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Z5100-14

Cellulosic nanomaterials — Test methods for characterization

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Preface

This is the first edition of CSA Z5100, *Cellulosic nanomaterials — Test methods for characterization*.

This Standard provides a consolidated set of test methods to characterize base cellulosic nanomaterials. This Standard is the first in a series on cellulosic nanomaterials intended to serve as a foundation for the development of both Canadian and international standards to facilitate introduction of cellulosic nanomaterials into global markets.

Cellulosic 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 Cellulosic Nanomaterials, under the jurisdiction of the Strategic Steering Committee on Health Care Technology, 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 the 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.*

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b) *relevant clause, table, and/or figure number;*

c) *wording of the proposed change; and*

d) *rationale for the change.*

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Cellulosic nanomaterials — Test methods for characterization

0 Introduction

0.1

Cellulosic nanomaterials (CNMs) are a family of nanomaterials (nano-objects and nanostructured materials) derived from nanostructures present in natural cellulose. These materials are a Canadian priority for commercial development.

0.2

The family of cellulosic nanomaterials can be subdivided, but is not limited to

a) Nano-objects:
   i) Cellulose nanofibril (CNF), which in nature is created as a few hundred cellulose chains developed together as a single primary fibril, in which there are highly-ordered crystalline regions linked by amorphous regions. Typically the crystalline regions have cross-section in the range of 5–15 nm and lengths 100 nm and up depending on the cellulose sources involved. These primary fibrils can be called cellulose nanofibrils.
   ii) Cellulose nanocrystal (CNC), which can be derived from the crystalline regions of the cellulose nanofibril, and is a singular member of the family of CNMs with morphology that reflects the source elemental fibril. CNC is often termed nanocrystalline cellulose (NCC).
b) Nanostructured materials:
   i) Cellulose microfibril (CMF) is a nanostructured fibre. In nature nanofibrils tend to be brought together into nanostructured bundles that have cross-sections that can extend beyond 100 nm. These nanostructured bundles are generally called cellulose microfibrils.
   ii) Cellulose microcrystal (CMC) is a cellulosic microfibrillar derivative with high crystalline content. CMC is often termed microcrystalline cellulose (MCC).

0.3

The terminology framework that displays this family of materials is under development by the Technical Association of the Pulp and Paper Industry (TAPPI) using the formal taxonomic terminology framework structure developed by ISO TC229, *Nanotechnologies*, and will be the basis of the terminology used in this Standard.

Note: *TAPPI terminology may be subject to future examination by ISO TC229 that may lead to an international ISO terminology standard for cellulosic nanomaterials.*

0.4

This Standard does not provide criteria for acceptability of the properties and characteristics determined from measurements using the methods herein.

0.5

A major challenge for cellulosic nanomaterials is the methods and protocols for characterization and measurement both for the base materials and for nano-enhanced or nano-enabled products that are produced from the base materials. See Table 1.

Table 1
Value-chain for characterization and measurement of cellulosic nanomaterials
(See Clause 0.5.)

Base cellulosic nanomaterials		**Cellulosic nanomaterial enhanced or enabled products**		
Cellulosic nanomaterial (CNM)	**Characterization**	**Modification and compatibilization**	**Dispersion** (in aqueous solution or a non-water medium)	**Inclusion in nano-enhanced or nano-enabled products**
Cellulose nanofibrils (CNF) Cellulose nanocrystals (CNC)	Purity; Size; Chemical properties; Physical properties; Dispersibility in water	Surface modification; Surface compatibilization	Processes; Conditions	Degree of enhancement of target properties per level of cellulosic nanomaterial addition
Environment, health & safety (EHS) **Commercial product life-cycle** **Commercial product requirements** **Sustainability**				

Note: *This Standard covers characterization of base cellulosic nanomaterials. See Annexes A to G for informative discussion of topics for consideration in future editions of this Standard.*

1 Scope

1.1

This Standard describes test methods for characterization of base cellulosic nanomaterials, specifically cellulose nanofibrils (CNFs) and cellulose nanocrystals (CNCs).

1.2

This Standard does not cover the characterization of nanostructured cellulosic materials, including cellulose microfibrils (CMF) and cellulose microcrystals (CMC).

1.3

This Standard does not cover cellulosic nanomaterial enhanced or enabled products.

Note: *This Standard may be expanded in future editions as cellulosic nanomaterial-enhanced and enabled products move towards commercialization. See Annex C.*

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.