

Defects in semiconductors

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I. INTRODUCTION

Defects are crucial to understanding semiconductor materials and designing semiconductor-based devices. In using the term “defects,” we include not only native point defects (such as vacancies and interstitials), but also dopant impurities, unintentional contaminants, and complexes between these species. While some defects can lead to detrimental nonradiative recombination and carrier trapping, other defects can be used to provide free carriers that are necessary for the design of transistors, light-emitting devices, and solar cells. Since the advent of semiconductors, a significant amount of research has focused on how to deduce and control the behavior of these defects. While traditional materials (such as silicon, germanium, and gallium arsenide) continue to present challenges in terms of understanding defects, a surge of interest in power electronics has motivated the study of newer classes of materials such as two-dimensional semiconductors and wide-bandgap nitrides and oxides. Growing interest in this area has sustained the relevance of longstanding international conferences such as the International Conference on Defects in Semiconductors.¹

As sources of electrical, optical, magnetic, and vibrational signals, defects in semiconductors provide an excellent testing ground for both theory and experiment. This Special Topic brings together contributions from researchers with wide-ranging expertise in the field of defects in semiconductors, documenting advances in our understanding of established materials like silicon carbide and gallium arsenide, but also includes progress in promising new materials, such as the II-IV-VI ternary compounds and ultrawide-bandgap oxides. While showcasing the latest breakthroughs in defects in semiconductors, we also wish to acknowledge the passing of our dear colleagues Audrius Alkauskas² and Władysław Walukiewicz,³ both of whom made fundamental contributions to this field.

II. BACKGROUND

As discussed above, defects in semiconductors can be native (or intrinsic), involving only those elements that compose the bulk compound. The introduction of extrinsic impurity elements, necessary for doping, also leads to the formation of defect species. Categorizing defects as intrinsic or extrinsic is often helpful for categorizing their behavior; sorting defects by dimensionality is often helpful as well. Most of the defects discussed in this Special Topic are “zero-dimensional” point defects, as they involve a defect on a single (or in some cases, a few) lattice sites. Defects can also have higher dimensionality: “one-dimensional” defects include dislocations, and stacking faults can be thought of as “two-dimensional defects,” both of which are also often crucial for understanding semiconductor behavior.

In this Special Topic, we categorize defects not by their chemical nature or dimensionality but instead by their semiconductor host material. Our hope is that this will allow the reader to quickly find the material classes of interest. Nevertheless, examining defect behavior across different materials systems is quite useful for understanding their underlying physics. While a fuller discussion of defect physics is beyond the scope of this Editorial, recent works^{4–6} provide much greater detail.

III. SUMMARY OF RESEARCH AREAS

A. Methodological advances in defect modeling and experimentation

The challenge of studying defects necessitates constant improvements and new developments in methods, both in theory and experimentation. Several of the works published in this issue describe such advancements.

Many of the papers in this area were motivated by the need to understand the role of defects in electronic devices. While defects

Radiation Damage And Defects In Semiconductors

Conference Series No 16

**Sheldon Datz, B. R. Appleton, C. D.
Moak**



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Atomic Collisions in Solids Sheldon Datz, B. R. Appleton, C. D. Moak, 2013-11-21 Perhaps the most controversial aspect of this volume is the number V assigned to the conference in this series. Actually the first conference to be held under the title Atomic Collisions in Solids was held at Sussex University in England in 1969 and the second at Gausdal Norway in 1971 which would logically make the conference held at Gatlinburg Tennessee U S A in 1973 the third. However the appearance of the proceedings of the 1971 Gausdal Conference published by Gordon and Breach bore the number IV. The reasoning behind this was that in fact two previous conferences had been largely dedicated to the same subject area. The first of these was at Aarhus Denmark in 1965 and the second in 1967 was held in ChaZk River Canada. Hence the number V for the 1973 meeting. Actually the conference can easily be traced back to Paris France in 1962 when it went under the cover of the 10th International Conference on Neutron Transmutation Doping in Semiconductors. In 1962 a small conference was held at Oak Ridge Tennessee U S A at which the discovery of channeling was first formally announced. This was followed by conferences at ChaZk River Canada in 1963 and at Harwell England in 1964. More over immediately following the ChaZk River conference in 1967 there was a conference on higher energy collisions at Brookhaven New York U S A. Thus strictly speaking the Gatlinburg meeting is the tenth X in the series.

Neutron Transmutation Doping in Semiconductors J. Meese, 2012-12-06 This volume contains the invited and contributed papers presented at the Second International Conference on Neutron Transmutation Doping in Semiconductors held April 23-26 1978 at the University of Missouri Columbia. The first testing of the waters symposium on this subject was organized by John Cleland and Dick Wood of the Solid State Division of Oak Ridge National Laboratory in April of 1976 just one year after NTD silicon appeared on the marketplace. Since this first meeting NTD silicon has become established as the starting material for the power device industry and reactor irradiations are now measured in tens of tons of material per annum making NTD processing the largest radiation effects technology in the semiconductor industry. Since the first conference at Oak Ridge new applications and irradiation techniques have developed. Interest in a second conference and in publishing the proceedings has been extremely high. The second conference at the University of Missouri was attended by 114 persons. Approximately 20% of the attendees came from countries outside the U S A making the conference truly international in scope.

Technology of Si, Ge, and SiC / Technologie Von Si, Ge und SiC W. Dietze, E. Doering, P. Glasow, W. Langheinrich, M. Schulz, A. Ludsteck, H. Mader, A. Mühlbauer, W.v. Münch, H. Runge, L. Schleicher, M. Schnöller, E. Sirtl, E. Uden, W. Zulehner, 1983-12

Mechanisms of Radiation Effects in Electronic Materials V. A. J. Van Lint, 1980
Gallium Arsenide John Sydney Blakemore, 1987

The Effects of Nuclear Weapons Samuel Glasstone, Dolan J. Philips, 1977

Crystalline Defects and Contamination Bernd O. Kolbesen, Electrochemical Society. Electronics Division, 2001

Intrinsic Point Defects, Impurities, and Their Diffusion in Silicon Peter Pichler, 2012-12-06 Basically all properties of semiconductor devices are influenced by the distribution of point defects in their active areas. This book

contains the first comprehensive review of the properties of intrinsic point defects acceptor and donor impurities isovalent atoms chalcogens and halogens in silicon as well as of their complexes Special emphasis is placed on compiling the structures energetic properties identified electrical levels and spectroscopic signatures and the diffusion behavior from experimental and theoretical investigations In addition the book discusses the fundamental concepts of silicon and its defects the electron system diffusion thermodynamics and reaction kinetics which form the scientific basis needed for a thorough understanding of the text Therefore the book is able to provide an introduction to newcomers in this field up to a comprehensive reference for experts in process technology solid state physics and simulation of semiconductor processes

Radiation Effects on and Dose Enhancement J. R. Srour, 1984-01-15 **Nuclear Science Abstracts** , 1975 NSA is a comprehensive collection of international nuclear science and technology literature for the period 1948 through 1976 pre dating the prestigious INIS database which began in 1970 NSA existed as a printed product Volumes 1 33 initially created by DOE s predecessor the U S Atomic Energy Commission AEC NSA includes citations to scientific and technical reports from the AEC the U S Energy Research and Development Administration and its contractors plus other agencies and international organizations universities and industrial and research organizations References to books conference proceedings papers patents dissertations engineering drawings and journal articles from worldwide sources are also included Abstracts and full text are provided if available

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