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Standard Guide for Reporting Production Information and Data for Nano-Objects[1]

This standard is issued under the fixed designation E3172; 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 guide provides guidelines for describing the production of one or more individual nano-objects. It establishes essential and desirable information categories and descriptors important to specify the production process, including the starting materials, the process itself, and the resulting nano-objects.

1.2 This guide is designed to be directly applicable to reporting production information and data for nano-objects in most circumstances, including but not limited to reporting original research results in the archival literature, developing of ontologies, database schemas, data repositories and data reporting formats, specifying regulations, and enabling commercial activity.

1.3 This guide is applicable to an individual nano-object and a collection of nano-objects.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ISO Standards:*[2]

ISO/TS 12805:2011(en) Nanotechnologies — Materials Specifications — Guidance on Specifying Nano-Objects

ISO/TS 80004-1:2010(en) Nanotechnologies – Vocabulary – Part 1: Core Terms

2.2 *Other Standards:*

Uniform Description System for Materials on the Nanoscale [3]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms used in this standard, see *Compilation of ASTM Standard Definitions*.[4]

3.2 *Definitions of Terms for Data Description:*

3.2.1 *descriptor, n*—numerical data or text that expresses the measurement, observation, or calculational result of some aspect of an object.

3.2.1.1 *Discussion*—A descriptor conveys both the semantics of the results as well as the result itself.

3.2.2 *information category, n*—a set or group of related descriptors that represent a property, characteristic, or feature of an object.

3.2.2.1 *Discussion*—Information categories may be hierarchical and contain subcategories (referred to as such), each containing a set of descriptors.

3.2.2.2 *Discussion*—Information categories and their subcategories are constructed to convey understanding of the structure, properties, features, and performance of an object.

3.2.2.3 *Discussion*—A descriptor may occur in more than one information category.

3.2.2.4 *Discussion*—It is the responsibility of the owner of data or information resources using an information category to ensure that data and information redundancy is adequately addressed.

3.3 *Definitions of Terms for Nanomaterials:*

3.3.1 *nanomaterial, n*—a material with one, two, or three external dimensions in the nanoscale.

ISO/TS 80004-3:2010(en)

3.3.2 *nano-object, n*—an instance of nanomaterial that has a distinct physical boundary in every direction and moves freely.

3.3.2.1 *Discussion*—A nano-object is the smallest unit of nanomaterial that exists as a separate functional entity.

[1] This guide is under the jurisdiction of ASTM Committee E56 on Nanotechnology and is the direct responsibility of Subcommittee E56.01 on Informatics and Terminology.

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[2] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

[3] Available from CODATA-VAMAS Working Group on the Description of Nanomaterials, http://www.codata.org/nanomaterials, as released on 25 May 2016.

[4] *Compilation of ASTM Standard Definitions*, 9th edition, ASTM International, 2000.

3.4 *Definitions of Terms for Production:*

3.4.1 *production technique, n*—a formal or informal technology to produce a new substance.

3.4.1.1 *Discussion*—Example production techniques include chemical vapor deposition (CVD), arc discharge, laser ablation, etc.

3.4.2 *recipe, n*—a documented procedure for taking specified amounts of substances and processing them in a specified sequence or sequences to produce one or more new substances.

3.4.2.1 *Discussion*—A recipe can describe how a production technique can be used to produce desired nano-objects.

3.4.2.2 *Discussion*—A recipe is often referred to as a standard operating procedure.

4. Summary of Guide

4.1 This guide enumerates information categories and their contained descriptors used to report the information and data necessary to specify the production of one or more individual nano-objects. In practice, only a subset of information categories or descriptors will be used in each report instance.

4.2 Different amounts of data and information are generated in different production scenarios. For example, production of new or novel nano-objects for research purposes differs from production of commercial nano-objects which in turns differs from the production of a sample of nano-objects suitable for toxicity testing.

4.3 Nano-objects are tangible materials that are always produced from already existing tangible materials. It is desirable in some report instances to describe the starting materials and in other instances, only the resulting nano-objects.

4.3.1 It is also desirable in many report instances simply to describe nano-objects in detail without specifying their production process. In these instances, it is critical to ensure that the reported nano-objects have not been subjected to change of any type.

5. Significance and Use

5.1 A nano-object at any specific time can be considered well-defined.

5.2 The life-cycle of a nano-object can be viewed as a series of production processes that transforms starting materials or a well-defined nano-object into a new, equally well-defined nano-object.

5.3 Each step of the life-cycle can be considered a separate production action and can be described by the information categories and descriptors within this guide.

5.4 The following are examples of nano-object productions that can be described by this guide.

5.4.1 The creation of carbon nanotubes by arc discharge.

5.4.2 The coating of a nano-object in a random or controlled manner when placed in a liquid.

NOTE 1—The reactivity of nano-objects makes it likely that even with the utmost precautions, various features and characteristics may change over time, for example, when a nano-object is placed in a liquid and coated. Such a coating can significantly change the properties, functionalities, and reactivity of the nano-object. This change can be considered one step of a life-cycle and is a production process.

NOTE 2—A nano-object may have more than one coating. For example, titania nano-objects are often coated by alumina by manufacturers to control certain properties. When these previously coated nano-objects are placed in liquid containing biological molecules, they can acquire a second coating. It can require very careful administration of test procedures to ensure the test results can meaningfully be ascribed to characteristics and features of the "initial" nano-objects.

5.4.3 A nano-object experiences changes to its size, shape, physical structure, and other characteristics.

NOTE 3—Events such as shock (unexpected forces), temperature and pressure changes, humidity changes, shipping, dissolution, and exposure to acids and bases can result in a changed nano-object with significantly different properties, functionalities, and reactivity. These events can be considered a production process.

5.4.4 Unless care is taken to carefully control potential changes to a nano-object before testing, measurement results should be carefully examined for unintended changes through good laboratory practices, statistical analysis of all data, and verification that test samples maintain their integrity throughout the testing process.

5.5 A nano-object can be subjected to a series or sequence of production steps. The steps can be fully planned and controlled or some steps can happen due to random events. This guide is applicable to describe one, many, or all steps in detail.

NOTE 4—For example, the testing of a nano-object for potential toxic effects may involve a sequence of steps as shown in Table 1. As can be seen, steps such as storage, insertion into biological media, or sampling can possibly involve random changes to the resulting nano-object.

5.6 Use of this guide to describe the individual production steps leading to the creation of a tested nano-object can be

TABLE 1 Possible Sequence of Steps in the Testing of Nano-Objects

Test Step	Nano-Object(s) State	Comments
Manufactured, natural, or prepared nano-object	This is the substance for which users, regulators, and others want results	Almost always a collection of nano-objects
As received	In spite of precautions, changes occur during shipping and storage	Agglomeration, aggregation, reactions, degradation
As prepared for testing	Some processing takes place to restore the nano-object(s) to its "original" state	Purification, deagglomeration, etc. to reverse shipping and storage effects
As sampled	A subset of the nano-objects is taken for testing, hopefully fully representative of the original nano-object(s)	Standard, specified, or ad hoc procedures
In the test environment	Reacts with components of test media	May experience reactions, additions, alterations, including coronas, surface modification, shape and size changes, pH changes