

Engineering Materials

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# Carbon-Based Nanomaterials for Environmental Applications

 Springer

# **Engineering Materials**

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*Dedicated to...*

**MY PARENTS**

*For their support throughout my education as  
well as for teaching me to be independent  
and responsible*

**MY BROTHERS, SISTERS**

*For their love and support*

# Preface

The domain of nanomaterials is one of the few areas in the history of scientific research that holds tremendous promise and possibility for transformation. Within this enormous arena, carbon-based nanomaterials stand out as true innovators, offering a wide variety of applications that hold the key to tackling some of the most severe environmental concerns of our day through the formulation of solutions. As we approach a new era characterized by growing worries about pollution, climate change, and sustainability, the need to create innovative solutions is more critical than ever. The merging of nanotechnology and environmental research is crucial in this setting.

The purpose of this book is to investigate the junction of these two topics, specifically to dig into the intriguing world of carbon-based nanomaterials and the numerous uses that they have in protecting our planet. These materials have a wide range of potential applications, including the reduction of pollutants in the air and water, and antibacterial activity and many other applications.

Over the course of these pages, readers will discover an in-depth investigation of the fundamental characteristics, synthesis processes, characterization techniques, and environmental applications of nanomaterials that are based on carbon. Through cutting-edge research and practical insights, we seek to give a complete knowledge of how these materials may shape a sustainable future. We have high hopes that this book will serve as a source of knowledge and inspiration for a wide range of individuals, including scholars, students, and practitioners. We hope that by developing a more profound appreciation for the extraordinary possibilities of carbon-based nanomaterials, we will be able to stimulate new lines of investigation and invention that will move us toward a future that is greener, cleaner, and more resilient.

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Multan, Pakistan  
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Tianjin, China

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Muhammad Ikram  
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Junaid Haider



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# Abbreviations

0D	Zero dimension
1D	One dimension
2D	Two dimension
3D	Three dimension
AOPs	Advanced oxidation process
APDT	Antibacterial Photodynamic Therapy
BOD	Biological oxygen demand
CB	Conduction band
CBNMs	Carbon-based nanomaterials
CDs	Carbon dots
CF	Carbon fibers
CNTs	Carbon nanotubes
COD	Chemical oxygen demand
Cr	Chromium
CSs	Carbon spheres
CVD	Chemical vapor deposition method
DCFH-DA	Dichlorodihydrofluorescein diacetate
e <sup>-</sup>	Electron
<i>E. coli</i>	Escherichia coli
E <sub>g</sub>	Bandgap energy
G +ve	Gram positive
G -ve	Gram negative
g-C <sub>3</sub> N <sub>4</sub>	Graphitic carbon nitride
GNRs	Graphene nanoribbon
GO	Graphene oxide
GONWs	Graphene oxide nanowalls
GQDs	Graphene quantum dots
Gr	Graphene
GSH	Glutathione
GSSG	Glutathione disulfide
Gt	Graphite