Graphene: Properties, Synthesis and Applications

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Preface

Graphene is an ultimately monolayer material with single-atom thickness. It possesses many fascinating properties including massless Dirac electronic structure, extraordinary high electron mobility, thermal conductivity, stiffness and strength, and large surface volume ratio etc. These interesting features lead directly to numerous applications of graphene and its derivative materials.

Interestingly, although discovered as early as 1961, by German scientists Hanns-Peter Boehm and his colleagues, graphene has not been a popular material until recently several experiments successfully uncover its unusual properties as mentioned before. Back to year 2004, the experimental establishment of producing high-quality graphene sheets is achieved by Andre Geim and Konstantin Novoselov of the University of Manchester, through a simple "scotch-tape" technique, which is followed by series of characterization and measurements in their group and others around the world, including Walt de Heer, Philip Kim et al. Geim and Novoselov are then awarded the 2010 Nobel Prize in physics.

It is worthy of note that in addition to the novel properties of graphene, the synthesis techniques and key applications in the industries such as electronics and renewable energy are of critical importance to drive the explosive growth of this field, and here you will find a summary of the current state of knowledge about this magic material.

This edited book is organized into two parts. The first part focuses on the electronic and mechanical properties of graphene materials. Gharekhanlou and Khorasani will firstly introduce a tight-binding picture for the two-dimensional carbon nanostructures in Chapter 1, which is followed by a discussion on the ballistic transport process therein by Rosenstein and his colleagues in Chapter 2. Studies on the properties of bilayer graphene and the graphene edges are then presented by Guo and Banerjee et al. in Chapter 3 and 4.

The second part of this book covers the application aspect of graphene and related materials. In Chapter 5, Xu and his colleagues firstly review the chemical synthesis methods for graphene materials. From Chapter 6 to 8, Zhu, Banks and Zou then introduce the key applications of graphene as energy materials, such as solar cells, electrochemical applications and composites. The carbon nanostructures are also of great novelty as an interface bridging organic and inorganic materials. Cai and his colleagues cover this interesting topic through two chapters 9 and 10 on the hybrids between graphene, metal nanostructure, and protein. Last but not least, biomedical applications of graphene oxide are discussed by Dash and his colleague in Chapter 11.

Graphene is a simple material, but also a building block for very complicate applications. The approach to understand the role of graphene and related materials in these fields relies not only on individual research by scientists in their own fields, but

also, and more, on interdisciplinary cross-talk, as we would like to present here in this book.

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