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ISO/TC 229

Secretariat: BSI

Nanotechnologies — Textiles containing nanomaterials and nanostructures — Superhydrophobic characteristics and durability assessment

Nanotechnologies — Textiles contenant des nanomatériaux et des nanostructures — Caractéristiques superhydrophobiques et évaluation de la durabilité

~~Publication stage~~

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Contents

Foreword

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

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Introduction

Recently superhydrophobic textiles (woven and nonwoven) have gained significant scientific and industrial interest for its potential applications in outdoor wear and protective clothing. The superhydrophobic textile surfaces refer to superior water repellency with a water contact angle exceeding 150° and low contact angle hysteresis of less than 10° (see Annex A). For this superhydrophobic textile, dirt and soils are loosely attached, and a rolling water drop can easily attach and remove them from the surface, giving self-cleaning properties. According to Young's, Wenzel and Cassie-Baxter Models superhydrophobicity of textile surface can be made by both the surface treatment with very low surface free energy materials and making nano-roughness (see Annex ~~A~~ B).

Nanotechnology is employed to artificially change the surface free energy and/or cause nano- roughness on the surface. The following methods are normally utilized in this respect:

— using nano-objects such as silica, TiO_2, CNT, ZnO, etc., in various ways~~.~~;

— surface etching, i.e. nano roughening (UV-laser or plasma), followed by grafting or physically/chemically attaching compounds with low surface energy~~.~~;

— using nanofibres.

The establishment of superhydrophobic relies on~~; (i)~~

a) superhydrophobic (non-polar) surface chemistry, and ~~(ii)~~

b) nanostructured surface texture (nano-roughness).

One of the most important obstacles affecting the market growth of textiles containing nanomaterials and nanostructures (TCNNs) showing superhydrophobic response is their relevant durability under different utilization and working conditions. This includes, laundering (washing), ironing, mechanical abrasion (rubbing) and light radiation exposure. If superhydrophobic properties are not durable, the TCNNs are useless in long term applications. Therefore, durability of superhydrophobic TCNNs over repeated use and wash are necessary.

In this regard, the durability and persistence of superhydrophobic ~~behavior~~behaviour of TCNNs needs to be assessed under above mentioned condition based on standard methods. Generally, from the consumer's perspective, the superhydrophobic durability of TCNNs is very important. However, there is no specific measurement method to evaluate the superhydrophobic durability. In fact, there is a lack of grading procedure for this characteristic.

This ~~TS~~document both specifies the characteristics, performance and durability of the TCNNs subjected to laundry (washing), ironing, mechanical abrasion (rubbing) and light exposure. The superhydrophobic durability of such textiles are assessed and reported based on contact angle and hysteresis measurement of the samples before and after subjected to mentioned conditions. In fact, a specific grading method is ~~compiled~~established in this ~~TS~~document. Further, ~~it~~this document also recommends relevant measurement methods to promote communication and mutual understanding of TCNNs for superhydrophobic application between buyers and sellers.

This ~~TS~~document supports less water consumption and less waste water production. In addition, ~~the standard~~this document supports responsible production in terms of superhydrophobic durability of textile. Furthermore, ~~the TS~~this document can provide a potential for the economic growth for small and medium size enterprises. These items ~~are in conformance~~conform with several Sustainability Development Goals (SDGs) defined by United Nations.

~~This standard supports following United Nations Sustainable Development Goals (SDGs).~~

ISO/DTS 10818 (E)

Nanotechnologies — Textiles containing nanomaterials and nanostructures — Superhydrophobic characteristics and durability assessment

1 Scope

This document specifies the characteristics and performance/s of the superhydrophobic textiles containing nanomaterials and nanostructures (TCNNs) based on contact angle measurement before and after being subjected to washing/drying (laundry), ironing processes, light sources and abrasion, ~~where applicable based on the~~that are to be determined by agreement between ~~interested parties.~~customer and supplier. This ~~standard~~document solely covers woven and nonwoven fabrics.

This document ~~addresses neither~~does not address safety and ~~nor~~ health related issues.

2 Normative references

~~The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.~~

~~ISO/TS 80004-1:2015 Nanotechnologies—Vocabulary—Part 1: Core terms ISO/TS~~

~~80004-2:2015 Nanotechnologies—Vocabulary—Part 2: Nano-objects~~

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

~~2.1~~3.1 Terms and definitions

~~**3.1 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:

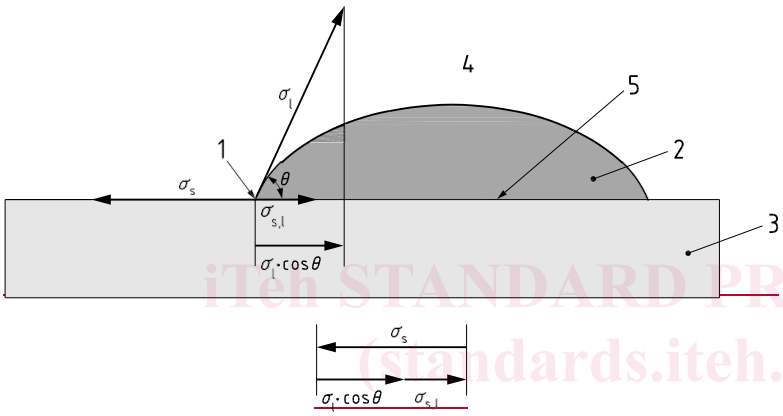
— ISO Online browsing platform: available at https://www.iso.org/obp

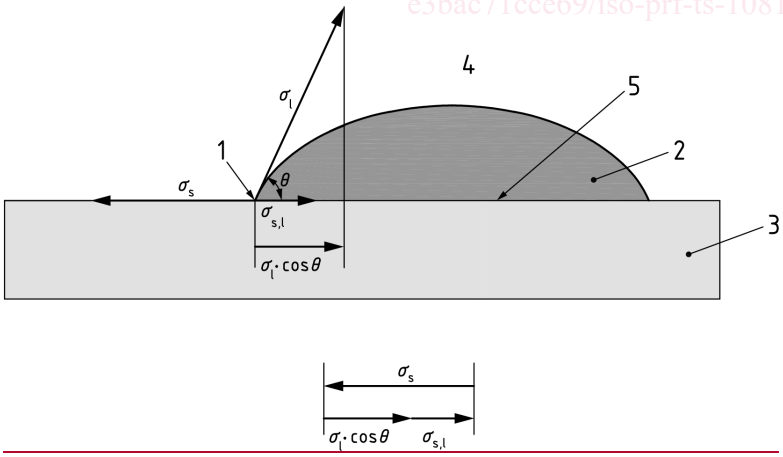
— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
contact angle
θ
angle to the base line within the drop, formed by means of a tangent on the drop counter through one of the three-phase points~~.~~

Note 1 to entry: See Figure 1.

Note 2 to entry: The contact angle is preferably indicated in degrees (°). 1° = (π/180) rad. If the system is in thermodynamic equilibrium, this contact angle is also referred to as thermodynamic equilibrium contact angle.





Key

1 Three-phase point

~~2 Liquid phase~~

~~Solid phase~~

~~3 Gas phase~~

~~3 Base line~~

~~σ_l Surface tension of the liquid surface~~

~~σ_s Surface free energy of the solid surface~~

~~σ_{sl} Interfacial energy between solid surface and liquid surface~~

~~θ Contact angle~~

1 three-phase point
2 liquid phase
3 solid phase
4 gas phase
5 base line
σ_l surface tension of the liquid surface
σ_s surface free energy of the solid surface
σ_{sl} interfacial energy between solid surface and liquid surface
θ contact angle

Figure 1~~.~~ — Illustration of a contact angle in a wetting equilibrium

[SOURCE: ISO 19403-1:2022, 3.1.9~~.~~, modified~~]~~ — "Illustration of a contact angle in a" has been added to the title of Figure 1.]

3.1.2
contact angle hysteresis
θ_{ar}
difference between the advancing angle and the receding angle ~~(θ_{ar})~~

[SOURCE: ISO 19403-6:2017, 3.4]

3.1.3
nano-roughness
~~the~~surface texture ~~at~~in the nanoscale ~~on the surface~~

3.1.4
textile containing nanomaterials and nanostructures
~~(~~TCNNs~~)~~
textile products incorporated by nanotechnologies in the form of coatings, treatments, fibre material composites and nanoscale fibres~~.~~

Note 1 to entry: TCNNs have been subdivided into three major types[1]~~]~~:

— nanofinished textiles;

— nanocomposite textiles.

— nanofibrous textiles.

3.1.5
superhydrophobic surface
a surface made from hydrophobic material for which the *contact angle* (3.1.1) with a water droplet exceeds 150°150° and *contact angle hysteresis* (3.1.2) is less than 10°.10°

3.1.6
superhydrophobic durability
ability of superhydrophobic properties to withstand washing, ironing, abrasion and light exposure.

Note 1 to entry: Durability means "ability to exist for a long time without significant deterioration in quality or value".

3.1.7
wettability
degree of wetting.

Note 1 to entry: *Contact angle* (3.1.1) $\theta = 0^{\circ} = 0°$ indicates a fully wetted surface and $\theta = 180^{\circ} = 180°$ indicates a not wetted surface.

[SOURCE: ISO 19403-1:2022]

, 3.3.2 Symbols]

3.2 Abbreviated terms

AFM	Atomic force microscopy
EDX	Energy dispersive x-Ray analysis
ICP/AES	Inductively coupled plasma atomic emission spectroscopy
ICP/MS	Inductively coupled plasma mass spectrometry
ICP/OES	Inductively coupled plasma optical emission spectroscopy
SAXS	Small angle X-ray spectroscopy
SEM	Scanning electron microscopy
SPM	Scanning probe microscopy
TEM	Transition electron microscopy
XRD	X-ray diffraction
XRF	X-ray fluorescence

Mandatory and abbreviations

AFM Atomic force microscopy

DLS Dynamic light scattering

EDX Energy dispersive x-Ray analysis