

# TECHNICAL SPECIFICATION



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**Nanomanufacturing – Key control characteristics –  
Part 4-8: Nano-enabled electrical energy storage – Determination of water  
content in electrode nanomaterials, Karl Fischer method**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**NANOMANUFACTURING –  
KEY CONTROL CHARACTERISTICS –****Part 4-8: Nano-enabled electrical energy storage – Determination of  
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## FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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

IEC TS 62607-4-8, 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
113/491/DTS	113/515/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- withdrawn,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.

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## INTRODUCTION

Nano-enabled electrical energy storage has been applied in many fields such as portable electronics, electric vehicles and energy storage systems. With continuous rapid development in these applications, nano-enabled electrical energy storage with high performance is in demand. The main properties of the electrical energy storage device are determined by its electrode nanomaterials.

The water content for electrode nanomaterials is one of the important characteristics to be determined as a quality control test. Water can affect electrical performance, cycling performance and safety performance of nano-enabled electrical energy storage devices [1]<sup>1</sup>, [2]. A high amount of water from electrode materials has a critical influence on both active materials and battery cells [3], and might affect performance or safety characteristics.

Several methods are available for the determination of water content. Karl Fischer titration method is a direct method that is suitable for testing water in gas, liquid and solid samples. The method is useful for low water content levels (< 1 %). Especially, Karl Fischer coulometric titration method is an absolute method which can determine the water content from the quantity of electricity consumed during the test. It can detect trace levels of free water (ppm level), which cannot be detected with normal drying or gravimetric methods. The Karl Fischer coulometric titration method is capable of distinguishing water levels as low as 0,000 1 %.

At present, there are 21 International Standards and/or Technical Specifications mentioning the Karl Fischer method to measure water content, of which 16 use the volumetric titration method, and 5 use the coulometric titration method. The accuracy and resolution of the volumetric method is not appropriate for electrode nanomaterials, whose water content is lower than 1 %. The sampling and measurement controls of the current coulometric method standards are not appropriate for electrode nanomaterials, which have highly hygroscopic characteristics. Therefore, the present standards are not suitable for electrode nanomaterials. This document, considering a sample's characteristic, will help to determine the water content of the electrode nanomaterials in a short time with high accuracy, and will be helpful for quality control in laboratories and industrial manufacturers.

This standardized method is intended for use in comparing the characteristics of raw materials [e.g. lithium cobalt oxide (LCO), lithium nickel cobalt aluminium oxide (NCA), lithium nickel cobalt manganese oxide (NCM), and lithium iron phosphate (LFP)] without any additives [e.g. carbon nanomaterials like carbon black (CB), carbon nanotubes or fibres] or organic binder [e.g. polyvinylidene difluoride (PVDF) or styrene-butadiene rubber (SBR)], their selection process and as a quality control method for the fully formulated electrode material, not for evaluating the electrode in end products.

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<sup>1</sup> Numbers in square brackets refer to the Bibliography.

## **NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –**

### **Part 4-8: Nano-enabled electrical energy storage – Determination of water content in electrode nanomaterials, Karl Fischer method**

#### **1 Scope**

This part of IEC 62607, which is a Technical Specification, specifies a test method for the determination of water content in electrode nanomaterials for nano-enabled electrical energy storage devices, using the Karl Fischer coulometric titration method.

This document includes:

- recommendations for sample preparation,
- outlines of the experimental procedures used to measure electrode nanomaterial properties, and
- methods of interpretation of results and discussion of data analysis.

NOTE This method has precision as low as 0,000 1 %. The best applicable measure range is 0,01 % to 1 %.

This document is not applicable for samples that can react with the main components of Karl Fischer reagent and produce water, or samples that can react with iodine or iodide ion.

#### **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.

ISO 760, *Determination of water – Karl Fischer method (General method)*

ISO 12492, *Rubber, raw – Determination of water content by Karl Fischer method*