PD IEC/TS 62607-4-4:2016

BSI Standards Publication

Nanomanufacturing — Key control characteristics

Part 4-4: Nano-enabled electrical energy storage — Thermal characterization of nanomaterials, nail penetration method

bsi.

This Published Document is the UK implementation of IEC/TS 62607-4-4:2016.

The UK participation in its preparation was entrusted to Technical Committee NTI/1, Nanotechnologies.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2016

ISBN 978 0 580 91370 9
ICS 07.120

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 November 2016.

Amendments/corrigenda issued since publication

Date	Text affected

®

Edition 1.0 2016-10

TECHNICAL SPECIFICATION

colour inside

Nanomanufacturing – Key control characteristics – Part 4-4: Nano-enabled electrical energy storage – Thermal characterization of nanomaterials, nail penetration method

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 07.120 ISBN 978-2-8322-3712-0

CONTENTS

FOREWORD ... 3
INTRODUCTION ... 5
1 Scope ... 6
2 Normative references ... 6
3 Terms and definitions ... 6
4 Sample preparation ... 8
4.1 General sample requirements ... 8
4.2 Pre-treatment ... 8
4.3 Puncture nail construction ... 9
4.4 Puncture nail temperature and isolation verification ... 9
5 Measurement of electric properties ... 10
5.1 Equipment and testing site requirements ... 10
5.2 Measurement system requirements ... 10
5.3 Sample setup ... 11
5.4 Puncture method ... 11
5.5 Design of testing method ... 12
6 Data analysis / interpretation of result ... 13
6.1 Samples classification from the results ... 13
6.1.1 Reference sample (without nanomaterials) ... 13
6.1.2 Test sample (with nanomaterials) ... 13
6.2 Data analysis ... 13
Annex A (informative) Data report example ... 15
Bibliography ... 17

Figure 1 – Schematic view of puncture nail ... 9
Figure 2 – Schemetic view of puncture nail and the heated metal block ... 10
Figure 3 – The puncture through depth of cell ... 11
Figure 4 – Flow chart of reference sample test procedures ... 12
Figure 5 – Voltage and temperatures versus time plot ... 13
Figure 6 – Repeatability plot of voltage and temperature versus time ... 14
Figure 7 – Performance comparison plot of voltage and temperature versus time ... 14

Table 1 – Hazard level description ... 12
Table A.1 – Anode specifications ... 15
Table A.2 – Cathode specifications ... 15
Table A.3 – Electrolyte specifications ... 15
Table A.4 – Separator specifications ... 15
Table A.5 – Cell specification ... 15
Table A.6 – Sample analysis ... 16

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 4-4: Nano-enabled electrical energy storage – Thermal characterization of nanomaterials, nail penetration method

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 62607-4-4, 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
113/306/DTS	113/329/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 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

- 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

Energy storage devices are becoming increasingly important for many applications such as consumer devices, electric vehicles and aircrafts. Energy storage devices with high performance and reliability are the key factors to earn the confidence of customers. Also, in smart grid and renewable energy applications, where energy efficiency and reliable power supplies are critical, an energy storage system is an essential device. There are many types of energy storage devices for various applications. Lithium-ion batteries are the most popular and promising energy storage devices for portable electronics, consumer electronics, military, electric vehicle and aerospace applications. It is a good test carrier for performance and reliability characteristics.

One of the characteristics that draws the attention of users is the thermal runaway behaviour when a short circuit occurs inside the energy storage devices due to a manufacturing process defect, improper operation or external shocks. The poor control of manufacturing process may cause the energy storage device's internal defects, such as particle impurity, defects of separator, burr of electrodes or a prominence of conductive arms. Energy storage devices operated under abnormal conditions, such as quick charging or piercing by external objects, may cause an internal short circuit. Large current generated short circuit will generate an abnormal exothermic reaction and a local temperature rise, but the temperature of the short circuit spot drops due to heat transfer. These effects cause the energy storage device's temperature to continue to rise rapidly. If it reaches thermal runaway temperature, it usually leads to fire and explosion of the energy storage devices. The event can result in damage to personnel and equipment. In the worst case scenario, this may hamper the development of such type of energy storage devices.

In order to prevent such a scenario, nanomaterial additives have been used to prevent thermal runaway to ensure the reliability and safety of energy storage devices. The nanomaterial additives may mix with active materials of electrodes, electrolyte, coated on the surface of electrodes or separator.

This document specifies general testing procedures and requirements for the assessment of thermal runaway performance and risk associated with the nano-enabled energy storage devices prepared by employing nanomaterial additives, and serves as the basis for further developing particular product specific standards. This method covers only large temperature rises in cell temperature caused by shorting of the anode and cathode. This method does not generally cover thermal runaway due to other causes such as high external temperature and is not a general method to prevent thermal runaway.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 4-4: Nano-enabled electrical energy storage – Thermal characterization of nanomaterials, nail penetration method

1 Scope

This part of IEC 62607, which is a Technical Specification, provides a measurement method for thermal runaway quality level test for nano-enabled energy storage devices. This method uses comparative measurement to enable a manufacturer to decide whether or not the nanomaterial additives used in energy storage devices are resilient against the thermal runaway caused by a faulty or accidental low resistance connection between two or several internal points depending on the number of stacking electrode layers of the test sample. The nanomaterial additives may mix with the materials of positive and negative electrodes, electrolyte, coated on electrodes or separator. This document includes definitions of terminology, test sample, puncture nail requirements, test procedures, data analysis and methods of interpretation of results and a case study.

This document does not apply directly to the safety testing for energy storage device products due to complex safety design schemes embedded in these products.

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 9001:2015, *Quality management systems – Requirements*

ISO 14001:2015, *Environmental management systems – Requirements with guidance for use*

ISO 26000:2010, *Guidance on social responsibility*

ISO/TS 80004-1:2015, *Nanotechnologies – Vocabulary – Part 1: Core terms*

ISO/TS 80004-2:2015, *Nanotechnologies – Vocabulary – Part 2: Nano-objects*

ISO/TS 80004-4:2011, *Nanotechnologies – Vocabulary – Part 4: Nanostructured materials*

IEC TS 80004-9:2016, *Nanotechnologies – Vocabulary – Part 9: Nano-enabled electro-technical products and systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9001, ISO 14001, ISO 26000, the core terms of ISO/TS 80004-1, ISO/TS 80004-2, ISO/TS 80004-4, IEC TS 80004-9 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses: