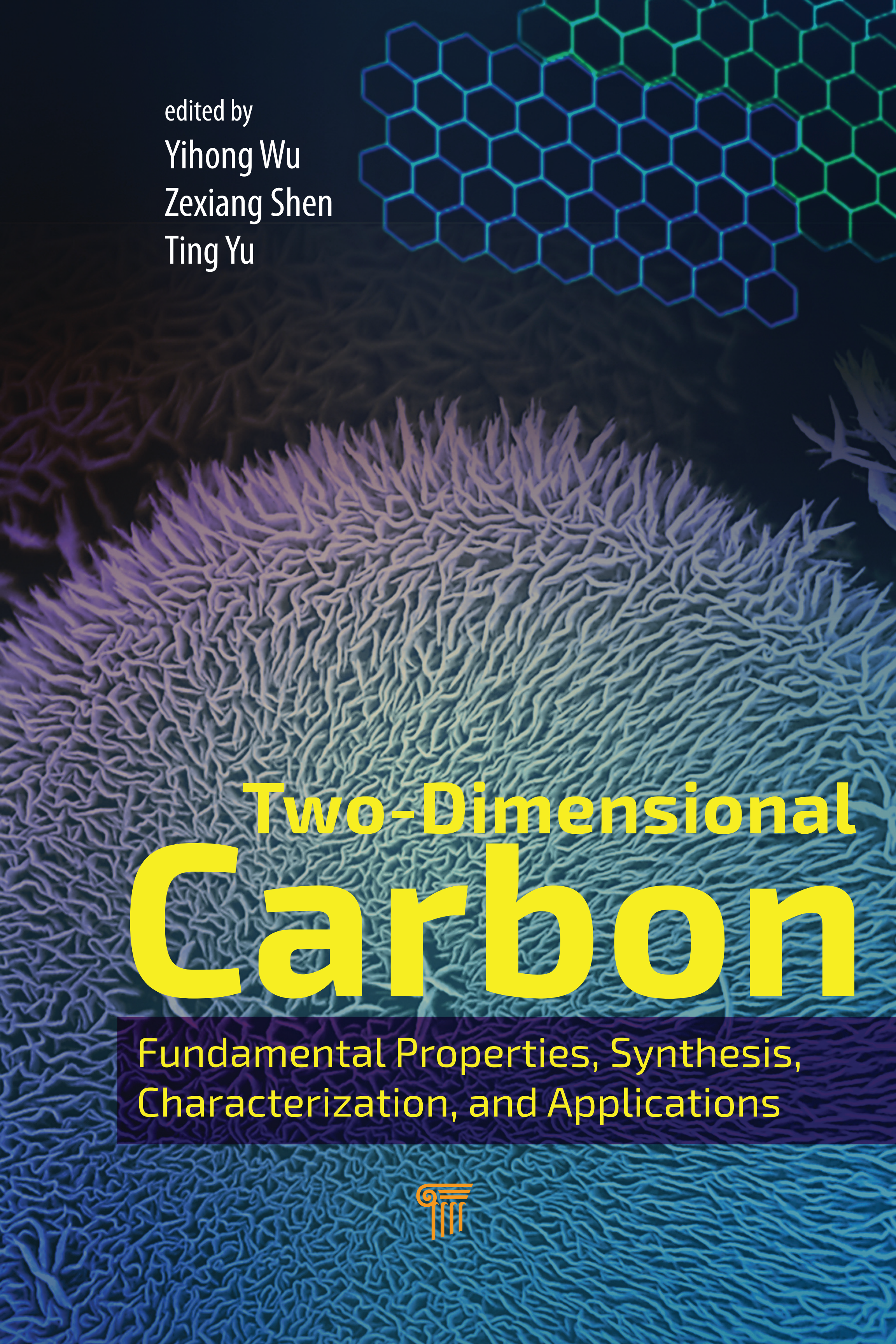

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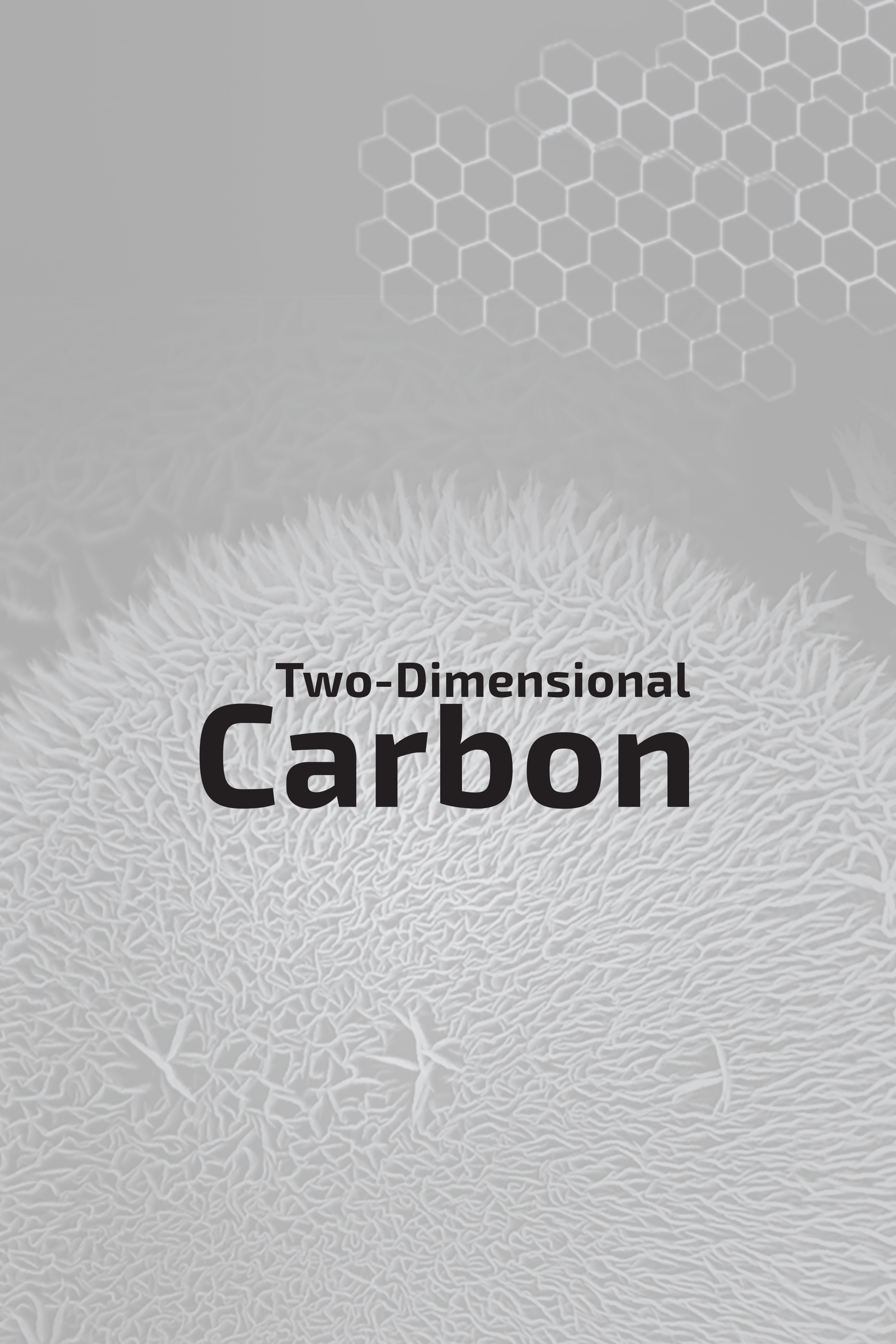
Fundamental Properties, Synthesis, Characterization, and Applications



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Contents

Preface

Graphene in the ideal form is a single layer of carbon atoms arranged in a honeycomb lattice, consisting of two interpenetrating Bravais sublattices. It is this unique lattice structure that gives graphene a range of peculiar properties that most metals and semiconductors lack. As far as electronic applications are concerned, its gapless and linear energy spectrum, high carrier mobility, frequency-independent absorption, and long spin diffusion length make it a material of choice for a variety of electronic, photonic, and spintronic devices. Apart from these applications, owing to its unique electronic properties, graphene has also attracted tremendous attention for applications that are due to primarily its unique shape and surface morphology, and low-cost production of related materials such as few-layer graphene sheets and graphene oxides. These graphene derivatives are more attractive and viable than single-layer graphene for applications that require a large quantity of materials with low cost and that rely less on graphene's electronic properties. These different types of graphene-based carbon nanostructures are referred to as two-dimensional (2D) carbon in this book, which include but are not limited to single layer graphene, few-layer graphene, vertically aligned few-layer graphene sheets (or carbon nanowalls), reduced graphene oxide and graphene oxide, etc. As far as large-scale applications are concerned, we feel that these graphene-related materials may be a step closer to reality than their pure graphene counterpart, in particular, in energy storage–related applications. This has motivated us to pull together a team of researchers who are doing frontier research in the respective fields to discuss fundamental properties of graphene, synthesis and characterization of graphene and related 2D carbon structures, and associated applications in an edited book.

The book is organized into 11 chapters. Following the introduction in Chapter 1, Yihong Wu gives a brief overview of electronic band structure and properties of graphene in Chapter 2. In addition to the description of band structure based on the tight-binding model, several unique electron transport properties of graphene are discussed. Chapters 3 and 4 cover the growth of graphene on

SiC substrates by Xiaosong Wu and on metallic substrates by Wei Wu and Qingkai Yu, respectively. The former discusses the growth mechanism of graphene on both Si-face and C-face of SiC, while the latter deals with the growth of graphene on nickel and copper substrates using chemical vapor deposition. Chapter 5 discusses the growth and electrical transport properties of carbon nanowalls on different types of substrates. Emphases are placed on how to design and form different types of electrical contacts that allow for the study of electrical transport properties of material structures with an unusual surface morphology. This is then followed by Chapter 6, in which Masaru Tachibana writes about the structural characterization of carbon nanowalls using Raman spectroscopy and transmission electron microscopy, and their potential applications in energy storage such as lithium ion batteries and fuel cells. In Chapter 7, Zexiang Shen and Da Zhan discuss the structural properties of 2D carbon based on Raman spectroscopy studies. Chapters 8 and 9 are devoted to the energy storage applications of graphene obtained by the chemical reduction route, which is more cost effective compared with other vapor deposition–based techniques. Xiu Song Zhao and Jintao Zhang focus on the applications of 2D carbon in supercapacitor in Chapter 8, followed by Zhaoping Liu and Xufeng Zhou dealing with battery applications in Chapter 9. The photonic properties of graphene are discussed by Won Jong Yoo and Hua-Min Li in Chapter 10. In Chapter 11, Hua Zhang and Shixin Wu discuss another important material derived from graphene, graphene oxide, and its potential applications in sensor and memory devices.

Owing to the very competitive environment of graphene research, many researchers would put their priority in doing research and writing papers rather than contributing to book chapters. In this context, we would like to thank all the contributing authors for their excellent chapters; without their extra efforts, we would not have the book in the present form. We would like to thank Prof. Andrew Thye Shen Wee of National University of Singapore for giving the opportunity to edit this book. Finally, we would like to thank Mr. Stanford Chong and his team at Pan Stanford Publishing for their help on this project.

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