

# Preface

Nanotechnology is one of the most important growth areas in the 21st century. Nanoscience, the science underpinning nanotechnology, is a multidisciplinary subject covering atomic, molecular and solid state physics, as well as much of chemistry. Nanostructures are known to exhibit novel and improved material properties. Fundamentally, these arise because the physical as well as chemical properties are very different when dimensions are reduced to the nanometer range. This book thus aims to introduce the various basic principles and knowledge needed for students to understand science at the nanoscale.

Many ideas proposed in nanotechnology are frontier and futuristic, although some have immediate technological applications. The fundamental scientific principles of all nanotechnology applications, however, are grounded in physics and chemistry.

Nanoscience and nanotechnology degree programmes are being increasingly offered by more and more universities around the world, especially in Australia and Europe.<sup>1</sup> A conventional undergraduate study of a science and engineering discipline normally specialises in the final year(s), but nanotechnology curricula often aim to confront students from their first or second years with the essence and interdisciplinarity of nanoscience and nanotechnology. By introducing the ideas and applications of nanoscience early, students receive a coherent overview of nanoscience to motivate them to learn the necessary basics in the traditional science disciplines of physics, mathematics, chemistry, materials science, biology and medicine. Real interdisciplinarity can be achieved by combining the breadth of nanoscience with the depth in each discipline.

---

<sup>1</sup> Wikipedia (under entry: "Nanotechnology Education", [http://en.wikipedia.org/wiki/Nanotechnology\\_education](http://en.wikipedia.org/wiki/Nanotechnology_education)) states the first programme involving nanotechnology was offered by the University of Toronto, where nanotechnology could be taken as an option within their Engineering Science programme. Interestingly, Wikipedia indicates that to date, Australia leads the world with nine universities offering bachelors degree programmes, followed closely by Europe with about seven

There are some recurring themes in nanoscience and nanotechnology education:

- The *basic foundational disciplines* are crucially important in any nanotechnology program;
- The *nanoscale* has always been important in chemistry, physics, biology and engineering, but with the advent of new tools and technologies, the nanoscale is now openly visible, comprehensible and manipulable;
- It is critical for students to recognize *connections* between the different scientific and engineering disciplines.

The metrics for identifying success in nanotechnology programs are typically the acquiring of multiscale scientific knowledge, and the ability of the programs to keep up-to-date with the latest scientific discoveries.

There are currently numerous specialised nanoscience and nanotechnology-related texts or monographs at the graduate and senior undergraduate levels. This textbook is targeted at the junior undergraduate levels or as a reference text for advanced learners at pre-university and senior high school, and has evolved from the authors' own teaching of the following modules at the National University of Singapore:

- GEK1509 Introduction to the Nanoworld
- UPC2206 Nanoscale Science and Technology
- SP2251 Science at the Nanoscale

The authors' own research expertise cover a diverse range of areas including nanomaterials chemistry and self-assembly (Chin Wee Shong), colloids, nanowires, optical tweezers and atomic force microscopy (Sow Chorng Haur), surface science and scanning tunneling microscopy (Andrew T S Wee). This book therefore aims to be a practical and user friendly textbook that could be adopted in introductory undergraduate courses in nanoscience and nanotechnology, materials science and engineering, physics and chemistry.

Supplementary materials, including solutions to exercises, for this textbook are available at [www.panstanford.com/nanotextbook](http://www.panstanford.com/nanotextbook).

**Chin Wee Shong, Sow Chorng Haur, Andrew T S Wee**  
*National University of Singapore*  
2009

## About the Authors



**Chin Wee Shong** is an Associate Professor of Chemistry at the National University of Singapore. Her research interests include the studies of nanostructures and their assemblies, the mechanism of size-, shape- and phase-controlled formation of nanocrystals, solution and templated synthesis of various types of nanomaterials and hybrid materials. She has vast experience in the teaching of undergraduate physical chemistry courses, including topics such as spectroscopy, kinetics, electrochemistry, solid state as well as surface chemistry.



**Sow Chong Haur** is an Associate Professor of Physics at the National University of Singapore. His research interests include the studies of nanomaterials systems such as carbon nanotubes and nanostructured metallic oxides, development of nanofabrication techniques such as focused laser beam nanofabrication, studies of colloidal systems, and development of the optical tweezers techniques for contactless manipulation of micro- and nanoscale objects.



**Andrew T S Wee** is a Professor of Physics at the National University of Singapore. His research interests include surface nanostructure formation, molecular self-assembly on nanotemplates, synchrotron and scanning tunneling microscopy studies of surfaces and interfaces, graphene and related nanomaterials. He is in the editorial board of several journals, including *Applied Physics Letters*-*Journal of Applied Physics*, *Surface and Interface Analysis*, *International Journal of Nanoscience*, *Surface Review and Letters*, and *Current Nanoscience*. He is also Past President & Fellow of the Institute of Physics Singapore, and a Fellow of the Institute of Physics (UK).