How to Use this Handbook

This work consists of independent educational Chapters and Units that begin at the introductory level and proceed into important applications areas. Each Unit consists of short, hands-on educational activities, called Modules in this Handbook. An instructor can choose to start at the beginning and proceed into each Unit as appropriate for his/her needs, or can focus on specific areas in different Chapters and Units. With flexibility and logical sequencing, the Handbook allows an instructor to start at the level of their students and proceed by choosing the best-fit activities for their class.

The Handbook provides proven instructional materials that can be utilized in a variety of settings. For K-12 classes, connections to the Next Generation Science Standards* are provided along with applicable connections to Science and Engineering Practice, Disciplinary Core Ideas and Crosscutting Concepts from A Framework for K-12 Science Education** These connections are provided in each Unit’s instructor’s guide and in a comprehensive listing in Appendix A. For workforce training and technician education, Core Competencies needed by technologists working with materials are included in the modules with an overall reference in Appendix C.

Because the Handbook is not intended to be a comprehensive textbook, it provides the instructor with wide latitude to introduce specific concepts and/or activities into existing courses. These activities and concepts have also been used successfully to develop introductory classes in Materials Science at the high school level, and more focused materials processing and manufacturing workshops for technology training.
Handbook Navigation

Development of the Handbook is focused on instructor usage, with each Chapter and Unit developing knowledge that advances in level as one proceeds from module to module. Instructors may start at any point, although some modules have recommended pre-requisites based on knowledge introduced earlier. For an instructor beginning to introduce materials concepts into a class or program, it is recommended that their program start with Chapter 1.

Handbook chapters, units and modules span a wide range of materials, processes and applications. Each Chapter is mounted as a separate file on the internet as follows:

- **Title page, Handbook Introduction, Table of Contents.**

- **How to Use this Handbook with How to Navigate this Handbook** and references.

- **Chapter 1, Introduction to Materials** provides introductory concepts and hands-on activities related to diverse parts of Materials Science. These lessons have been used successfully from K-12 to college as introductions to the subject. Generally, this Chapter should be presented first, and can be covered rapidly in more advanced classes.

- **Chapter 2, Metals and Alloys** provides an in-depth knowledge of metals and alloys based on properties, structure and processing. It concludes with an advanced look at the substitution of aluminum for steel in auto body construction.
• **Chapter 3, Composite Materials** focuses on the manufacture of composite materials, with separate sections appropriate for K-12 science and technology classes and for college-level/technology training programs. The Chapter looks at materials used in engineering composites, manufacturing processes, and at the design of composite parts in larger systems along with testing and evaluation procedures.

• **Chapter 4, Polymers and Plastics** considers the properties and applications of polymers based on their structure, using hands-on classroom activities. Consideration is also given to biodegradable polymers and recycling.

• **Chapter 5, Ceramic Materials** investigates ceramic materials properties with activities and lessons related to mechanical behavior as well as optical and electronic applications used every day, with considerations of materials design for maximum performance.

• **Chapter 6, Engineering Materials and Design** applies engineering design principles to the selection and modification of materials properties, constraints based on materials performance, smart materials and sustainable design.

• **Appendix A**: Correlations to Next Generation Science Standards* and A Framework for K-12 Science Education** for all Chapters and Modules in this Handbook.

• **Appendix B**: Principle Authors, Reviewers, National Advisory Board and Project Staff.

• **Appendix C**: Core Competencies for Technicians Working with Materials.
Appendix D: Author Index by Module.

Additional Curricula

Instructors wanting additional educational activities related to specific materials-related topics can find a variety of other, peer-reviewed modules, sortable by subject and author, at www.materialseducation.org/educators/matedu-modules. Further references are to be found in the lists of references provided in the Chapters and Modules.

A comprehensive list of further information may be found in the resources section of www.materialseducation.org, which includes relevant Materials Science-related references, including

- Websites and videos,
- Texts and other reference books,
- Workshop reports, and
- Published papers and publications.

* Next Generation Science Standards, NGSS is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the productions of this product and do not endorse it.