

Preface

Composites are engineered materials that consist of two or more insoluble phases combined together: a continuous phase, known as the *matrix*, as well as some interdispersed components, known as the *reinforcing* elements. Now if at least one of the constituent phases of a composite material is less than 100 nm in size, this composite is commonly termed *nanocomposite*.

The matrix is typically the major constituent that provides durability for the overall composite and it can be for instance, a metallic, ceramic, or polymer material. The reinforcing inclusions are on the other hand, the structure's load carriers that can be in the form of fibers, particles, or flakes. This phase of the composite structure provides its stiffness and strength. Therefore, suitable selection of type, amount, and orientation of these components plays a very important role on the overall characteristics of the pertaining composite, such as its tensile and compressive strengths, fatigue strength and failure mechanisms, electrical and thermal conductivities, specific gravity, etc.

Composite materials mostly show more significant advantageous properties compared to monolithic materials. Monolithic metals and their alloys cannot always meet the demands of today's advanced technologies and performance requirements. It means that by incorporating reinforcements into, for instance, a metallic, ceramic, or polymer matrix, the properties of the matrix improves to a higher mechanical strength, more significant temperature stability, and better chemical durability. The existence of reinforcing elements, on the other hand, improves the structure's physical and chemical properties significantly.

Among all the variety of different fillers that can be used as a nanocomposite's reinforcing phase, *carbon nanotubes* (CNTs) have shown to be promising candidates for their very specific mechanical, electrical, optical, and thermal properties that will be explained later. Carbon nanotube-based nanocomposites, i.e., composite materials in which carbon nanotubes are used as the composite's reinforcing phase, are therefore very much interesting for scientists and scholars. There are many outstanding and remarkable applications that CNT-based composites can contribute to the world of science and industry. They are expected to influence many fields in terms of technology and industry. Either as stand-alone

nanomaterials or as reinforcements in composites, they have applications in many diverse fields such as energy, signal processing, medicine, biotechnology, information technology, aerospace, agriculture, and environment. Therefore, exploring different properties of carbon nanotubes and carbon nanotube-based composite materials is of never-ending importance.

In the first three chapters of this volume, therefore, carbon nanotubes and carbon nanotube-based nanocomposites are introduced. Their material structure, major mechanical, electrical, and optical properties and their applications are further represented and the most common fabrication methods are also introduced. Finally, defects involved with carbon nanotubes, CNT-based composites are introduced, and the finite element techniques to model the introduced defects and to study their impact on the mechanical properties of the nanostructures are revealed for those who are interested in the area.

Chapter 4, then provides a detailed study on experimental aspects and challenges of fabricating carbon nanotube-based nanocomposites and controlling the appearance of defects in them. Finally, the major mechanical properties of the produced structures are reviewed and the effects of fabrication and processing steps on the resulted properties are introduced. Although mechanical properties of CNT-based composites are of major consideration in this volume, a specific subsection is devoted to highlight the special electrical conductance of the fabricated CNT composites.

The final chapter introduces CNT-fiber reinforced polymer composites specifically, as one of the most famous CNT-based composites and covers all major facts about the fabrication process of this nanocomposite type. The quality of the impact of modifying various fabrication factors of the polymer nanocomposites on its mechanical behavior is also explained with a detailed look at the tribological properties the composite.

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