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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- 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 62607-4-2, 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:

Enquiry draft	Report on voting
113/289/DTS	113/328/RVC

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 publication 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 document 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

- transformed into an International Standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Compared with normal bulk materials, nanomaterials often exhibit many unique properties, such as mechanical, thermal, magnetic, optical and electrochemical properties. Decreasing particle size of the cathode materials, e.g. lithium iron phosphate (LFP), down to nanoscale greatly enhances their electrochemical performance. For example, smaller particle size will shorten the diffusion length of lithium ion during lithium intercalation/de-intercalation process. Higher surface area will increase the electrode/electrolyte contact area, and subsequently improve the high current charge/discharge rates. Furthermore, the particle surfaces may introduce a sub-gap, which can smooth the electrode discharge curve, then help to prolong the cycling life of the electrode.

Density is one of the key control characteristics for cathode nanomaterials and affects the performance of electronic energy storage devices significantly. At an appropriate density, the electrochemical performance, such as low-temperature and high-temperature charge/discharge, and the ratio of charge/discharge capability, will be dramatically increased.

Among different densities, changing the compacted density of cathode nanomaterials to a suitable value can increase their charge capacity, decrease the internal resistance, lower the polarization effect, increase cycling life of electrical energy storage devices, and improve the usability of electrical energy storage devices. It is important to find the optimum compacted density for the electronic energy storage device design. If the compacted density is too large or too small, the intercalation and de-intercalation of ions will be affected. In general, compacted density is in a positive correlation to the device’s specific capacity, and is considered as one of the key parameters for material energy density.

Rolling density affects the electrochemical performance characteristics of cathode nanomaterials in a similar way. Rolling density indicates the ratio of the mass of coating slurry compound to its volume. Rolling density is a valuable quantity not only for evaluating the volumetric energy density, but also for selecting a cathode nanomaterial candidate for Hybrid-Electric Vehicles (also known as HEVs) and Electric Vehicles (also known as EVs).

Both of these two types of properties need to be considered in the density assessment of a nano-enabled electrical energy storage device. Comparable results will be used to judge the consistence of cathode nanomaterials, which relates to performance and safety issues. Therefore, a standardized density measurement procedure for cathode nanomaterials becomes indispensable to its users for comparing the values of nanomaterials from different suppliers.

This standardized method is intended for use in comparing the characteristics of cathode nanomaterials in the study stage, not for evaluating the electrode in end-products. The method is applicable to materials exhibiting function or performance only possible with nanotechnology, intentionally added to the active materials to measurably and significantly change the characteristics of electrical energy storage devices.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 4-2: Nano-enabled electrical energy storage – Physical characterization of cathode nanomaterials, density measurement

1 Scope

This part of IEC 62607, which is a Technical Specification, provides a standardized method for the determination of the density of cathode nanomaterials in powder form used for electrical energy storage devices. This method provides users with a key control characteristic to decide whether or not a cathode nanomaterial is usable, or suitable for their application.

This document includes

- definitions of terminology used in this document,
- recommendations for sample preparation,
- outlines of the experimental procedures used to measure cathode nanomaterial properties,
- methods of interpretation of results and discussion of data analysis,
- case studies, and
- references.

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/TS 80004-1, *Nanotechnologies – Vocabulary – Part 1: Core terms*