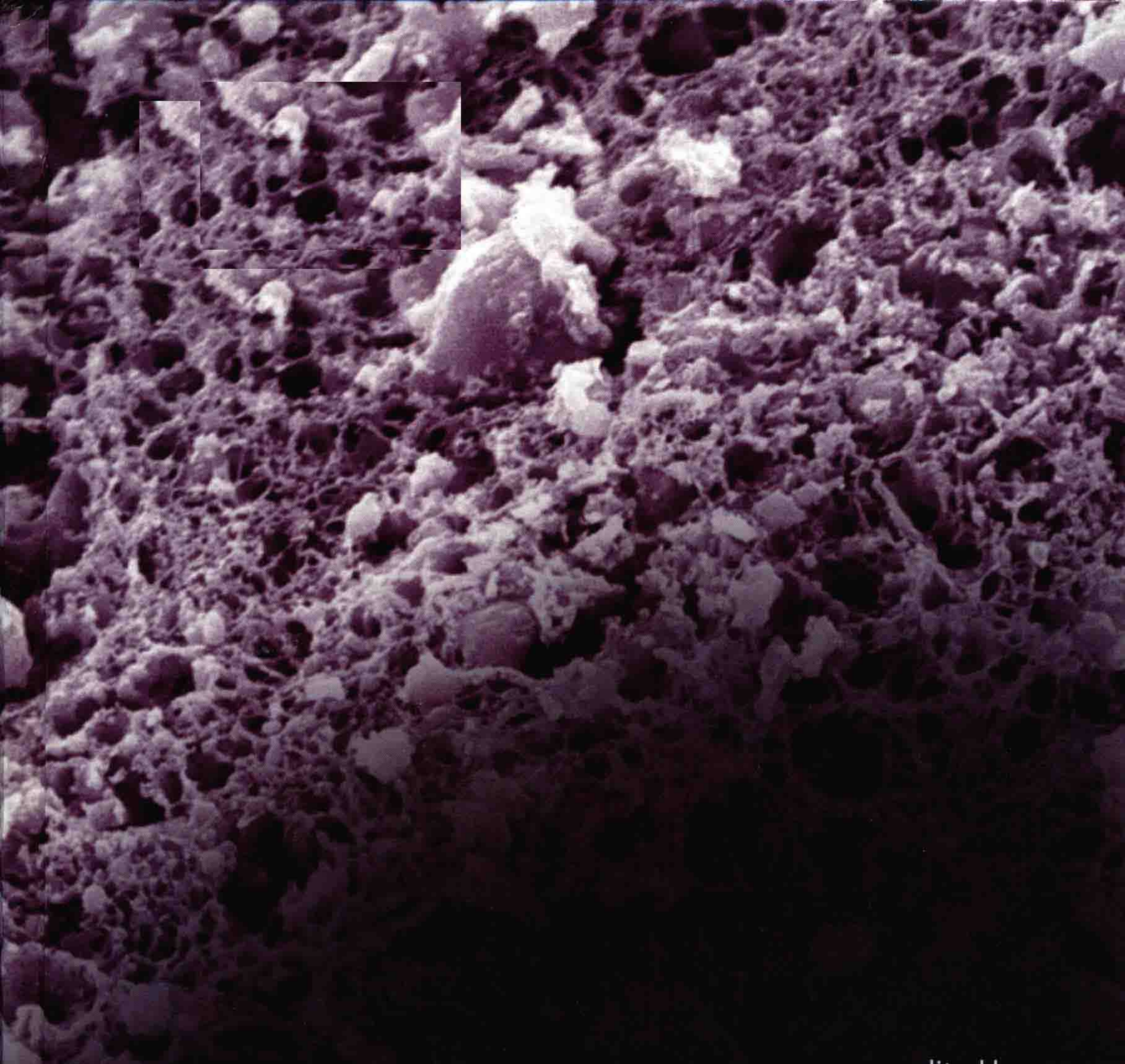

edited by
Thomas E. Rufford | Denisa Hulicova-Jurcakova | John Zhu

GREEN CARBON MATERIALS

Advances and Applications

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GREEN CARBON MATERIALS

Preface

Carbon is a versatile material that forms four known allotropes (amorphous, graphite, diamond, and fullerenes) and can be produced in a wide range of forms, including powders, foams, monoliths, cloth fibers, thin films, and granular particles. The physicochemical properties of carbon materials such as surface area, pore size, surface chemistry, and electrical conductivity can be tuned through the choice of precursor materials, preparation methods, and various secondary treatments. The versatility and possibilities to control the properties of carbon have seen carbon materials such as activated carbons used in a wide range of applications, including as adsorbents for wastewater treatment and gas purification, as energy storage materials, and as catalysts.

Novel carbon nanomaterials such as carbon nanotubes have shown great potential as electronic materials, catalysts, and adsorbents. However, significant advances in the carbon nanomaterial production techniques are required if the cost of materials such as carbon nanotubes are to be reduced and their available volumes are to be increased to a level that would allow their widespread industrial application. In contrast, activated carbons, graphite, and graphitic materials have been used for many years as economically viable adsorbents, catalyst supports, and catalyst materials. In this book, we examine the recent advances in technologies to produce low-cost carbons using less energy-intensive production processes and the application of these so-called "green carbons" in the development of cleaner and more efficient energy production and utilization processes. Of particular interest in this book is the use of agricultural and food industry waste materials as a feedstock for activated carbon production.

The content of this book is organized into 10 chapters written by experts in their fields. The first chapter provides an introduction to the functional groups that can be found on the surface of carbon materials described in the rest of the book, including a brief description of the most commonly used analytical techniques to characterize these surface functional groups. Chapter 2 provides an overview of the technologies used to produce activated carbon from lignocellulosic biomass materials, including conventional methods such as chemical and thermal activation and novel methods such as hydrothermal carbonization.

Chapters 3 to 5 highlight the recent advances in the use of carbon materials in energy storage and conversion. Carbons with high specific surface areas have been studied for the adsorption of hydrogen and methane for use onboard hydrogen- or natural gas–powered vehicles (Chapter 3, by Alcañiz-Monge *et al.*) as well as electrode materials for electric double-layer capacitors (Chapter 4, by Rufford *et al.*) and lithium-ion batteries (Chapter 5, by Rooke *et al.*). Chapter 5 also covers the use of cellulose-based carbons as platinum catalyst supports in proton exchange membrane fuel cells (PEMFC).

The second half of the book (Chapters 6 to 10) focuses on the use of carbon materials in pollution control, including the capture of toxic pollutants and volatile organic compounds (VOCs) from wastewater and industrial gases. Chapter 6 (Matos) reports the effect of the surface chemistry of activated carbon prepared from saw dust on the degradation of 4-chlorophenol by photooxidation in the presence of TiO_2. Chapter 7 (Bandosz) surveys the recent advances in the use of activated carbons to remove toxic gases such as ammonia, hydrogen sulfide, and sulfur dioxide from the emissions of industrial processes. This chapter studies the role of surface functional groups, the inorganic content of the carbon, and carbon pore structure in adsorption-reactive adsorption mechanisms involving the toxic gases. Chapter 8 (Cannon and Nieto-Delgado) presents the tailoring of the activated carbon properties for removing the natural organic matter, algal odorants, and endocrine disrupting compounds from water, along with case studies from municipal wastewater treatment plants. In Chapter 9, Dr. Peter Lodewyckx reviews the fundamentals of the adsorption of VOCs on carbon and the kinetics of the adsorption of VOCs in fixed beds. The final chapter (Chapter 10, by Jana and Gamesan) investigates the use of carbon foams prepared from sucrose as a radionuclide trap in sodium-cooled fast nuclear reactors.

The multiple authors in this book have covered many of the significant industrial applications of carbon materials. However, the content of the book is not exhaustive and some notable omissions from the scope of the book include the use of carbon materials as catalysts and catalyst supports (aside from the discussion of PEMFC catalysts in Chapter 5) and the capture of carbon dioxide from flue gases. Each of these topics is significant industrially and scientifically, and as such have been covered in detail in other books (for example, *Carbon Materials for Catalysis*, edited by Phillipe Serp and José Luis Figueiredo, Wiley 2008) and review articles (for example, Marta Sevilla and Antonio B. Fuetes in *Energy & Environmental Science*, 2011, **4**, pp. 1765–1771).

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