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TECHNICAL SPECIFICATION

Nanomanufacturing – Material specifications – Part 5-2: Nano-enabled electrodes of electrochemical capacitors – Blank detail specification

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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IEC TS 62565-5-2 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
113/628/DTS	113/643/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/standardsdev/publications.

A list of all parts in the IEC 62565 series, published under the general title *Nanomanufacturing – Material specifications*, 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- withdrawn,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.

INTRODUCTION

This Technical Specification specifies how to report the various characteristics of electrodes for industrial use in electrotechnical products, and how to incorporate these into a bilateral detail specification between vendor and user.

Electrochemical capacitors are widely used in the fields of electric vehicles, high speed trains, aircraft, photovoltaic, wind power and electronics, due to their ultra-fast charge/discharge capability, long cycle life, wide working temperature range, high security reliability and low maintenance cost [1][1]. In the manufacture process of electrochemical capacitor, the electrode is a bridge between raw material and device. Therefore, the performance of the electrode is very critical in the whole electrochemical capacitor industry chain because the properties of electrodes not only reflect the performance of upstream raw material but also determine the performance of electrochemical capacitor [2][3][4][5][6][7][8][9].

For the purposes of development and commercialization of raw nanomaterials for electrodes and the electrochemical capacitor and assembly produced therefrom, the product characteristics and characterization methods need to be specified in a standardized way. This blank detail specification will benefit different stakeholders as follows: for material suppliers, it provides necessary feedback from the manufacturers to guide the design and production of raw materials; for the end-product manufacturers, it provides a toolbox for evaluating product quality so as to manage and improve process control, yield of products; for commercialization and trade, it provides a guidance on referred test methods for electrode classification; in addition, it will strengthen the links between material manufacture and down-stream user.

In this blank detail specification, the key chemical, physical, structural and electrochemical characteristics that will significantly influence the performance of electrochemical capacitors and their measurement methods are listed. These characteristics and characterization methods are not limited only to nano-enabled electrodes but also can be reference for other electrodes which are constructed by coating electrode materials on a current collector.

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1 Numbers in square brackets refer to the Bibliography.

NANOMANUFACTURING – MATERIAL SPECIFICATIONS –

Part 5-2: Nano-enabled electrodes of electrochemical capacitors – Blank detail specification

1 Scope

This part of IEC 62565, which is a Technical Specification, establishes a blank detail specification that lists the relevant key control characteristics (KCC) including chemical, physical, structural, and electrochemical characteristics of nano-enabled electrode for electrochemical capacitors. Electrodes of both electric double layer capacitors and pseudo capacitors with nano/ nanostructured materials such as nanoporous activated carbon, graphene, carbon nanotube, carbon black, carbon aerogel, carbon nanomaterial coating collector, etc., are included. For other electrodes, this document can be used for reference.

In addition, this document enables the customer to specify requirements in a standardized manner and to verify through standardized methods that the nano-enabled electrode of the electrochemical capacitors meets the required properties.

Numeric values to be specified for the characteristics in this document are intentionally left blank and are determined by agreement between customer and electrochemical capacitor supplier. Properties and characteristics deemed by the customer or supplier as not relevant to a specific application are classified as "not applicable" or "not specified".

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.

IEC TS 62607-4-2, *Nanomanufacturing – Key control characteristics – Part 4-2: Nano-enabled electrical energy storage – Physical characterization of cathode nanomaterials, density measurement*

IEC TS 62607-4-3, *Nanomanufacturing – Key control characteristics – Part 4-3: Nano-enabled electrical energy storage – Contact and coating resistivity measurements for nanomaterials*

IEC TS 62607-4-8, *Nanomanufacturing – Key control characteristics – Part 4-8: Nano-enabled electrical energy storage – Determination of water content in electrode nanomaterials, Karl Fischer method*

IEC TS 62607-6-20, *Nanomanufacturing – Key control characteristics – Part 6-20: Graphene-based material – Metallic impurity content: ICP-MS* [2]

ISO 9277, *Determination of the specific surface area of solids by gas adsorption – BET method*

ISO 15901-2, *Pore size distribution and porosity of solid materials by mercury porosimetry and gas adsorption – Part 2: Analysis of nanopores by gas adsorption*

[2] Under preparation. Stage at the time of publication: IEC DTS 62607-6-20:2021.

ISO 25178 (all parts), *Geometrical product specifications (GPS) – Surface texture: Areal*