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Nanotechnologies — Sample preparation for the characterization of metal and metal-oxide nano-objects in water samples

Nanotechnologies — Préparation des échantillons pour la caractérisation de nano-objets métalliques et d'oxydes métalliques dans les échantillons d'eau

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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 of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

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.

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Introduction

With the increasing use of manufactured nano-objects in commercial products and applications, such as consumer and healthcare products, solar panels, batteries, surface coatings, and water treatment, it is likely that these nano-objects will eventually be released to the environment, especially in aquatic environments. There are, however, limited technical data available on the occurrence/transport/fate of manufactured nano-objects after they are released to the aquatic environment. Together with the current global shortage of water supply and an increasing demand for water recycling, concerns for the potential health impacts of manufactured nano-objects in water will increase.

Related to nano-objects in aqueous matrices, knowledge of environmental parameters like natural organic matter content, pH, ionic strength (IS) etc., is important since these may influence particle size, fate, stability and chemical composition. An aqueous sample can be a complex mixture of particles of different nature, size, reactivity, composition, agglomeration state and shape. Hence the initial preparation of the samples, such as pre-treatment and size fractionation, are critical steps for any subsequent analysis of the nano-objects. A consolidated table listing common fractionation techniques is given by Simonet, et al.[1] and Hassellov, et al.[2].

Although several methods for the detection and characterization of manufactured nano-objects in aqueous matrices are described in ISO/TR 18196:2016, the methods are at various stages of development into technical specifications or standards. Most importantly, there is no accepted standard as yet on pre-analysis treatment (i.e. collection, storage and size fractionation) of manufactured nano-objects in water. This document can contribute to the development of a future international standard for the analysis and characterization of metal and metal-oxide nanoparticles in aqueous matrices. This will allow interlaboratory comparison of results and contribute to future studies of commercial products containing manufactured nano-objects, thus, finally, support the growth of nanotechnology related industries.

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Nanotechnologies — Sample preparation for the characterization of metal and metal-oxide nano-objects in water samples

1 Scope

This document provides an overview of approaches of sample preparation (i.e. pre-treatment and size-fractionation) for analytical measurements applied to surface and drinking water, potentially containing relevant amounts and types of metal and metal oxide nano-objects, including collection from source and storage of samples, pre-concentration of analytes, and their fractionation.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
manufactured nanomaterial
nanomaterial intentionally produced to have selected properties or composition

[SOURCE: ISO/TS 80004-1:2015, 2.9]

3.2
measurand
quantity intended to be measured

[SOURCE: ISO/IEC Guide 99:2007, 2.3, modified — The notes to entry have been deleted.]

3.3
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]

3.4
nanostructured material
material having internal nanostructure or surface nanostructure

Note 1 to entry: If external dimensions are in the nanoscale, the term *nano-object* (3.2) is recommended.

[SOURCE: ISO/TS 80004-1:2015, 2.7, modified — Note 1 to entry has been replaced.]

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3.5
surface water
water which flows over, or rests on, the surface of a land mass

[SOURCE: ISO 13164-1:2013, 3.1.20]

3.6
drinking water
water either in its original state or after treatment, intended for drinking, cooking, food preparation, or other domestic purposes, regardless of its origin

Note 1 to entry: Also known as potable water.

[SOURCE: ISO 5667-5:2006, 2.2, modified]

4 Symbols and abbreviated terms

HDPE	high density polyethylene
FFF	field-flow fractionation
Flow FFF	flow field-flow fractionation
UF	ultrafiltration
SEC	size exclusion chromatography
GPC	gel permeation chromatography
SDS	sodium dodecyl sulfate
DLS	dynamic light scattering
UV-vis	ultraviolet–visible spectroscopy
RC	regenerated cellulose
PES	polyethersulfone

5 Types of metal and metal oxide-based manufactured nano-objects

Based on the relevance of existing commercial products[1)], the following metal and metal oxide-based nano-objects were considered in the development of this document:

— Titanium dioxide (TiO_2): One of the most commonly used nanomaterial ingredients in many common consumer products (e.g. sunscreens, antifungal paints) and medical products;

— Zinc oxide (ZnO): Also widely used in sunscreens and medical products;

— Silver (Ag): Commonly used as an antibacterial agent in consumer textiles and medical products;

— Gold (Au): Widely used in biomedical applications, including bioassays, drug delivery and hyperthermal therapy.

6 Types of water matrices of interest

Two types of water matrices were considered in this document, surface water and drinking water. Surface water is the primary water source receiving waste streams, and thus it is prone to receive

1) Industry-wide applications: http://www.understandingnano.com/nanoparticles.html.

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