Preface

We did not want this to be a book that glosses over the nitty-gritty stuff, assuming you already know everything, nor a book that uses "hand-waving" to magically skirt around real explanations of the complex stuff. The tone of the book is intended to make it more readable—which is to say that it is not too "textbook-y." Having used hundreds of textbooks ourselves, we knew how we did not want this one to be, and that was stodgy.

This book is about nanotechnology, a gigantic topic about small things. It is a book that is intended to excite, inspire, and challenge you. We want to uncover the most important things about nanotechnology and give you the tools you need to dig deeper on your own. We want you to enjoy learning (maybe even laugh) and for you to find out a lot in a short time. There will be plenty of rigorous scientific support, but concepts will be conveyed in clear, simple language that you can digest and apply immediately. We do "back-of-the-envelope" calculations together throughout the process so that you get a good feeling for the numbers of nanotechnology. Creative problem sets (Homework Exercises) follow each chapter to test your understanding of new concepts.

Nanotechnology represents a convergence of many sciences and technologies at the nanometer scale. In fact, it is becoming its own discipline altogether. It requires the ability to apply various scientific principles to system-level design and analysis. The multidisciplinary nature of nanotechnology—which draws from physics, chemistry, biology, and engineering—has the inherent challenge of teaching students with backgrounds in different knowledge domains.

And because the synthesis of disciplines is at the core of nanotechnology, we focus on *systems* in this book. A system is a set of interacting, interrelated, or interdependent elements that are put together to form a complex whole. We discuss nanotechnology on a system-by-system basis to foster both an appreciation and an understanding of this multifaceted topic.

We start with an overview treatment of nanotechnology, with special emphasis on the history, key personalities, and early milestones. Then on to the issues, promises, and fundamentals of nanotechnology. In fact, Chapter 1, "Big Picture and Principles of the Small World," stands alone as a comprehensive introduction, intended to answer your first questions as to what nanotechnology really is and could be. This chapter is self-contained and comprehensive; there is enough information for a freshman or general public course. It includes a discussion of the effects this new industry could have on human life, careers, education, and the environment.

Chapter 2 discusses scaling laws, giving us intuition about the physical ramifications of miniaturization. (While we think this is a useful chapter, be warned: it could bore you. If so, feel free to skip or skim it and use it as a reference.)

Then we dive headlong into nanotechnology. We begin with an "Introduction to Nanoscale Physics" (Chapter 3). Then we tackle the seven main disciplines: nanomaterials (Chapter 4), nanomechanics (Chapter 5), nanoelectronics (Chapter 6), nanoscale heat transfer (Chapter 7), nanophotonics (Chapter 8), nanoscale fluid mechanics (Chapter 9), and nanobiotechnology (Chapter 10). In these "nano" chapters, we provide the specific, fundamental differences between macroscale and nanoscale phenomena and devices, using applications to teach key concepts.

Welcome!