFECT CONTROL IN SEMICONDUCTORS

Vol.1

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the Science and Technology of Defect Control in Semiconductors
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PREFACE

This book contains 254 papers presented at "The International Conference on the Science and Technology of Defect Control in Semiconductors (IC-STDCS)" which was held on September 17–22, 1989 in Yokohama, Japan. The conference was organized as *The Yokohama 21st Century Forum 1989* to commemorate the centenary of Yokohama City.

Defect control in semiconductors is a key technology for realizing the ultimate possibilities of modern electronics. It is obvious that the basis for such control lies in an integrated knowledge of a variety of defect properties. From this viewpoint, the aim of the conference was to provide a forum for the discussion of defect-related problems in connection with defect control in semiconducting materials. The organizers of the conference especially hoped that scientists in the field of basic research and engineers involved in application related to electronic devices could mutually benefit from joint discussion.

Basic research on defects in semiconductors seems to have initially started with the question of what effects appear if the regular tetrahedral coordination of a typical semiconductor is disturbed locally by the introduction of some structural defects or impurities which have different valences, different sizes and different inner shells. A large number of papers have so far been published in this research field. The problems have also been discussed at a series of international conferences such as the ICDS. Fairly great progress seems to have been achieved in this field, especially in understanding the nature of relatively simple types of defects. However, the field of research is now expanding very rapidly, and defects to be investigated are becoming more and more complicated.

On the one side, the study of defects in semiconductors is becoming increasingly important to the field of applications as great progress is made in electronic device technology on the basis of developments in material-processing of semiconductors. In the early stages of the study, only negative or harmful aspects of defects were recognized. Thus, defect study in this field initially focused on finding methods of suppressing or avoiding generation of harmful defects during crystal growth or device processing in order to facilitate device fabrication. Recently, a new trend has appeared in which defects are positively utilized to improve device performance and reliability. Typical examples are intrinsic and extrinsic gettering techniques in silicon technology and utilization of EL2 to achieve semi-insulation of GaAs. The most important matter now seems to be to find ways to control the distribution, density and even properties of any defects rather than to completely eliminate such defects from crystals.

As a matter of fact, when materials engineers of electronic devices attempt to apply the results of basic research, they often feel that these results are too basic to yield practical and profitable results in device fabrication. As a consequence, a considerable share of the development in the modern technology of electronic materials now seems to result from experiences practically encountered during device fabrication processes. Various technological difficulties have been practically overcome by means of such trial and error. Conversely, when scientists involved in basic research observe any defect-related phenomena which are encountered in device fabrication processes, they recognize that the phenomena are usually too complicated to allow for any immediate self-consistent interpretation. Most of the important processes take place at high temperatures where various types of reactions can occur among numerous kinds of defects and impurities by means of thermal activation.

However, it is obvious that no matter how complicated the phenomena seem to be, they are just the results of accumulation of elementary processes which are rate-controlled by the behaviour of simple types of defects and impurities. Even when engineers practically develop a new technology on the basis of their experience in device production processes, it can be achieved more efficiently if they understand the underlying physical phenomena correctly. So, engineers need to deepen their knowledge of the basic properties of defects. At the same time, it seems true that various phenomena encountered in the practical field often lead scientists to new fields of research. Phenomena really occuring in nature are much richer in variety than those human brains can imagine. Actually many basic studies of seminconductor defects now being done have their origin in practical device production processes.

At any rate, the organizers of the conference believed that exchange between scientists and engineers in the field of semiconductor defects was becoming more and more important, and this idea motivated them to organize this conference. Indeed, human history after the Industrial Revolution tells us that progress in natural science and development of technology are mutually dependent and inseparable. This proposition is obvious also in the rather narrow field of semiconductor defects.

Over 460 participants from 24 different countries attended the conference. Discussion at each technical session was extremely active. The organizers of the conference were well satisfied that their intention in organizing the conference had been understood by all participants.

The papers submitted to the conference have all been reviewed and revised as required in preparation for publication. They have been organized into seven sections in this book, namely, General, Silicon, Bulk Compounds, Thin Layers and Heterostructure, Dislocations and Deformation-induced Defects, Defect Characterization, and Organic Crystals. Although the editor realizes that this is by no means a unique way of classifying the papers, he feels that this classification to some extent reflects the present level of the science and technology of semiconductor materials. He feels also that the conference itself was a significant experiment for finding the most effective way of bringing together scientists involved in basic research and engineers seeking to apply such research.

K. Sumino

Acknowledgement

Many colleagues from both universities and industries of Japan participated eagerly in organizing the conference. Especially, Dr. S. Kawado, Dr. J. Matsui, Dr. N. Inoue and Professor K. Kojima served as session-chairpersons and were in charge of organizing sessions related to Silicon, Bulk Compounds, Thin Layers and Heterostructure, and Organic Crystals, respectively. Dr. I. Yonenaga and Mrs. U. Onose served as conference secretaries. We thank all of the colleagues for their efforts which made the conference successful. We are also grateful to many Japanese industries for their financial support of the conference.

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