

Preface

This book covers the current research on graphene oxide (GO), including its synthesis and characterization, structural modeling and fundamental physical properties, as well as potential applications, aiming to giving a comprehensive reference for scientists in the related fields or graduate students who want to know about GO.

Graphite oxide is a substance known for almost 150 years. The monolayer sheet of graphite oxide, namely graphene oxide, is not only an important raw material to synthesize graphene, but also shows excellent physical and chemical properties that might find important applications in electronics and optics. Meanwhile, existence of various oxygen-containing functional groups also enables GO promising prospects in energy and environmental science, as well as biotechnology. Due to numerous literatures in this fast-growing field, here we only highlight the most essential progresses instead of presenting an exhaustive bibliography. Eight chapters included in this book are summarized as follows.

Chapter 1 begins with the fabrication and reduction of GO. Three main methods to fabricate graphite oxide are described. Monolayer or multilayer GO sheets can be obtained from exfoliating graphite oxide. On the other hand, the production of graphene from reduction of GO is also introduced, focusing on chemical reduction of GO and its atomistic mechanism.

Chapter 2 illustrates the structural characterization of GO by means of both spectroscopic and microscopic approaches. In general, spectroscopic techniques (e.g., NMR, XPS, and FT-IR) can directly feature the atomic structures of GO, including the types of oxygenated functional groups and their distributions. On the other hand, microscopic techniques (e.g., TEM, STM, and AFM) can provide essential insights into the lattice atoms and topological defects.

Chapter 3 covers the theoretical modeling of GO structure, as well as the physical properties based on these structural models. As the most abundant oxygen-containing groups in GO, epoxy and hydroxyl groups are mainly considered in various structural models of GO. Depending on the coverage and arrangement of these functional groups, the physical properties of GO, such as electronic band gap, electrical conductivity, Young's modulus, and optical transmittance, are tunable in wide ranges.

Chapter 4 summarizes the application of GO in electronics and optics. By appropriately controlling the deposition and reduction parameters, GO films can be made insulating, semiconducting, or semimetallic, while maintaining optical transparency. The tunable electronic and optical properties of GO films lead to some exciting applications in the fields of transparent conductors, field-effect devices, flexible electronic materials, surface-enhanced Raman scattering, optical sensing/detecting, etc.

Chapter 5 describes the great potential of GO and GO-based composites in energy storage and conversion. The tunable electronic properties render GO and GO-based composites excellent catalysts for light-driven hydrogen production from water splitting. Also, their high surface area or porous configurations together with the functional groups contribute to the dehydrogenation of hydrides as well as the physisorption of molecular hydrogen. Moreover, moderate functional groups on GO can immobilize various active species, render various hybrid architectures and simultaneously retain the electrical conductivity for electrode materials in both lithium batteries and supercapacitors.

Chapter 6 depicts the utility of GO and GO composites in air pollutant removal and wastewater treatment. The oxygenated functional groups on the basal plane and edges make GO capable to covalently and noncovalently interact with different molecules. Moreover, the high surface area and functional groups endow GO-based materials great capability to capture the heavy metal ions and organic species. Owing to surface chemistry and architectures, GO-based materials can also function as excellent catalysts or further hybridize with the effective catalysts for converting the harmful gases and organic species in wastewater.

Chapter 7 addresses the application of GO in biotechnology. Benefiting from functional groups such as hydroxyl, epoxy, and carboxyl, GO is allowed to non-covalently interact with biomolecules through electrostatic interaction, π - π stacking, and hydrogen bonding. Moreover, the excellent optical and electromechanical properties of GO extend its applications in biotechnology, especially as a biosensor, which can be used to detect enzyme, DNA, and other biomolecules with high sensitivity and selectivity.

Chapter 8 briefly summarizes the structures, physical properties, and applications of GO and gives some outlooks of this field from the authors.

Graphene Oxide: Physics and Applications

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2015, XIII, 154 p. 81 illus., 45 illus. in color., Softcover

ISBN: 978-3-662-44828-1