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Nanomanufacturing – Key control characteristics – Part 6-18: Graphene-based material – Functional groups: TGA-FTIR

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IEC TS 62607-6-18 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
113/680/DTS	113/706/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 in 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- withdrawn,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

One of the most well-studied routes for the preparation of graphene is the oxidation and reduction process. The most cost-effective process to obtain graphene is the exfoliation of natural graphite layers after oxidation to get individual oxidized layers and then de-oxygenation (reduction) of these individual layers [1], [2] [1]. During the oxidation process, various functionalized groups (-OH, -O-, -COOH, C=O, etc.) go into the graphene skeleton, breaking the π bond of graphene structure [3]. Oxygen attachment to graphene in any chemical form (epoxide, hydroxyl, carboxyl and ketonic-type functional groups) both on the basal plane and at the edges reduces electronic states at the Fermi level [4], [5], [6]. The type and content of functional groups affect the physiochemical properties of graphene. Therefore, the identification and quantification of functional groups on graphene powder is believed to be a key control characteristic for its production and application.

Coupling thermal gravimetric analysis (TGA) and Fourier transform infrared spectroscopy (FTIR) is an excellent solution to identify and quantify functional groups on graphene powder. In TGA-FTIR, while mass changes such as sample pyrolysis and vaporization that accompany changes in temperature are measured quantitatively by the TGA, qualitative analysis of the gaseous components can be conducted simultaneously by FTIR measurement of the obtained spectra. This document focuses on determining the type and content of functional groups (e.g. hydroxyl, amino, carboxyl, alkyl, carbonyl, sulfonic acid group) on graphene powder by coupling TGA and FTIR.

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

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 6-18: Graphene-based material – Functional groups: TGA-FTIR

1 Scope

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

- functional groups

for functionalized graphene-based material and graphene oxide by

- thermogravimetry analysis (TGA) coupled with Fourier transform infrared spectroscopy (FTIR), referred to as TGA-FTIR.

The content of functional groups is derived by changes in mass of the sample as a function of temperature using TGA. Materials evolved during these mass changes are then analysed using coupled FTIR to identify functional groups.

- The functional groups determined according to this document will be listed as a key control characteristic in the blank detail specification for graphene IEC 62565-3-1 for graphene powder.
- The method is applicable for functionalized graphene powder and graphene oxide that can be pyrolysed and gasified with elevated temperature during TGA.
- Typical application areas are quality control for graphene manufacturers, and product selection for downstream users.

2 Normative references

There are no normative references in this document.