

TECHNICAL REPORT



IEC nanoelectronics standardization roadmap



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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IEC nanoelectronics standardization roadmap

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC NANOELECTRONICS STANDARDIZATION ROADMAP

FOREWORD

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IEC 62834, which is a technical report, has been prepared by IEC technical committee 113: Nanotechnology standardization for electrical and electronic products and systems.

The text of this technical report is based on the following documents:

| | |
|---------------|------------------|
| Enquiry draft | Report on voting |
| 113/161/DTR | 113/197/RVC |

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

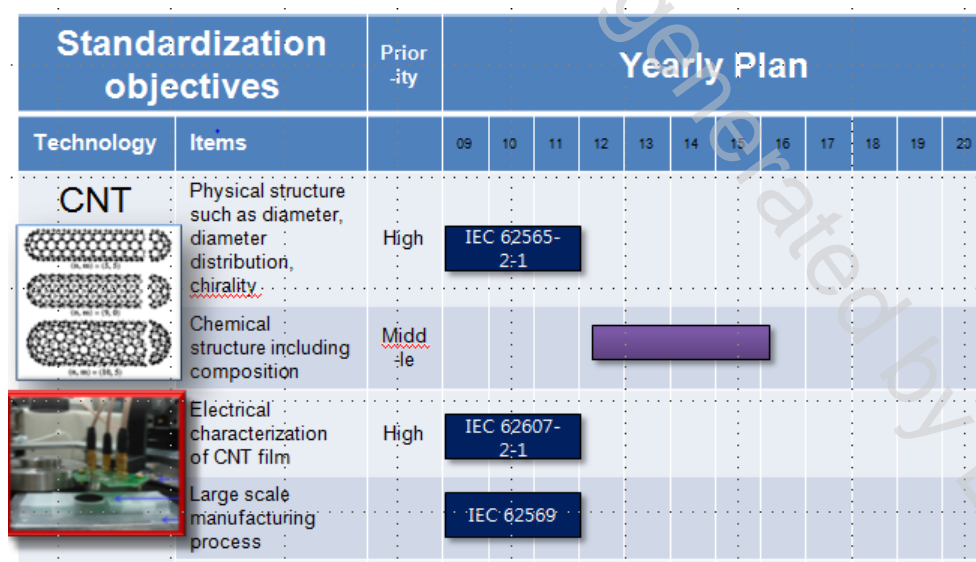
In IEC TC113 a survey on nano-electrotechnical standardization needs was initiated by the National Institute of Standards and Technology (NIST) in the USA to establish a strategy of standardization priorities regarding the nanoelectronics area. A TC 113 Project Team was then organized to build a “Nanoelectronics standards roadmap”. This document covers nanoscale devices and nanomaterials which will be in the market or are already commercialized for nanoelectronic applications. When selecting the devices and materials to be included in the roadmap, the Project Team considered their market size and the period of time needed for their technology development. Because most of the experts in TC 113 are from an electronics background, the first version (Part A) of this roadmap covers electronics and ICT (information and communication technology) rather than energy or convergence technologies.

Regarding nanomaterials, roadmaps for carbon nanotubes (CNT), graphene, nanofibres, nanoparticles and quantum dots were established. For each material there are several detailed items that need to be standardized, including physical properties and characterization methods. Some of such standards are already under development in TC 113, such as IEC 62565-2-1 and IEC 62569.

In the nanoelectronics device roadmap, nanoscale contacts, CNT interconnects, three-dimensional nanotransistors, nanoscale memory devices, and molecular devices were selected. Though the priority was on memory devices and new types of transistors, molecular devices were included in this version considering the impact of this technology.

The time span of the roadmap is important in order to cover the technology which may be realized in a certain period of time. However, with regard to nanoelectronics development, little information on the average technology development period is available at this stage. Thus TC 113 set the span of the roadmap up until the year 2020 to show the starting point of standardization tasks and the end of activity.

As the format should give insights and detailed information to the user of the roadmap, the Gantt chart format was used, including photos (see Figure 1). When a new version of the roadmap is prepared, TC 113 will develop a new format in parallel, which can give more accurate information to users.



IEC 2281/13

Figure 1 – Roadmap format

IEC NANO ELECTRONICS STANDARDIZATION ROADMAP

1 Scope

This Technical Report covers nanomaterials and nanoscale devices. To achieve consensus more quickly when building the roadmap, an ICT “More Moore” area has been adopted for the priority standardization items of this first version, as shown in Table 1.

Table 1 – Categories and detail potential products

| Categories | | Detail potential products | Version 1 |
|--|------------------------------------|--|----------------------|
| Nanomaterials | Zero-dimensional nanomaterial | Nanoparticles/Nanopowders Quantum dot | √ √ |
| | One-dimensional nanomaterial | Carbon nanotube Nanowire (III-V, II-VI, ZnO) | √ |
| | Two-dimensional nanomaterial | Nanofunctional thin film Nanostructural film Graphene | √ |
| | Three-dimensional nanomaterial | Nanopore materials Nanocomposites | |
| Nanoscale devices | Nanoelectronic devices | Nanoscale non-volatile memory devices 1- and 3-dimensional nanoscale transistors Single electron transistor Nanoscale logic devices Nanoscale interconnection Post-CMOS signal processing | √ √ √ √ |
| | | Silicon optical devices Photonic crystal optical devices All-optical logic devices Quantum dot optical devices | |
| | | Highly integrated memory devices High-speed magnetic logic devices | √ √ |
| | | Molecular logic device Molecular memory device Molecular sensors Molecular mechanics devices Molecular optical devices | √ √ |
| | | Nanomaterials-based flexible devices Nanomaterials-based displays | |
| Nanofabrication processes, equipment measurement | Nanofabrication process | Nano lithography Self-assembly | |
| | Nanoscale metrology and simulation | SPM | |