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Nanotechnologies — Measurement technique matrix for the characterization of nano-objects

Nanotechnologies — Matrice de méthodes de mesure pour les nano-objets manufacturés

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 229, *Nanotechnologies*.

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Introduction

This document connects the nano-object parameters that most commonly need to be measured with corresponding measurement techniques. This document will be a useful tool for nanotechnology interested parties to rapidly identify relevant information for measuring nano-objects. The common nano-object parameters are listed along the top row of the Quick-Use-Matrix (see Table 1). If a measurement technique listed in the first column of the matrix is applicable, the box in the matrix will be marked. Once a measurement technique of interest is identified, it is recommended that the reader then enter this document's body of text (see Clause 5), where you will find an alphabetical listing of the measurement techniques and descriptions of the advantages, limitations, relevant standards, measurand(s), and applicable nano-object parameters of each technique.

As scientific advances are made and additional commercial measurement techniques become available, this document will be periodically reviewed and updated to maintain its relevance.

Many of the techniques listed in this document have not been validated through round-robin testing or any other means for the measurement of nano-objects. This document is intended as a starting point and resource to help identify potentially useful and relevant techniques; it is not an exhaustive or primary source. It is recommended that once a technique has been identified, the reader refers to relevant international standards and conducts a literature search for similar or comparable applications. Other sources of information include instrument manufacturer's applications notes and technical literature.

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Nanotechnologies — Measurement technique matrix for the characterization of nano-objects

1 Scope

This document provides a matrix that guides users to commercially available techniques relevant to the measurements of common physiochemical parameters for nano-objects. Some techniques are also applicable to nanostructured materials.

NOTE Guidance on sample separation and preparation is given in Annex A.

2 Normative references

There are no normative references in this document.

3 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:

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

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

3.1 General terms

3.1.1
dispersion
heterogeneous system in which a finely divided material is distributed in another material

[SOURCE: ISO 472:2013, 2.288]

3.1.2
measurand
quantity intended to be measured

[SOURCE: ISO Guide 99:2007, 2.3]

3.1.3
nano-object
discrete piece of material with one, two or three external dimensions in the nanoscale

Note 1 to entry: The second and third external dimensions are orthogonal to the first dimension and to each other.

[SOURCE: ISO/TS 80004-2:2015, 2.2]

3.1.4
nanostructured material
material having internal or surface structure in the nanoscale

Note 1 to entry: If external dimensions are in the nanoscale, the term *nano-object* (3.1.3) is recommended.

[SOURCE: ISO/TS 80004-4:2011, 2.11]

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3.2 Nano-object parameters

3.2.1
chemical composition
identity and possible quantification of a material's composite parts and its impurities

3.2.2
concentration
content of nano-objects in a sample, quantified as number, area, volume or mass content

Note 1 to entry: Transformation calculation from one type of quantity to another (e.g. number to volume) requires the knowledge of the complete particle size distribution and the assumption of a size-independent shape, porosity or density[6].

3.2.3
crystal property
effect due to the presence of three-dimensional order at the level of molecular dimensions

Note 1 to entry: See Reference [1].

3.2.4
electrokinetic potential
difference in electric potential between that at the slipping plane and that of the bulk liquid

Note 1 to entry: See Reference [7].

Note 2 to entry: Electrokinetic potential is expressed in volts.

Note 3 to entry: Often called "zeta potential".

3.2.5
shape
external geometric form of a particle

Note 1 to entry: See Reference [8].

Note 2 to entry: For quantitative description by macroshape, mesoshape or microshape descriptors, see Reference [9].

3.2.6
size
linear dimensions of a particle determined by a specified measurement method and under specified measurement conditions

Note 1 to entry: See Reference [10].

Note 2 to entry: Different methods of analysis are based on the measurement of different physical properties. Independent of the particle property actually measured, the particle size is reported as a linear dimension, e.g. as the equivalent spherical diameter.

Note 3 to entry: Examples of size descriptors are those based at the opening of a sieve or a statistical diameter, e.g. the Feret diameter, measured by image analysis.

Note 4 to entry: In ISO 9276-1, the symbol x is used to denote the particle size. However, it is recognized that the symbol d is also widely used to designate these values. Therefore, the symbol x can be replaced by d.

3.2.7
particle size distribution
cumulative distribution of particle concentration as a function of particle size

[SOURCE: ISO 14644-1:2015, 3.2.4]

Note 1 to entry: Particle size distribution is of statistical nature so it can be expressed as a function of particle size[11].

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Note 2 to entry: The type of quantity (number, area, volume or mass) as well as the measurand, the measured equivalent spherical diameter, shall be indicated.

Note 3 to entry: Particle size distribution can be expressed as cumulative distribution or a distribution density (distribution of the fraction of material in a size class, divided by the width of that class).

3.2.8
surface area
extent of available surface area as determined by given method under stated conditions

Note 1 to entry: See Reference [12].

Note 2 to entry: Surface area is the quantity of accessible surface of a sample when exposed to either gaseous or liquid adsorbate phase. Surface area is conventionally expressed as a mass-specific surface area or as volume-specific surface area where the total quantity of area has been normalized either to the sample's mass or volume[13].

4 Parameters included in the matrix

Several comprehensive literature searches, input from ISO/TC 229 experts, and a review of current ISO work have identified frequently sought nano-object parameters that are listed across the top of the Quick-Use-Matrix (see Table 1). The parameters listed from left to right are in alphabetical order. A single technique alone often cannot provide sufficient information about all parameters of interest for a particular nano-object under study, nor is one technique likely to fully capture relevant information for a single parameter. Therefore, when available, it is recommended that more than one technique should be used for any parameter investigation.

Table 1 — Quick-Use-Matrix[4]

Technique									
	Acronym	Chemical composition	Concentration	Crystal properties	Electrokinetic potential	Shape	Size	Size distribution	Surface area
Acoustic spectroscopy			+				+	+	
Analytical centrifugation	AC							+	
Aerosol particle mass analyser	AMS		+				+		
Auger electron spectroscopy (scanning)	AES	+	+			+	+		
Brunauer-Emmett-Teller	BET								+
Condensation particle counter	CPC		+						
Differential mobility analysis system[a]	DMAS		+				+	+	
Differential scanning calorimetry	DSC	+							
Dynamic light scattering[b]	DLS						+	+	
Electroacoustic spectroscopy					+				

[a] Requires a special detector or additional instrumentation to obtain the desired parameter.

[b] Light scattering technique.

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