

# Preface

Carbon nanotubes (CNTs) are lighter than aluminum, stronger than steel, and more thermally conductive than copper. Additionally, with their exceptionally large fracture strain and extremely high aspect ratio, CNTs have emerged as promising nano-particulate reinforcements that can be used to tailor the physical and mechanical properties of polymer. Due to their surface/volume ratio, nanoscopic size, and exceptional properties, it is believed that by suitably dispersing a few weight percentages of CNTs into a polymer, the physical and mechanical properties of that polymer can be significantly tailored leading to multifunctional *nanocomposites*. The unique property combinations that result from the dispersion and interactions between the properly dispersed CNTs, the interface, and the polymer provide greater opportunities for the development of novel material technologies to meet the challenges of the next century. Their applications have been demonstrated in electronic packaging, photonics, sensing, imaging, drug delivery, among others.

There are four reasons for the surge and interest in nanocomposites research. The first stems from the desire to tailor the electro-thermo-opto-mechanical properties of engineered materials to suit a specific application(s). The second from the desire to reduce our carbon print and ensure effective use of resources. The third from the current advances in computational nanomechanics and multiscale modeling. The fourth from the advances and the expanded efforts needed for conducting experiments at the nanoscopic level that would allow greater understanding of the CNT-polymer interactions.

This book is not an attempt to exhaustively cover all the relevant topics on nanocomposites. Instead, it is dedicated to recent developments in the field and the most exciting aspects of nanocomposites. It covers a range of topics that clearly demonstrate the depth, the diversity, and the breadth of this fertile area of research which is governed by size/scale, anisotropy, and morphology dependence of interacting phases that define the bulk properties of the resulting nanocomposites. It contains nine chapters authored/coauthored by some of the most talented and respected researchers in the community. Specifically, it covers multiscale modeling

of nanoreinforced composites (Chap. 1), piezoelectric response at nanoscale (Chap. 2), nanoscale mechanical characterization of 1D and 2D materials with application to nanocomposites (Chap. 3), effects of nano-porosity on the mechanical properties and applications of aerogels in composite structures (Chap. 4), smart fuzzy fiber-reinforced piezoelectric composites (Chap. 5), composite nanowires for room-temperature mechanical and electrical bonding (Chap. 6), recent developments of multiscale thermo-mechanical analysis of nanocomposites (Chap. 7), magnetoelectric coupling and overall properties of a class of multiferroic composites (Chap. 8), and snap-through buckling of micro/nanobeams in bistable micro/nanoelectromechanical systems (Chap. 9). In each chapter, the state of the art in the respective field and the future trends are covered and discussed.

This effort offers an up-to-date coverage of diverse but highly related topics on modeling, characterization, and applications of nanocomposites in a single volume. We believe that it is an excellent resource and it should be of interest to undergraduate and graduate physics and engineering students as well as researchers in academic institutions, government agencies, and industry specializing in material science, aerospace, electrical, biomedical, and mechanical engineering. We are confident that the readers will find the information covered in this book current, useful, and informative.

Finally, I wish to take this opportunity to express my gratitude to the authors for their outstanding contributions in addressing many of the exciting new concepts and developments in nanocomposites. Their informative efforts should guide both the experienced and the newcomers to this fascinating new area of research. I'm also indebted to my wife Valerie Meguid for her affectionate encouragement and support throughout the different stages of this effort.

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