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Nanotechnologies — Nanostructured porous alumina as catalyst support for vehicle exhaust emission control — Specification of characteristics and measurement methods

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Nanostructured porous alumina as catalyst support for vehicle exhaust emission control plays an important role in automotive exhaust treatment[15]. Three-way catalytic converters (TWCs) have been used in vehicle exhaust control systems worldwide, which can convert carbon monoxide (CO), hydrocarbon (HC) and oxynitride (NOx) into carbon dioxide (CO_2), nitrogen (N_2) and oxygen (O_2). Nanostructured porous alumina has the advantages of a high specific surface area (SSA) and excellent thermal stability, which makes TWCs keep high catalytic activity at a temperature of 900 °C to 1 000 °C in gasoline cars. As one of the most important materials in the catalytic converter[16], nanostructured porous alumina with proper performance is in great demand. In the automotive exhaust treatment field, almost 11,000 tons of porous alumina powders are needed per year.

SSA, specific pore volume, impurities and thermal stability are the main characteristics affecting the performance of nanostructured porous alumina as catalyst support[17]. A high SSA can facilitate homogeneous dispersion of noble metal. A suitable specific pore volume ensures efficient noble metal loading and allows reaction gas to pass through and contact with the catalyst. Impurities can deactivate the noble metal catalyst and thus are harmful. An excellent thermal stability guarantees that TWCs maintain at high activity levels after a long distance running and thus have a prolonged service life. The schematic illustration is shown in Annex A.

The world market demand for nanostructured porous alumina is growing year by year. Currently, however, there are no standards for manufacturers in managing quality control and assurance, and for users in selecting suitable materials for TWCs.

This document provides characteristics and measurements of nanostructured porous alumina as catalyst support for vehicle exhaust emission control. It aims to facilitate worldwide transactions between buyers and sellers of nanostructured porous alumina.

Nanotechnologies — Nanostructured porous alumina as catalyst support for vehicle exhaust emission control — Specification of characteristics and measurement methods

1 Scope

This document specifies characteristics to be measured of nanostructured porous alumina in powder form as catalyst support for vehicle exhaust emission control and their relevant measurement methods. It includes critical characteristics that are required to be measured and additional characteristics that are recommended to be measured, based upon agreement between the interested parties. Measurement methods for each characteristic are recommended.

This document is applicable to nanostructured porous alumina for gasoline-powered cars. It does not apply to characteristics specific for health, the environment and safety issues.

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*

ISO/TS 80004-6, *Nanotechnologies — Vocabulary — Part 6: Nano-object characterization*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 80004-1, ISO/TS 80004-6 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
specific surface area
SSA
absolute surface area of the sample divided by sample mass

[SOURCE: ISO 9277:2010, 3.11]

3.1.2
specific pore volume
volume of open pores per unit mass of a material

3.1.3
pore diameter
diameter of a pore in a model in which the pores typically are assumed to be cylindrical in shape and which is calculated from data obtained by a specified procedure

[SOURCE: ISO 15901-1:2016, 3.15]

3.1.4
apparent density
loose bulk density
dry mass per unit volume of a powder obtained by free pouring under specified conditions

[SOURCE: ISO 9161:2019, 3.1]

3.1.5
tap density
dry mass per unit volume of a powder in a container that has been tapped under specified conditions

[SOURCE: ISO 9161:2019, 3.2]

3.1.6
impurity
metallic or non-metallic element present in a material, but not intentionally added to the material

[SOURCE: ISO 3522:2007, 3.10, modified — "in a material, but not intentionally added to the material" has replaced "but not intentionally added to a metal, and the minimum content of which is not controlled".]

3.1.7
loss on ignition
change in mass of a material held at a specified temperature, excluding the loss due to hygroscopic moisture

[SOURCE: ISO 11323:2010, 8.4, modified — "a material held at a specified temperature" has replaced "an ore held at 1 000 °C".]

3.1.8
ceramic honeycomb
fine ceramic body having multiple channels typically arranged in a honeycomb structure

[SOURCE: ISO 20507:2014, 2.1.18, modified — Note 1 to entry has been deleted.]

3.2 Abbreviated terms

BET	Brunauer–Emmett–Teller
BJH	Barrett–Joyner–Halenda
ICP-AES	inductively coupled plasma atomic emission spectrometry
ICP-OES	inductively coupled plasma optical emission spectrometry
SSA	specific surface area
TWC	three-way catalytic converters
XRF	X-ray fluorescence spectrometry

4 Characteristics and their measurement methods

4.1 General

Critical and additional characteristics to be measured of nanostructured porous alumina are listed in Tables 1 and 2, respectively.

Although the International Standards given in Tables 1 and 2 are individually applicable to general or specific materials, all the documents are not yet fully validated whether they are specifically applicable to nanostructured porous alumina. Their application shall be validated and decided by the standards users themselves.

As the nanostructured porous alumina is liable to adsorb moisture, its characteristics can be affected by the storage conditions. The sample for measurements should be stored in a dry environment. If not, the buyers and the sellers should agree upon the storage conditions of the samples for comparability of results.

4.2 Critical characteristics and their measurement methods

The critical characteristics listed in Table 1 shall be measured. The measured values of these characteristics shall be provided to the buyers during purchase. The SSA and the specific pore volume shall be measured before and after thermal treatment.

The measurement methods listed in Table 1 should be used.

Table 1 — Critical characteristics and their measurement methods

Characteristics	Units	Measurement methods	Relevant standard(s)
Specific surface area	m^2/g	Gas adsorption method	ISO 18757:2003
Specific pore volume	m^3/kg	Gas adsorption method	ISO 15901-2:2006
Pore diameter	nm	Gas adsorption method	ISO 15901-2:2006
Impurity content	% mass fraction	ICP-OES/-AES	ISO 17942:2014 ISO 10058-3:2008

4.3 Additional characteristics and their measurement methods

The additional characteristics listed in Table 2 should be measured. The measurement methods listed in Table 2 should be used for the individual characteristics.

Table 2 — Additional characteristics and their measurement methods

Characteristics	Measurement methods	Relevant standard
Apparent density	Funnel method	ISO 3923-1:2018
Tap density	Cylinder tapping method	ISO 3953:2011
Particle size	Laser diffraction method	ISO 13320:2020
Loss on ignition	Incineration and gravimetry	ISO 11536:2015

5 Descriptions of characteristics and measurement methods

5.1 General

The following clauses describe the characteristics and associated measurement methods listed in Tables 1 and 2 in more detail.