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Nanomanufacturing – Key control characteristics – Part 6-30: Graphene-based material – Anion concentration: Ion chromatography method

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IEC TS 62607-6-30 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
113/824/DTS	113/846/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 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- withdrawn, or
- revised.

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INTRODUCTION

In recent years, graphene-based materials have drawn increasing attention from academia and industry due to their unique physical and chemical properties. Powders consisting of graphene-based material are now mass produced and widely used in fields such as battery, capacitor, coating, heat conducting, etc.

Anions are common and significant non-metallic impurities in graphene-based materials, originating from raw materials or chemicals used during the production process. These anions play a crucial role in influencing the applications of graphene-based materials. For instance, anions can lead to changes in reversible capacity and coulombic efficiency when graphene-based materials are employed in batteries and capacitors. Therefore, anion concentration stands as a key characteristic of graphene-based materials. Fluoride, chloride, nitrite, bromide, nitrate, sulphate, and phosphate are among the prevalent anions detected in numerous graphene-based materials gathered from the market.

Various methods have been utilized for determination of anions. The most common techniques for quantifying anions include titration, colorimetric determination, and ion chromatography (IC). IC offers several advantages – such as unique selectivity, fast analysis speed, high sensitivity, good accuracy, and easy operation – over alternative techniques in the analysis of anions. Moreover, one of its significant advantages is the capability to simultaneously determine multiple types of anions.

Sample preparation is a critical step in the analytical process, particularly when dealing with powders characterized by very low density and strong hydrophobic properties. It is essential to obtain a sample extraction solution to effectively isolate the analytes from the matrix before conducting IC instrumental determinations. Consequently, the accuracy, precision, and quantification limits of the analysis are significantly influenced by the sample preparation process. This document furnishes specific sample preparation details tailored for powders composed of graphene-based materials. Importantly, the described method is not confined solely to graphene-based materials but is also applicable to other carbonaceous materials such as graphite and graphite oxide.

The purpose of this document is to describe a test method to determine contents of anions in graphene-based material. A case study illustrating the application of this document can be found in Annex D.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 6-30: Graphene-based material – Anion concentration: Ion chromatography method

1 Scope

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

- anion concentration

  for powder of graphene-based material by

- ion chromatography.

In this document, the measured anions are fluoride, chloride, nitrite, bromide, nitrate, sulphate, and phosphate. These anions, present in the extraction solution of graphene-based materials, are separated into distinct elution bands on the ion chromatographic separation column and subsequently measured using a conductivity detector. Quantification of these anions is accomplished by establishing a proportional relationship between the measured signal (peak area or peak height) and the concentration of each anion. This is achieved by calibrating the system using a series of standards containing known amounts of each anion. Subsequently, unknown samples are analysed under the same conditions as the standards to determine their anion concentrations.

– Powder of graphene-based material addressed by this document includes graphene oxide, reduced graphene oxide and functionalized graphene, graphene, bilayer graphene, trilayer graphene and few-layer graphene.

  NOTE This document can also be used for other carbonaceous material such as graphite and graphite oxide.

– This document targets graphene-based material manufacturers and downstream users to guide their material design, production and quality control.

2 Normative references

There are no normative references in this document.