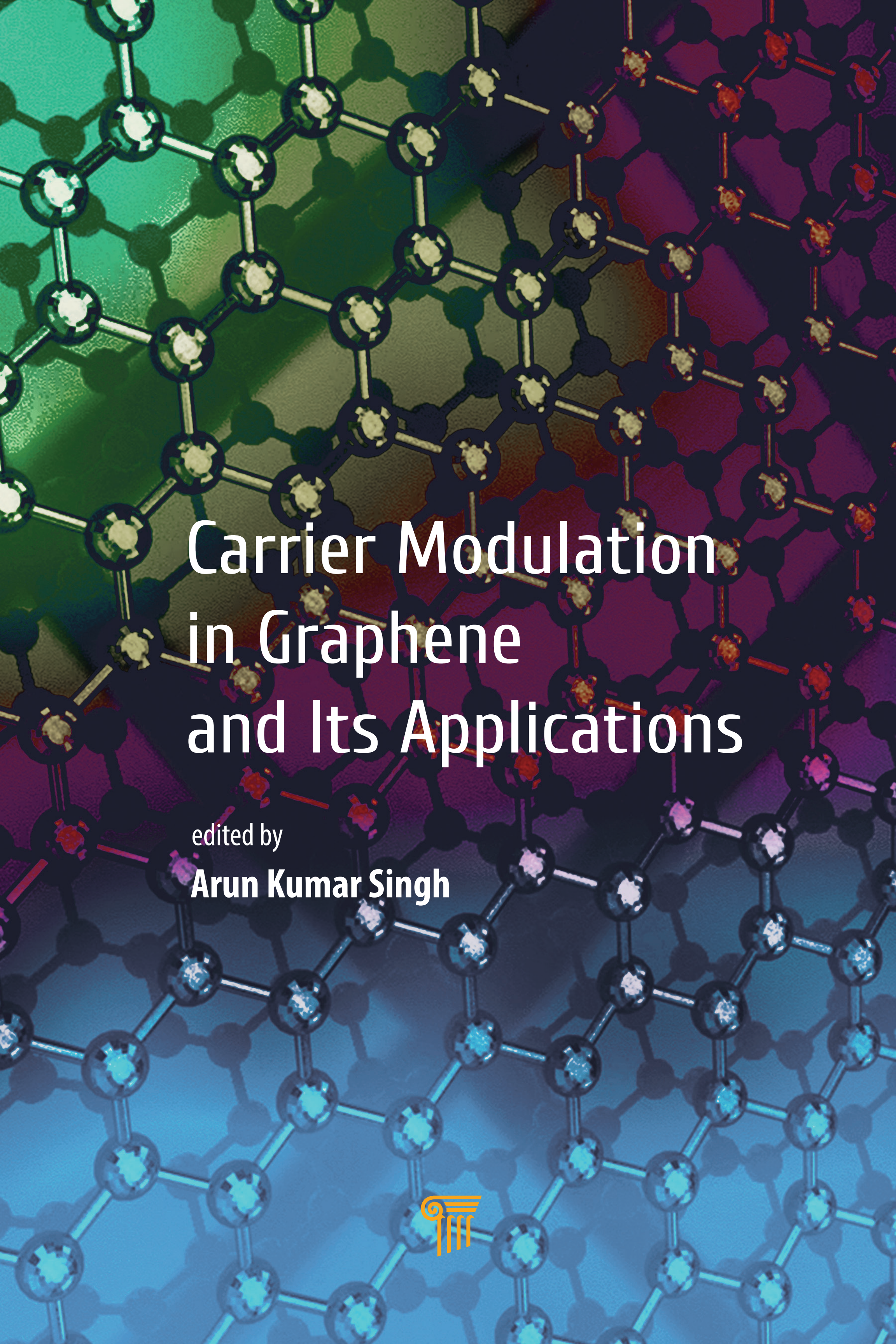
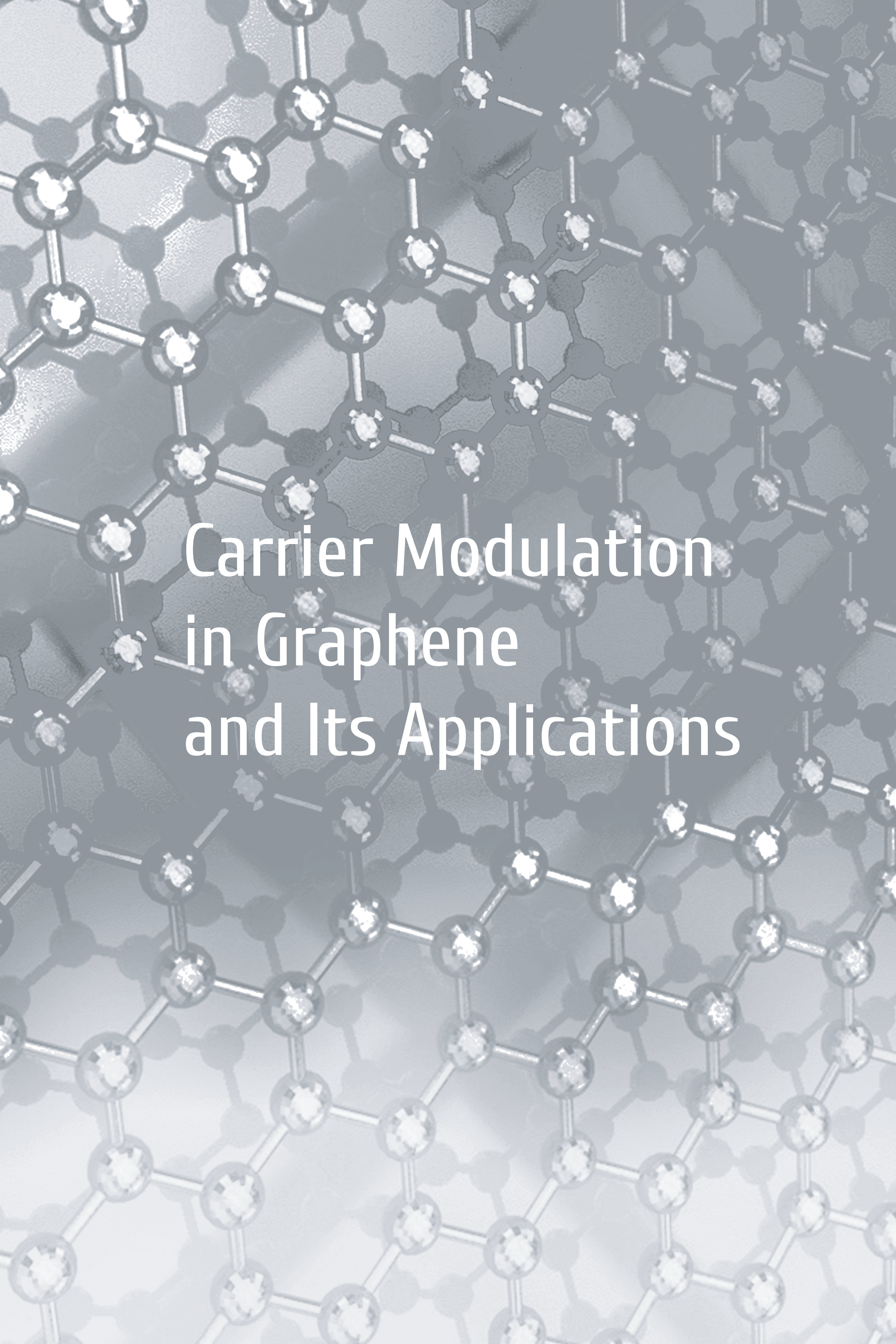


Carrier Modulation in Graphene and Its Applications

edited by

Arun Kumar Singh



Carrier Modulation in Graphene and Its Applications

Carrier Modulation in Graphene and Its Applications

edited by

Arun Kumar Singh

Jenny Stanford Publishing

Published by

Jenny Stanford Publishing Pte. Ltd.
Level 34, Centennial Tower
3 Temasek Avenue
Singapore 039190

Email: editorial@jennystanford.com
Web: www.jennystanford.com

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Carrier Modulation in Graphene and Its Applications

ISBN 978-981-4877-60-2 (Hardcover)
ISBN 978-1-003-16028-1 (eBook)

Dedicated to

my

Family

Contents

Preface

Graphene is a two-dimensional single sheet of carbon atoms and has unique crystal and electronic structure, physical properties such as ambipolar electric field effect, flexibility, transparency (97.7% for single layer), very high charge carrier mobility, anomalous quantum Hall effect, thermal conductivity, and much more that is yet to be discovered. These properties have generated tremendous excitement in the scientific community and make graphene appropriate for many applications, including flexible electronic and optoelectronic devices, supercapacitors, transparent conducting electrodes, and chemical, and bio sensors. There has been great interest in charge carrier modulation of graphene because it tuned the Fermi level of graphene. The tuning of graphene's Fermi level is an important factor in determining the successful operation of electronic/optoelectronic devices. The Fermi level of graphene can be easily tuned by the modulation of charge carriers in graphene.

The electrical properties of graphene are very sensitive to the charge impurities, doping level, and defects. Recently, several approaches have been applied to modulate the electronic properties of graphene. For example, depositing dopant atoms on a graphene surface induces interstitial doping, chemical modification by absorption of gas molecules or by aromatic compounds and by electrostatic field tuning. Doped graphene has attracted considerable attention due to their exciting electronic properties and demonstrate immense potential for various applications such as transparent conducting electrodes, light-emitting diodes, photovoltaic devices, and supercapacitors. Therefore, it is necessary to tune the Fermi level of graphene for high performance of devices. This book covers all aspects of graphene. It discusses the fundamental properties of graphene and various synthesis methods of graphene nanosheets, focuses on different methods of carrier modulation in graphene and their impact on charge transport as well as on device performance, and gives an overview of the current status of research and development activities in the field. The book will be very useful for scientists, researchers, engineers, and students who wish to know about graphene and its applications.

Arun Kumar Singh

"This book focuses on many aspects of carrier modulation in graphene with applications in various electronic devices such as diodes and field-effect transistors, optoelectronic devices including solar cells, and energy storage devices such as supercapacitors. In addition, the current status of the research and development in this area has been thoroughly documented. The book will be very useful for academic students and faculties as well as researchers working in the area of nanomaterials and nanotechnology."

Dr. Ram Sevak Singh
OP Jindal University, Chhattisgarh, India

"In recent years, there has been tremendous development in cost-effective synthetic processes of graphene. Graphene-based devices have been reaching the market, but the full industrial scale has not been achieved in areas such as electronics, photovoltaics, and energy storage. This book covers very significant aspects of graphene's properties and its applications. It will be very useful to readers in both academic and industrial contexts."

Dr. Varun Rai
Nanyang Technological University, Singapore

Graphene has many unique properties that have generated tremendous interest in the scientific community and make it suitable for several applications. The tuning of graphene's Fermi level by the modulation of its charge carriers is an important factor in determining the successful operation of electronic/optoelectronic devices.

This book focuses on different methods of performing carrier modulation in graphene and the application of doped graphene in diodes, field-effect transistors, solar cells, transparent conducting electrodes, and supercapacitors. It discusses the current status of the research and development in graphene and will be helpful for the readers who want to know about graphene and its applications and also other 2D nanomaterials.

Arun Kumar Singh is associate professor at the Department of Pure and Applied Physics, Guru Ghasidas Vishwavidyalaya, India. He received his MSc in physics from Banaras Hindu University (BHU), India, and PhD from the School of Materials Science and Technology, Indian Institute of Technology (BHU), Varanasi, India. After his PhD, he began postdoctoral research work at the Graphene Research Institute, Sejong University, South Korea. In 2013, he got India's most prestigious research "INSPIRE Faculty" award from the Department of Science and Technology, India, and many other fellowships and awards from scientific societies. He worked as assistant professor (INSPIRE faculty) at the Department of Physics, Motilal Nehru National Institute of Technology Allahabad, India. Dr. Singh has authored or co-authored more than 75 articles in international journals and conferences in the areas of materials science and physics. He is also a life member of many scientific societies and a reviewer for several international scientific journals. His research work focuses on the fabrication and characterizations of organic semiconductors/2D nanomaterials/hybrid materials for electronics device applications.

V818
ISBN 978-981-4877-60-2
9 789814 877602

JENNY STANFORD
PUBLISHING