Z5200-17

# Cellulose nanomaterials — Blank detail specification

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# *Z5200-17*

# *Cellulose nanomaterials — Blank detail specification*



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# Preface

This is the first edition of CSA Z5200, *Cellulose nanomaterials — Blank detail specification.*

This Standard specifies how to report measurable properties and characteristics of cellulose nanomaterials in commercial applications, for use between vendor and user. Since the quality of an end product depends, among other things, on the properties and characteristics of the nanomaterial, it is necessary to define a material specification for intended applications.

This Standard is the second in a series on cellulose nanomaterials intended to serve as a foundation for the development of both Canadian and international standards to facilitate introduction of cellulose nanomaterials into global markets. This is a companion standard to CSA Z5100.

Cellulose nanomaterials extracted from cellulose sources, such as wood pulps, are biodegradable, sustainable, and retain the non-toxicity of cellulose. These materials have numerous potential applications in areas such as composite materials, optical films and devices, catalysts and pharmaceuticals.

This Standard was reviewed by the Technical Committee on Cellulose Nanomaterials, under the jurisdiction of the Strategic Steering Committee on Health Care Technology and Systems and has been formally approved by the Technical Committee.

**Notes:**

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   *Committee interpretations are processed in accordance with the* CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at* ***standardsactivities.csa.ca****.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *Relevant clause, table, and/or figure number;*
   c) *Wording of the proposed change; and*
   d) *Rationale for the change.*

# *Z5200-17*
# *Cellulose nanomaterials — Blank detail specification*

## 1 Scope

### 1.1
This Standard provides guidance and a blank detail specification for cellulose nanomaterials (CNMs), for determining and listing essential properties and characteristics with reference to corresponding test methods in CSA Z5100 and other standards. CNMs in this Standard include cellulose nanocrystals (CNCs), cellulose nanofibrils (CNFs), and cellulose microfibrils (CMFs).

### 1.2
Numeric values for properties and characteristics in the blank detail specification are intentionally left blank and should be determined by agreement between the customer and the cellulose nanomaterial supplier. Properties and characteristics deemed by the customer and supplier as not relevant to a specific cellulose nanomaterial or application may be classified as "not applicable" or "not specified".

### 1.3
This Standard does not include detail specifications for cellulose nanomaterial-based nano-enhanced or nano-enabled products.

### 1.4
In this Standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; and "may" is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

### 1.5
The values given in SI units are the units of record for the purposes of this Standard. The values given in parentheses are for information and comparison only.

## 2 Reference publications
This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

**CSA Group**
Z5100-17
*Cellulose nanomaterials — Test methods for characterization*

**ISO (International Organization for Standardization)**
2470-1:2009
*Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

DTS 20477 (under development)
*Nanotechnologies — Standard terms and their definition for cellulose nanomaterial*

TS 80004-1:2015
*Nanotechnologies — Vocabulary — Part 1: Core terms*

TS 80004-2:2015
*Nanotechnologies — Vocabulary — Part 2: Nano-objects*

# 3 Definitions

The following definitions shall apply in this Standard:

**Agglomerate** — collection of weakly or medium strongly bound particles or aggregates or mixtures of the two where the resulting external surface area is similar to the sum of the surface areas of the individual components.

**Notes:**

1) *The forces holding an agglomerate together are weak forces, for example van der Waals forces, or simple physical entanglement.*
2) *Agglomerates are also termed "secondary particles" and the original source particles are termed "primary particles".*

**Source:** *ISO TS 80004-2, 3.4*

**Amorphous** — solid structure of ions, molecules, or atoms that are oriented randomly lacking any order.
**Source:** *ISO DTS 20477*

**Cellulose** — linear polymer chains of β (1→4) linked D-glucopyranose units.
**Source:** *ISO DTS 20477*

**Cellulose nanocrystal (CNC)** — nanocrystal predominantly composed of cellulose with at least one elementary fibril containing predominantly crystalline and paracrystalline regions, with aspect ratio of usually less than 5 but usually greater than 5, not exhibiting longitudinal splits, inter-particle entanglement, or network-like structures.

**Notes:**

1) *The dimensions are typically 3-50 nm in cross-section and 100 nm to several µm in length depending on the source of the cellulose nanocrystal.*
2) *The aspect ratio refers to the ratio of the longest to the shortest dimension.*
3) *Historically cellulose nanocrystals have been called "nanocrystalline cellulose (NCC)", whiskers such as "cellulose nanowhiskers (CNW)", and microfibrils such as "cellulose microfibrils"; they have also been called "spheres", "needles", or "nanowires" based on their shape, dimensions, and morphology; other names have included "cellulose micelles", "cellulose crystallites", and "cellulose microcrystals".*

**Source:** *ISO DTS 20477*

**Cellulose nanofibril (CNF)** — cellulose nanofibre composed of at least one elementary fibril, containing crystalline, paracrystalline, and amorphous regions, with aspect ratio usually greater than 10, which may contain longitudinal splits, entanglement between particles, or network-like structures.

**Notes:**

1) *The dimensions are typically 3-100 nm in cross-section and typically up to 100 µm in length.*
2) *The aspect ratio refers to the ratio of the longest to the shortest dimensions.*
3) *The terms "nanofibrillated cellulose (NFC)", "nanofibrillar cellulose (NFC)", "microfibrillated cellulose (MFC)", "microfibrillar cellulose (MFC)", "cellulose microfibril (CMF)", and "cellulose nanofiber (CNF)" have been used to describe cellulose nanofibrils produced by mechanical treatment of plant materials, often combined with chemical or enzymatic pre-treatment steps.*
4) *Cellulose nanofibrils produced from plant sources by mechanical processes usually contain hemicellulose and in some cases lignin.*
5) *Some cellulose nanofibrils might have functional groups on their surface as a result of the manufacturing process.*
6) *The term "cellulose nanoribbon" has been used to describe cellulose nanofibrils from bacterial sources.*

**Source:** *ISO DTS 20477*

**Cellulose nanomaterial (CNM)** — material composed predominantly of cellulose with any external dimension in the nanoscale, composed predominantly of cellulose, or a material having internal structure or surface structure in the nanoscale, with the internal structure or surface structure composed predominantly of cellulose.

**Notes:**

1) *The term "nanocellulose (NC)" is synonymous with "cellulose nanomaterial (CNM)" and "cellulosic nanomaterial (CNM)".*
2) *Some cellulose nanomaterials can be composed of chemically modified cellulose.*
3) *This generic term is inclusive of cellulose nano-object and cellulose nanostructured material.*

**Source:** *ISO DTS 20477*

**Crystalline** — solid structure of ions, molecules, or atoms that are in an ordered, three-dimensional arrangement.

**Source:** *ISO DTS 20477*

**Hemicellulose** — one of any non-cellulose polysaccharides in organisms, typically containing monomers such as, but not limited to, xylose, glucose, mannose, galactose, arabinose, and glucuronic acid, which can be branched polymers, and which are usually extractable with dilute alkaline solutions.

**Source:** *ISO DTS 20477*

**Lignin** — macromolecule consisting of various aromatic alcohols, the chief noncarbohydrate constituent of wood.

**Nano-enabled** — exhibiting function or performance only possible with nanotechnology.

**Source:** *ISO TS 80004-1, 2.15*

**Nano-enhanced** — exhibiting function or performance intensified or improved by nanotechnology.

**Source:** *ISO TS 80004-1, 2.16*

**Nanomaterial** — material with any external dimension in the nanoscale or having internal structure or surface structure in the nanoscale.

**Notes:**

1) *This generic term "nanomaterial" includes nano-object and nanostructured material.*

  

2) *See also "engineered nanomaterial", "manufactured nanomaterial", and "incidental nanomaterial" in ISO TS 80004-1.*

**Source:** *ISO TS 80004-1, 2.4*

**Nano-object** — discrete piece of material with one, two or three external dimensions in the nanoscale.
**Note:** *The second and third external dimensions are orthogonal to the first dimension and to each other.*
**Source:** *ISO TS 80004-1, 2.5*

**Nanoscale** — length range approximately from 1 nm to 100 nm.
**Note:** *Properties that are not extrapolations from larger sizes are predominantly exhibited in this length range.*
**Source:** *ISO TS 80004-1, 2.1*

**Nanostructure** — composition of inter-related constituent parts in which one or more of those parts is a nanoscale region.
**Note:** *A region is defined by a boundary representing a discontinuity in properties.*
**Source:** *ISO TS 80004-1, 2.6*

**Nanostructured material** — material having internal nanostructure or surface nanostructure.
**Note:** *This definition does not exclude the possibility for a nano-object to have internal structure or surface structure. If external dimension(s) are in the nanoscale, the term "nano-object" is recommended.*
**Source:** *ISO TS 80004-1, 2.7*

**Paracrystalline** — structure in the intermediate state between crystalline and amorphous, having short and medium range ordered lattice structure but lacking long range order in at least one direction.
**Source:** *ISO DTS 20477*

# 4 General

## 4.1 Blank detail specification

A blank detail specification provides a template that lists material properties and characteristics potentially critical to the quality of the end product. The specification includes information regarding the preferred measurement method for each of the specified material properties and characteristics. The blank detail specification does not specify numerical values for the material properties and characteristics.

This Standard includes blank detail specification for cellulose nanomaterials, including non-mandatory guidance as to significance of listed properties and characteristics. See Tables 1, 2, and 3.

## 4.2 Detail specification

Applicable material properties and characteristics in a blank detail specification can be selected and developed into a detail specification. A detail specification populates the blank detail for specific properties and characteristics applicable for a material's use in a specific commercial product. It specifies numerical values for the material properties and characteristics critical to quality of the end product. See Clause 5.2 for further guidance.

  

# 5 Cellulose nanomaterial specification

## 5.1 Basic specification requirements

### 5.1.1 General

This Standard recommends appropriate measurement methods for each material property and characteristic. In the absence of adequate standardized methods for commercial use, the following minimum documentation requirements shall be met:

a) description of the sample preparation;
b) measurement procedure;
c) sample size and statistical significance; and
d) description of how the original measurement data are converted to the specified material properties and characteristics, e.g., data analysis methods.

The choice of measurement methods and procedures shall be made with respect to the application of the material taking into account the cost, robustness, reliability, and efficiency of the methods and procedures. Such methods should be agreed upon between vendor and user, taking into consideration whether standards that address these methods are available.

### 5.1.2 Recommended specification format

The properties and characteristics provided should be listed in the format of the following tables: Table 1 for purity, Table 2 for morphology, and Table 3 for chemical and physical properties.

General information about a cellulose nanomaterial should be provided by the manufacturer or product specifier, e.g., date of manufacture, batch or ID number, method of manufacture, etc.

### 5.1.3 Purity properties and characteristics

The requirements for purity of cellulose nanomaterials shall be reported in accordance with Table 1.

**Note:** *In Table 1, the rightmost column, Significance, is optional and may be omitted.*

  