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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 Alkauskas[2] and Wladyslaw 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

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Radiation Damage And Defects In Semiconductors Conference Series No 16:

Atomic Collisions in Solids Sheldon Datz,B. R. Appleton,C. D. Moak,2013-11-21 Perhaps the most controversiaZ aspect of this voZume is the number V assigned to the conference in this series ActuaZZy the first conference to be heZd under the titZe tomic CoZZisions in SoZids was heZd at Sussex University in EngZand in 1969 and the second at GausdaZ Norway in 1971 which wouZd ZogicaZZy make the conference heZd at GatZinburg Tennessee U S A in 1973 the third III However the appearance of the proceedings of the 1971 GausdaZ Conference pubZished by Gordon and Breach bore the number IV The reasoning behind this was that in fact two pre vious conferences had been ZargeZy dedicated to the same subject area The first of these Was at Aarhus Denmark in 1965 and the second in 1967 was heZd in ChaZk River Canada Hence the number V for the 1973 meeting ActuaZZy the conference can easiZy be traced back to Paris France in 196Z when it went under the coZorfuZ titZe of e Bom bardement Ionique In 1962 a smaZZ conference was heZd at Oak Ridge Tennessee U S A at which the discovery of channeZing was first formaZZy annunciated This was foZZowed by conferences at ChaZk River Canada in 1963 and at HarweZZ EngZand in 1964 More over immediateZy foZZowing the ChaZk RiVer conference in 1967 there was a conference on higher energy coZZisions 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 con ference 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 interna tional in scope **Mechanisms of Radiation Effects in Electronic Materials** V. A. J. Van Lint,1980

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 **Gallium Arsenide** John Sydney Blakemore,1987 *The Effects of Nuclear Weapons* Samuel Glasstone,Dolan J. Philips,1977 Nuclear Science Abstracts ,1975 **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 **Annual Solid State Physics Conference** Solid State Physics Conference,1975 Vols for 1971 contains outlines of papers compiled for the convenience of those attending the conference **Theoretical Chemistry** Amyand David Buckingham,Charles Alfred Coulson,1975 Molecular charge distributions their display and use correlated wave functions obtcuned by the variational nethod and the method of moments Electron momentum distribution in atoms molecules and solids Electronic structure of small molecules ESCA chemical bonding aspects of some solid state phenomena The SCF Xa scat tered ware method and its application to molecular problems The theory of rotationally inelastic molecular collisions Radiationless transitions **INIS Atomindex** ,1985 **Proceedings of the International Symposium on Quantum Chemistry, Solid-State Theory, and Computational Methods** Per-Olov Löwdin,1988 The 28th Sanibel Symposia organized by the faculty of the Quantum Theory Project were held March 12 March 19 1988 and gathered about 250 participants at the University of Florida Whitney Marine Laboratory at Marineland on the Atlantic Coast of Florida This location provided a rustic setting for the conference not unlike that of Sanibel Island where the first several symposia were held The format of this years s symposia provided a compact eight day schedule with an integrated program of quantum biology quantum chemistry and condensed matter physics The topics covered in the eleven plenary sessions on quantum chemistry and condensed matter physics included Electron Transfer Molecular Mechanics and Microscopic Theory Metallic Cluster Novel Electronic Structure Methods Relativistic Methods High T Superconductors Weird Molecules and other current topics MJM Detector Research And Development For The Superconducting Super Collider - Proceedings Of The Symposium Valerie Kelly,Tom Dombeck,George P Yost,1991-05-29 Over the last three years a significant program of detector technology research and development for high luminosity high energy hadron hadron colliders has been underway in the United States Japan and Europe In as much as the first formal steps have been undertaken to initiate the experimental program at the Superconducting Super Collider SSC it is appropriate to assess in detail the status of this R Particle Tracking and Identification Techniques Vertex Detection Magnets Front End Electronics Data Acquisition Electronics Techniques in Triggering Data Transmission Data Analysis and Simulation Software Studies on Radiation Damage to Materials and Electronics ULSI Science and Technology, 1989 C. M.

Osburn,John M. Andrews,1989 **Proceedings of the Royal Society of London** Royal Society (Great Britain),1983 Publishes research papers in the mathematical and physical sciences Continued by Proceedings Mathematical and physical sciences and Proceedings Mathematical physical and engineering sciences **The Journal of Physics and Chemistry of Solids** ,1975 **Extended Defects in Semiconductors** D. B. Holt,B. G. Yacobi,2007-04-12 The elucidation of the effects of structurally extended defects on electronic properties of materials is especially important in view of the current advances in electronic device development that involve defect control and engineering at the nanometer level This book surveys the properties effects roles and characterization of extended defects in semiconductors The basic properties of extended defects dislocations stacking faults grain boundaries and precipitates are outlined and their effect on the electronic properties of semiconductors their role in semiconductor devices and techniques for their characterization are discussed These topics are among the central issues in the investigation and applications of semiconductors and in the operation of semiconductor devices The authors preface their treatment with an introduction to semiconductor materials and conclude with a chapter on point defect maldistributions This text is suitable for advanced undergraduate and graduate students in materials science and engineering and for those studying semiconductor physics Soviet Physics ,1988

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