

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD



Nanomanufacturing – Material specifications –
Part 2-1: Single-wall carbon nanotubes – Blank detail specification



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IEC-PAS 62565-2-1 has been processed by IEC technical committee 113: Nanotechnology standardization for electrical and electronic products and systems.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
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Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

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INTRODUCTION

This Publicly Available Specification is intended to provide guidance on how to list, illustrate and define various characteristics of single-wall carbon nanotubes (SWCNTs) for industrial use in electronic products, and how to incorporate these into a bilateral detail specification between vendor and user.

One particular point of interest is the fact that there are different modifications of carbon nanotubes. Subtle differences in the physical structure lead to marked differences in electrical, optical and chemical properties; therefore these characteristics need special attention.

To permit common processing equipment and common unit processes with predictable and reproducible results to be used in multiple fabrication lines, it is essential for the carbon nanotubes characteristics to be described and assessed in a standardized manner and to standardize the methods for quality control of the manufacturing processes.

To enable low-cost mass production (or production of pure fractions), a reliable, affordable means of preparing one type of carbon nanotubes (e.g. single-wall semiconducting carbon nanotubes, with a certain specified length) is necessary. To facilitate a reliable source of carbon nanotubes with tailored properties (length, diameter, purity, chirality, conduction type), it is necessary to specify the characteristics in a standardized way, stating the specification limits and the characterization methods to prove conformance. This does not only reduce transaction costs, but eliminates a major source of error, as explained below.

Accurately measuring and characterising the quality of nanotube-containing materials and the dispersion of nanotubes in liquids or polymers, are both considered crucial for the continued growth of applications incorporating single-wall carbon nanotubes. Significant differences in both methodology and interpretation continue to exist from one measurement laboratory to another. For this reason, comparison and specification of the quality of CNT materials is extremely difficult. While progress in these measurements is being made, significant improvements are still needed to accurately measure and characterise the quality of carbon nanotube-containing materials and the protocol for doing so (e.g. how to describe / specify the characteristics relevant for the quality of the final nano-enabled product).

Furthermore, the development of reference materials is as important as improvements to measurement / characterization techniques. In addition, it is stressed that for any of the analysis methods, it is mandatory to specify the sample preparation method, sample size and the sampling method.

Experiences with this PAS should be reported to the Secretariat of IEC Technical Committee 113 to provide improvements for the future IEC 62565 International Standards under development in IEC/TC 113.

NANOMANUFACTURING – MATERIAL SPECIFICATIONS –

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1 Scope

This PAS establishes a blank detail specification for the essential electrical properties and certain other common characteristics including dimensional, structural and mechanical properties of single-wall carbon nanotubes.

This PAS provides a standardized format for detail specifications characterising essential basic properties of single-wall nanotubes and recommends measurement methods.

Single-wall carbon nanotubes with a chemical modification, dispersed into a solvent or grown on a substrate are included.

Properties and characteristics not of relevance for a specific application may be classified as not applicable or not specified.

NOTE 1 The present state of the art in manufacturing carbon nanotubes does not produce purely single-wall carbon nanotubes. The consequences are reflected in the requirements part.

NOTE 2 A revisable version of Tables 2 to 8 is attached to this file. These tables are intended to be used in the detail specification to be agreed between manufacturer and user of single-wall carbon nanotubes.



2 Normative references

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

IEC 62624, *Test methods for measurement of electrical properties of carbon nanotubes*

NOTE 1 Supplementary information is provided in the bibliography

NOTE 2 Terminology and nomenclature are under development in IEC/TC113/JWG 1 in cooperation with ISO/TC 229. Published terminology standards or specifications from this group will be incorporated into this document.

NOTE 3 Measurement and characterization are under development in IEC/TC113/JWG 2 in cooperation with ISO/TC 229. Published measurement standards or specifications from this group will be incorporated into this document.

3 Terms and definitions

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

NOTE 1 Terminology and nomenclature are under development in IEC/TC113/JWG 1 in cooperation with ISO/TC 229. Published definitions from this group will be incorporated into this document. Not yet specified definitions are taken from the scientific literature.

NOTE 2 Measurement and characterization are under development in IEC/TC113/JWG 2 in cooperation with ISO/TC 229. Published definitions from this group will be incorporated into this document. Not yet specified measurement methods are taken from the scientific literature.