
**Nanotechnologies — Assessment of
peroxidase-like activity of metal and
metal oxide nanoparticles**

*Nanotechnologies — Evaluation de l'activité de type peroxidase des
nanoparticules métalliques et d'oxydes métalliques*



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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.

Introduction

Enzymes are the biological catalysts that control biochemical reactions. The enzyme peroxidase is a metalloenzyme with many isoforms. It catalyses the oxidation of various organic substrates by hydrogen peroxide, which is used extensively in biochemistry applications. Metal and metal oxide nanoparticles have a wide range of applications in biomedicine, environment protection, and some other fields, such as magnetic separation, detection, anti-bacterial, degradation of contaminants, medical imaging and tumour therapy. In recent years, an intrinsic peroxidase-like activity was observed in some metal and metal oxide nanoparticles, which means that these metal and metal oxide nanoparticles can catalyse the oxidation of substrates of natural peroxidase by hydrogen peroxide under mild reaction conditions in comparable efficiency and kinetics. Iron oxide (Fe_3O_4) nanoparticles are one representative material, and cobalt oxide (Co_3O_4) nanoparticles, copper oxide (CuO) nanoparticles, manganese oxide (MnO_2) nanoparticles, vanadium oxide (V_2O_5) nanoparticles, gold (Au) nanoparticles and platinum (Pt) nanoparticles have been reported to have the peroxidase-like activity as well. These findings extend enzyme mimics from organic compounds to inorganic nanomaterials.

Certain metal and metal oxide nanoparticles can catalyse the transfer of electrons from H_2O_2 to colorimetric indicator under physiological condition. This phenomenon is like the colorimetric reaction mediated by peroxidase and thus is called as peroxidase-like catalysis. Such catalytic property can be used to produce colorimetric, chemiluminescent or electrochemical signals which have great potential applications in biosensors, electrochemical sensors and immunoassays. The nanoparticles with peroxidase-like activity may have anti-tumour, antibacterial or antioxidant functions in biological system. In addition, the nanoparticles with such activity can have potential impacts on health, safety and the environment. Therefore, it is important to assess the peroxidase-like activity of a nanoparticle in practical applications.

The peroxidase-like activity of nanoparticles strongly depends on multiple factors including the composition, size, surface chemistry and crystal structure of the nanoparticles, as well as the measurement conditions. Therefore, it is important to establish a standard method for assessing the peroxidase-like activity of metal and metal oxide nanoparticles.

This document provides a specification for the assessment of peroxidase-like activity of metal and metal oxide nanoparticles. This protocol is useful to enterprises, research laboratories or institutions and metrological organizations that are working on nanomaterials used in biomedical applications and environment protection.

Nanotechnologies — Assessment of peroxidase-like activity of metal and metal oxide nanoparticles

1 Scope

This document specifies a method for assessing the peroxidase-like activity of metal and metal oxide nanoparticles by spectrophotometry. This document can serve as a reference for the measurements of peroxidase-like activities in other types of nanoparticles.

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 18153:2003, *In vitro diagnostic medical devices — Measurement of quantities in biological samples — Metrological traceability of values for catalytic concentration of enzymes assigned calibrators and control materials*

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

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO/TS 80004-2 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

nanoparticle

nano-object with all external dimensions in the nanoscale where the lengths of the longest and the shortest axes of the nano-object do not differ significantly

[SOURCE: ISO/TS 80004-2:2015, 4.4, modified — Note 1 to entry has been removed.]

3.1.2

catalytic activity

property of a component corresponding to the catalysed substance rate of conversion of a specified chemical reaction, in a specified measurement system

Note 1 to entry: In this document, the “component” is one kind of metal or metal oxide nanoparticles.

Note 2 to entry: In this document, the catalytic activity is the peroxidase-like activity of metal and metal oxide nanoparticles.

Note 3 to entry: The coherent derived SI unit is “katal” (kat), equal to “mole per second” (mol·s⁻¹).

[SOURCE: ISO 18153:2003, 3.2, modified — Notes 1, 2 and 3 to entry have been added.]