PD ISO/TS 23690:2023



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Nanotechnologies — Multiwall carbon nanotubes — Determination of carbon impurity content by thermogravimetric analysis

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee NTI/1, Nanotechnologies.

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Published by BSI Standards Limited 2023

ISBN 978 0 539 16123 6

ICS 07.120

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2023.

Amendments/corrigenda issued since publication

Date	Text affected

PD ISO/TS 23690:2023

TECHNICAL SPECIFICATION

ISO/TS 23690

First edition
2023-07-27

Nanotechnologies — Multiwall carbon nanotubes — Determination of carbon impurity content by thermogravimetric analysis

Nanotechnologies – Nanotubes de carbone multicouches – Détermination de la teneur en impureté de carbone par analyse thermogravimetrique

Reference number
ISO/TS 23690:2023(E)

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Foreword

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This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Multiwall carbon nanotubes (MWCNTs) are quasi-one-dimensional tubular carbon nanomaterials rolled up or coaxial nested by three or more graphene sheets. The production of carbon nanotubes (CNT) generally results in significant amounts of carbon impurities (carbon material content not in the form of CNT, including amorphous carbon and trace amounts of other types of structured carbon), which influence the physical and chemical properties of the nanomaterial. Therefore, the measurement of carbon impurities content in MWCNT samples is highly desirable for the determination of their purity.

Several methods have been reported to characterize carbon impurities in MWCNT samples, including transmission electron microscopy (TEM), temperature programmed oxidation (TPO) and thermogravimetric analysis (TGA), etc., among which TGA can provide quantitative results.[1][2][3][4][5][6] This technique makes use of the fact that MWCNTs are more stable than the majority of carbon impurities, so carbon impurities less stable than MWCNTs will react firstly with carbon dioxide in carbon dioxide atmosphere. The oxidation of carbon impurities with carbon dioxide is an endothermal process, which prevents overheating in certain areas and restrains the reaction of MWCNTs at the same time. Therefore, the separation between the oxidation of carbon impurities and those of MWCNTs is enhanced,[7][8][9][10] allowing the amount of carbon impurities less stable than MWCNTs to be calculated from the mass loss in thermogravimetric analysis.

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TECHNICAL SPECIFICATION **ISO/TS 23690:2023**

Nanotechnologies — Multiwall carbon nanotubes — Determination of carbon impurity content by thermogravimetric analysis

1 Scope

This document specifies a mild oxidation method to determine the content of carbon impurities (carbon material content not in the form of CNT, including amorphous carbon and trace amountd of other types of structured carbon) less stable than multiwall carbon nanotubes (MWCNTs) by thermogravimetric analysis (TGA) under carbon dioxide atmosphere.

This document is applicable to the characterization of carbon impurities content in MWCNT samples prepared by chemical vapour deposition (CVD). Measurement of carbon impurities in MWCNT samples prepared by other methods can refer to this document. This method is not applicable to functionalized MWCNT samples or MWCNT samples with encapsulant species.

NOTE This method is applicable for the case of TG curves with a single-stage.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
multiwall carbon nanotube
MWCNT
multi-walled carbon nanotube
carbon nanotube composed of nested, concentric or near-concentric graphene layers with interlayer distances similar to those of graphite

Note 1 to entry: The structure is normally considered to be many single-walled carbon nanotubes nesting each other and would be cylindrical for small diameters but tends to have a polygonal cross-section as the diameter increases.

[SOURCE: ISO/TS 80004-3:2020, 3.3.6[11]]

3.1.2
amorphous carbon
carbon material without long-range crystalline order

[SOURCE: IUPAC, Compendium of Chemical Terminology[12]]

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