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Nanomanufacturing – Key control characteristics – Part 2-4: Carbon nanotube materials – Test methods for determination of resistance of individual carbon nanotubes

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Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62607-2-4, which is a Technical Specification, has been prepared by IEC technical committee 113: Nanotechnology for electrotechnical products and systems.

The text of this Technical Specification is based on the following documents:

DTS	Report on voting
113/492/DTS	113/509/RVDTS

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

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

A list of all parts in the IEC 62607 series, published under the general title *Nanomanufacturing – Key control characteristics*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Carbon nanotubes (CNTs) are one-dimensional conductors that exhibit a rich variety of low-dimensional electric transport phenomena. Ballistic conduction is the typical nano-enabled characteristic that possesses the largest potential for industrial application. In the field of nanoelectronics, for example, CNT-based interconnects are a promising alternative to conventional Cu interconnects. However, even in the academic research society, the resistive characteristics have not yet been systematically investigated. This is because these characteristics are very sensitive to the protocol and the measurement conditions. Furthermore, since the individual CNT reaches the nanometre dimension, the contact resistance has a larger relative impact on the measurement. These bottlenecks impede not only the above-mentioned interconnect application but also developments of various electrotechnical applications, such as thermoelectric devices in which the electrical resistance is required to evaluate the figure of merit.

This document offers the accurate and reproducible test method for determining the resistance of CNT and the dependability of the measurement.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 2-4: Carbon nanotube materials – Test methods for determination of resistance of individual carbon nanotubes

1 Scope

This part of IEC 62607 specifies the test method for determining the resistivity and the contact resistance of an individual CNT and the dependability of the measurement.

This document includes:

– outlines of the experimental procedures used to measure resistance of carbon nanotubes,
– methods of interpretation of results and discussion of data analysis, and
– case studies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*

ISO/TS 80004-1, *Nanotechnologies – Vocabulary – Part 1: Core terms*

NOTE IEC 62624 describes the general procedures for characterization of CNT. For example, no environmental condition is specifically required. On the other hand, this document focuses not only on the characterization of the individual CNT but also the reproducibility. To obtain the intrinsic nano-originated result and to measure up to the dependable measurement, in-vacuum non-destructive measurements are indispensable, and therefore this document (IEC TS 62607-2-4) is required.