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TECHNICAL SPECIFICATION

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Nanomanufacturing – Key control characteristics – Part 6-20: Graphene-based material – Metallic impurity content: Inductively coupled plasma mass spectrometry

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NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 6-20: Graphene-based material – Metallic impurity content: Inductively coupled plasma mass spectrometry

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IEC TS 62607-6-20 has been prepared by IEC technical committee 113: Nanotechnology for electrotechnical products and systems. It is a Technical Specification.

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

Draft	Report on voting
113/609/DTS	113/629/RVDTS

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

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available

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A list of all parts of the IEC TS 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Graphene-based materials have wide potential applications because of their unique electrical, thermal and mechanical properties, especially in the electronics industry: batteries, integrated circuits, high-frequency electronics, displays, etc. [1], [2], [3][1]. As industry uptake on graphene-based materials increases, international standardization is critical to enable the commercialization of graphene-based materials and related products. Metal impurities within graphene-based materials have significant impact on the electrical performance in the process of industrial application. Considering the multiple production routes and producers of graphene-based materials, in order to maintain product quality and reach a consensus between the supplier and the customer, there is no doubt that accurate, reliable and reproducible measurement methods for the key parameters of graphene-based materials need to be established.

Inductively coupled plasma mass spectrometry (ICP-MS) can carry out accurate detection of trace amounts of a variety of metal impurities simultaneously, obtain species and content of each metal impurity in graphene-based materials.

The purpose of this document is to enable accurate and quantitative determination of metal impurities using ICP-MS [4], through providing optimized digestion operation, preparation procedures for graphene-based materials in powder form, measurement method and data analysis. A similar document was published as ISO/TS 13278 for carbon nanotubes (CNTs) [5]; however, it is not suitable for graphene powder because of the noticeable difference between CNTs and graphene powder, especially in terms of sample preparation (including digestion technique and digestion procedure), the properties of test samples (many more species and much wider range of content of metal impurities in graphene powder), measurement procedure and so on. Therefore, this document has been developed for graphene powder; it is based on study in VAMAS Technical Working Area 41 (TWA 41).

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[1] Numbers in square brackets refer to the Bibliography.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 6-20: Graphene-based material – Metallic impurity content: Inductively coupled plasma mass spectrometry
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1 Scope

This part of IEC TS 62607 establishes a standardized method to determine the chemical key control characteristic

– metallic impurity content

for powders of graphene-based materials by

– inductively coupled plasma mass spectrometry (ICP-MS).

The metallic impurity content is derived by the signal intensity of measured elements through MS spectrum of ICP-MS.

– The method is applicable for powder of graphene and related materials, including bilayer graphene (2LG), trilayer graphene (3LG), few-layer graphene (FLG), reduced graphene oxide (rGO) and graphene oxide (GO).
– The typical application area is in the microelectronics industry, e.g. conductive pastes, displays, etc., for manufacturers to guide material design, and for downstream users to select suitable products.

2 Normative references

There are no normative references in this document.

3 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:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 General terms

3.1.1
graphene
graphene layer
single-layer graphene
monolayer graphene
single layer of carbon atoms with each atom bound to three neighbours in a honeycomb structure

Note 1 to entry: It is an important building block of many carbon nano-objects.

Note 2 to entry: As graphene is a single layer, it is also sometimes called monolayer graphene or single-layer graphene and abbreviated as 1LG to distinguish it from bilayer graphene (2LG) and few-layer graphene (FLG).

Note 3 to entry: Graphene has edges and can have defects and grain boundaries where the bonding is disrupted.

[SOURCE: ISO/TS 80004-13:2017 [6], 3.1.2.1]