



Standard Practice for Workforce Education in Nanotechnology Characterization¹

This standard is issued under the fixed designation E3001; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes a procedure to provide the basic education of characterization methods for nanometer-scale materials, to be taught at an undergraduate college level. This education should be broad and include a suite of characterization methods to prepare an individual to work in various capacities within one of the many areas in nanotechnology research, development, or manufacturing.

1.2 This practice may be used to develop or evaluate an education program for characterization in the nanotechnology field. It provides listings of key methods that are relevant to such a program, with a minimum number of these methods to be taught as a requirement for such an education. This practice does not provide specific course material to be used in such a program.

1.3 While no units of measurements are used in this practice, values stated in SI units are to be regarded as standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This standard does not purport to address all of the characterization methods for nanometer-scale materials, nor is it meant for use in certification processes. It is the responsibility of the user of this standard to utilize other knowledge and skill objectives as applicable to local conditions or required by local regulations.*

2. Referenced Documents

2.1 ASTM Standards:²

E2456 Terminology Relating to Nanotechnology

¹ This practice is under the jurisdiction of ASTM Committee E56 on Nanotechnology and is the direct responsibility of Subcommittee E56.07 on Education and Workforce Development.

Current edition approved Jan. 1, 2015. Published March 2015. DOI: 10.1520/E3001-15.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 Other Standards:

BSI PAS 133 Terminology for Nanoscale Measurement and Instrumentation³

ISO/TS 27687 Nanotechnologies – Terminology and Definitions for Nano-Objects – Nanoparticle, Nanofibre, and Nanoplate⁴

ISO/TS 80004-6 Nanotechnologies – Vocabulary – Part 6: Nano-Object Characterization⁴

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms related to nanotechnology in general, refer to Terminology **E2456** and ISO/TS 27687.

3.1.2 For definitions of terms related to measurement methods and instrumentation used, refer to BSI PAS 133 and ISO/TS 80004-6.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *characterization, n*—measurement(s), using one or more methods, to determine the structure and composition of a material as well as its physical or chemical properties.

3.2.2 *education, n*—the teaching of specific topics as part of a degree or certificate program, or as training to provide additional skills and knowledge.

4. Summary of Practice

4.1 This practice designates a list of nineteen characterization methods to be relevant to nanotechnology workforce education. Methods are grouped into two tiers, with five methods classified as Tier 1 and the others as Tier 2. Method selection and tier classification are based on inputs from industry, nanotechnology educators, and subject matter experts.

4.2 From this list, five methods have been classified as Tier 1. An educational program is to select at least three Tier 1 methods to be taught in detail, and to teach the remaining two Tier 1 methods plus a minimum of five Tier 2 methods at an introductory level.

NOTE 1—Tier 1 methods are considered key. This requirement ensures

³ Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., <http://www.bsigroup.com>.

⁴ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.