Technical Specification

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# Nanotechnologies — Silica nanomaterials — Specification of characteristics and measurement methods for silica with ordered nanopore array (SONA)

*Spécification des caractéristiques et méthodes de mesure de la silice à réseau de nanopores ordonnés (SONA)*

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

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# Introduction

Silica with ordered nanopore array (SONA) is expected to act as novel catalysts and adsorbents because of the presence of their uniform nanopores. In addition to SONA, recently developed synthetic strategies have created a huge number of compositional and morphological variations. Therefore, SONA is expected to be applied in various fields such as electronics, optics and materials. They also have potential uses as electrodes for fuel cells and hydrogen-storage materials, all of which are owing to the presence of periodic nanopore and the physical properties of inorganic frameworks.

SONA, as described in the previous reports[1]-[5], has an amorphous structure like silica-gel and exhibits a honeycomb (hexagonal), 3D (cubic) and wormhole (gyroid) pore structure (see Annex A) with ordered cylindrical channels from 2 nm to 50 nm in diameter. The pores are constructed with thin silica walls which are connected to form the regular pore arrangements. The delicate structures of silica walls and their connected structures are influenced by their preparation, aging and storage conditions. The global SONA market is anticipated to witness significant growth on account of a wide range of existing and potential applications of the product in electronics, biomedical, drug delivery and optical fields. A market survey shows extensive use of SONA in the chemical industry as a catalyst support for synthesis of various chemicals[6].

SONA have a variety of industrial applications as catalysts, adsorbents, molecular sieve, where their properties and use cases highly depend on their production processes that affect their nanopore arrangements. They do not have long-range $SiO_2$ ordering confirmed by powdered X-ray diffraction, showing XRD peaks in low angle region (see Annex A). Having the ability to characterize these materials helps developers adapt to new research frontiers, such as bulky organometallic or inorganic complexes, biosensors from embedded enzymes on nanostructured silica,[7]-[8] to application in energy-efficient desiccation. Standardization of SONA can unify different types of SONA test reports in industry. This allows users to compare or select most suitable and qualified SONA for their applications.

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## 1 Scope

This document specifies the characteristics of samples of silica with ordered nanopore array (SONA) to be measured in powder form and the industrially available measurement methods used to determine said characteristics. This document provides a sound base for the research, development and commercialization of SONA for various applications.

This document excludes silica-gel, fumed silica and chemically modified SONA.

NOTE The pore size of SONA ranges usually from one nanometre to several tens of nanometres.

## 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 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**
**area equivalent diameter**
diameter of a circle having the same area as the projected image of the particle

Note 1 to entry: It is also known as the Heywood diameter or as the equivalent circular diameter.

[SOURCE: ISO 13322-1:2014, 3.1.1]

**3.2**
**Feret diameter**
distance between two parallel tangents on opposite sides of the image of a particle

[SOURCE: ISO 13322-1:2014, 3.1.5]

**3.3**
**nanopore**
cavity with at least one dimension in the *nanoscale* (3.4), which can contain a gas or liquid

Note 1 to entry: The shape and content of the cavity can vary. The concept of nanopore overlaps with micropore (i.e. pore with width of about 2 nm or less), mesopore (i.e. pore with width between approximately 2 nm and 50 nm), and macropore (i.e. pore with width greater than about 50 nm).

Note 2 to entry: When nanopores are appropriately interconnected, they can allow for transport through the material (i.e. permeability).

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