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INTERNATIONAL ELECTROTECHNICAL COMMISSION

NANOMANUFACTURING – LARGE SCALE MANUFACTURING FOR NANOELECTRONICS

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International Standard IEC/IEEE 62659 has been prepared by IEC technical committee 113, Nanotechnology standardization for electrical and electronic products and systems, in cooperation with the Standards Committee of the IEEE Nanotechnology Council¹, under the IEC/IEEE Dual Logo Agreement.

The text of this standard is based on the following documents:

FDIS	Report on voting
113/271/FDIS	113/280/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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¹ A list of IEEE participants can be found at the following URL: http://standards.ieee.org/downloads/62659/62659-2015/62659-2015_wg-participants.pdf

INTRODUCTION

In order to fully benefit from the cost, performance, and flexibility of new electronics products manufactured on a large-scale, industries accustomed to the purchase, use, and engineering of continuum materials need to grow to embrace appropriate new practices at the nanoscale. The purpose of this International Standard is to enable the quick, low-risk adoption of nanomaterials into large-scale electronics manufacturing. In addition a best set of common practices for use by semiconductor fabricators will be delineated.

The description of nanomaterials to be incorporated into the electronics process can be described in terms of: composition (material), density, purity, size/dimensions, properties such as electrical characteristics (conductive, non-conductive, and semiconductive), associated media (delivery medium), fabrication, surface functionalization, particle size distribution, surface area, shape, and degree of aggregation and agglomeration, etc.

These standards for the characterization of nanomaterials also provide an opportunity to help ensure consistency in metrics and measurement methods when specifying or producing nanomaterials for electronics applications. This is important when multiple vendors or technology partners are involved.

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NANOMANUFACTURING – LARGE SCALE MANUFACTURING FOR NANOELECTRONICS

1 Scope

This International Standard provides a framework for introducing nanoelectronics into large scale, high volume production in semiconductor manufacturing facilities through the incorporation of nanomaterials (e.g. carbon nanotubes, graphene, quantum dots, etc.). Since semiconductor manufacturing facilities need to incorporate practices that maintain high yields, there are very strict requirements for how manufacturing is performed. Nanomaterials represent a potential contaminant in semiconductor manufacturing facilities and need to be introduced in a structured and methodical way.

This International Standard provides steps employed to facilitate the introduction of nanomaterials into the semiconductor manufacturing facilities. This sequence is described below under the areas of raw materials acquisition, materials processing, design, IC fabrication, testing, and end-use. These activities represent the major stages of the supply chain in semiconductor manufacturing facilities.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

None.

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

nanoscale

size range from approximately 1 nm to 100 nm

Note 1 to entry: Properties that are not extrapolations from a larger size will typically, but not exclusively, be exhibited in this size range. For such properties the size limits are considered approximate.

Note 2 to entry: The lower limit in this definition (approximately 1 nm) is introduced to avoid single and small groups of atoms from being designated as nano-objects or elements of nanostructures, which might be implied by the absence of a lower limit.

[SOURCE: ISO/TS 80004-1:2010, 2.1]

3.2

nanotechnology

application of scientific knowledge to manipulate and control matter in the **nanoscale** (3.1) in order to make use of size- and structure-dependent properties and phenomena, as distinct from those associated with individual atoms or molecules or with bulk materials

Note 1 to entry: Manipulation and control includes material synthesis.

[SOURCE: ISO/TS 80004-1:2010, 2.3]

3.3

nanoelectronics

electronic devices that incorporate **nanoscale** (3.1) materials, processes and properties

3.4

nanomanufacturing

intentional synthesis, generation or control of **nanomaterials** (3.6), or fabrication steps in the **nanoscale** (3.1), for commercial purposes

[SOURCE: ISO/TS 80004-1:2010, 2.11]

3.4.1

bottom-up nanomanufacturing

processes that use small fundamental units to create larger functionally rich structures or assemblies

3.4.2

hybrid nanomanufacturing

combination of additive and subtractive controlled processing to create an intentional nanoscaled structure

3.4.3

top-down nanomanufacturing

processes that create structures at the nanoscale from macroscopic designs

3.5

nanomanufacturing process

ensemble of activities to intentionally synthesize, generate or control **nanomaterials** (3.6), or fabrication steps in the **nanoscale** (3.1)

[SOURCE: ISO/TS 80004-1:2010, 2.12]

3.6

nanomaterial

material with any external dimension in the nanoscale or having internal or surface structure in the **nanoscale** (3.1)

Note 1 to entry: This generic term is inclusive of nano-object and nanostructured material.

[SOURCE: ISO/TS 80004-1:2010, 2.4]

3.7

nano-object

material with one, two or three external dimensions in the **nanoscale** (3.1)

Note 1 to entry: Generic term for all discrete nanoscale objects.

[SOURCE: ISO/TS 80004-1:2010, 2.5]

3.8

nanostructure

composition of inter-related constituent parts, in which one or more of those parts is a **nanoscale** (3.1) region

Note 1 to entry: A region is defined by a boundary representing a discontinuity in properties.

[SOURCE: ISO/TS 80004-1:2010, 2.6]