

Preface 2nd Ed

This book is the update of the initial volume, which was the culmination of more than eight years of effort. In 2006, the Nanomaterials Application Center at Texas State University was involved in evaluating nanotechnology for commercialization. One of the items that was raised was “safety.” At that time, there were concerns about the impact of nanomaterials on both people and the environment. There was a significant amount of work being done on toxicity, but it was focused on individual cases. A white paper was produced that listed elements required to ensure the safety and proper handling of nanotechnology.

An award by a government agency to develop any aspects of safety for nanotechnology came from Occupational Safety and Health Administration (OSHA) as a Susan Harwood award. It was awarded to Kristen Kulinowski at Rice University to develop an eight-hour course for practitioners. Texas State supported the Rice contract, with Walt Trybula as principle investigator (PI). The resultant effort was tested at a number of national conferences. The response from course participants indicated that the eight-hour course was preferred over a four-hour course. That course is available through OSHA.

Additional efforts followed from that contract at Texas State University. Several proposals were submitted to the National Science Foundation (NSF) over a three-year period. There was an NSF award made to Texas State in 2013, with Jitendra Tate as PI and Dominick Fazarro of UT Tyler and Craig Hanks of Texas State as co-PIs. The award was to develop nanotechnology safety education courses. One course was to be at an introductory level, and the other course was to include more advanced topics. Each course consisted of nine independent modules to be used for standalone insertion into existing courses. During the development of the contents of the courses, it was apparent that there was a need to consider ethical concerns in the courses. Judgment calls are required when working with materials with unknown properties, so the courses needed to include some basis for making decisions. Those decisions need to look at the impact on people and the environment. Inclusion of the topic of ethics was considered a necessity by the team. The material was developed and tested with students at Texas State University and UT Tyler. UT Tyler offered complete courses, whereas Texas State courses were in modular form, enabling insertion of individual modules into a number of existing courses. The feedback from students and NSF evaluators provided the opportunity to tune the courses. This material is available from NSF. For this work, the team was honored by the National Academy of Engineering as having one of the 25 exemplary programs in engineering ethics.

After developing the courses, with successful response to the material, it was time to develop an educational book to be used to supplement the work on nanotechnology education. There was an outreach to leaders in the field to contribute chapters to the book. The editors are professionals who have contributed to this work.

In addition to the technologies developed over the five years since the original publication, this book has had two years in updating and proofing in order to ready it for

publication. The content is structured to provide a logical flow from one topic to the next. The first chapter, *“The World of Nanotechnology”* by Barbara Foster, starts by examining the world of nanotechnology and safety. Nanotechnology is not the first technological development that might contain significant risks to both people and the environment. Proper planning enables the development of controls to ensure the safety of workers involved. In this first chapter, Barbara Foster discusses previous development of new technology and mentions how some of the controls were established. Chapter 2, *“The World of Engineering Nanomaterials”* by Eylem Asmatulu, provides an overview of how the understanding and application of nanomaterials have evolved. Chapter 3, *“The Importance of Safety for Manufacturing Nanomaterials”* by W. S. Khan and R. Asmatulu, presents the involvement of safety with manufacturing and usage of nanomaterials. Chapter 4, *“Safety Approaches to Handling Engineered Nanomaterials”* by Jitendre S. Tate and Roger A. Hernandez, covers engineered nanomaterials and some of the possible sources of health hazards. Chapter 5, *“Certification: Validating Workers’ Competence in Nano-safety”* by Christie M. Sayes, James Y. Liu, and Matthew Gibb, addresses the need for training in safety and certification to ensure that safety is dominant in nanotechnology efforts. Chapter 6, *“Understanding the Implications of Nanomaterial Unknowns”* by Walt Trybula and Deb Newberry, covers the facts that the vast majority of nanomaterial properties are unknown, and that their impact on people and the environment will not be known for some time. Chapter 7, *“What is Considered Reliable Information”* by Evelyn Hirt and Walt Trybula, addresses the fact that many sources of nano-safety information are not renewed on a regular basis and new regulations may change the existing recommendations. Consequently, there is a need to develop an understanding of reliable information sources. Chapter 8, *“Ethics and Communication: the Essence of Human Behavior”* by Craig Hanks, delves into the need for an ethical approach to nanotechnology safety, without which many questionable decisions might be made. Chapter 9, *“Behavior-Based Worker Safety for Engineered Nanomaterials”* by Christie M Sayes, James Y. Liu, and Matthew Gibb, addresses the issue that worker training and the implementation of controls for the application and handling of nanomaterials need to be thorough and built on the need for safety. Chapter 10, *“The Future of Nanotechnology Safety”* by Dominick Fazarro, provides a hypothetical view of the future, where safety is properly incorporated into the world of nanotechnology, and highlights the possible mechanisms for ensuring safety.

This author and the editors thank all the people who have been involved in this effort and is pleased to see the publication of this book, which represents years of development as nanotechnology has grown. Our goal with this book is to provide a basis for additional learning as the field develops and matures. No one organization or source has all the answers, but we hope that we have provided the reader with a starting point to ensure that he or she is creating and working in an environment that can be considered safe.