GreenNano Technologies Inc.

Clean Tech Advanced Materials for Today's World

Technical Data Sheet

Nanocellulose Suspension

Description:

1-5% nanocellulose suspension in distilled water made from soft wood pulp

Product Features:

Highly viscose and absorbent; high fibre aspect ratio; translucent and well dispersed

Suggested Applications:

- Rheological additive for paints and coatings
- Reinforcement filler for thermalsets and thermal plastics
- Making high strength nanofilms for gas barrier products or transparent nanocomposites
- Fillers for paper and paperboard products
- Fracturing fluid for oil recovery or drilling mud
- Hygiene and absorbent products

Typical Physical and Chemical Properties:

Appearance: Translucent gel
Density: 1.01g/cm3 @ 0°C (32°F)
Cellulose Content: 83% (based on dry weight)
Fibre Diameter: 10-25nm (majority)
Degree of Polymerization: 1200
Crystallinity: 71%
Degradation Temperature: 310°C (on-set); 340°C (maximum weight loss)
Film Strength: ≥ 200MPa (film density: 1.3g/cm3)
Film Modulus: ≥ 13GPa (film density: 1.3g/cm3)
Film Transparency: 20%@600nm
(film density: 1.3g/cm3, film thickness: 40μm)

Storage:

Store in a cool, dry place in sealed containers.

Precaution:

Refer to the material safety data sheet (MSDS) prior to the use of this product.

Disclaimer:

Phone: 905 264 6700
Fax: 905 264 1577

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Toronto, ON
Canada, M9B 0A1

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Material Safety Data Sheet

Nanocellulose Fibril Suspension

Section 1: Chemical Product and Company Identification

Product Name: Nanocellulose Suspension
Synonyms: Cellulose
CAS#: 9004-34-6
Chemical Name: Cellulose
Chemical Formula: $(C_6H_{10}O_5)_n$
Molecular Weight: N/A
Manufacturer: Centre for Biocomposites and Biomaterials Processing
Faculty of Forestry, University of Toronto
33 Willcocks Street
Toronto, Ontario, Canada
M5S 3B3

Section 2: Composition and Information on Ingredients

Ingredients	Weight %	CAS#
Cellulose	1-3	9004-34-6
Distilled Water	97-99	7789-20-0

Toxicological Data on Ingredients: N/A

3: Hazards Identification

Potential Acute Health Effects: Slightly hazardous in case of eye contact (irritant), of ingestion, of inhalation. Non-irritant for skin.
Potential Chronic Health Effects: CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. Repeated or prolonged exposure is not known to aggravate medical condition.

Section 4: First Aid Measures

Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
Skin Contact: Wash with soap and water. Get medical attention if irritation develops.
Inhalation: Inhalation unlikely. However, If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.
Ingestion: Ingestion unlikely. However, if ingested, do not induce vomiting unless directed to do so by medical personnel. If large amounts were swallowed, give water to drink. Get medical attention if symptoms appear.

Section 5: Fire and Explosion Data

Flammability of the Product: May have localized burn when in contact with high temperature.
Auto-Ignition Temperature: Not available.
Flash Points: Not available.
Flammable Limits: Not available.
Products of Combustion: Not available.

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Fire Hazards in Presence of Various Substances: When dried, cellulose is slightly flammable to flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks.
Explosion Hazards in Presence of Various Substances: Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions: SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.
Special Remarks on Fire Hazards: Damp cellulose can be a significant fire hazard since it may undergo spontaneous combustion. Fire and explosions may occur from reactions involving pentafluoride, acetic acid and cellulose. Contact between cellulose and sodium nitrite at elevated temperatures results in vigorous burning from decomposition reaction.
Special Remarks on Explosion Hazards: Fire and explosions may occur from reactions involving pentafluoride, acetic acid and cellulose. Contact between dried cellulose and fluorine may result in violent explosion. Excess dust generation may create explosion hazard.

Section 6: Accidental Release Measures

Leak/Spill: Wear slip-resistant footwear. Use appropriate tools to put the leak/spill in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface. If the leak/spill has dried up, remove all sources of ignition, ventilate the area and clean with damp cloth. Dispose according to local and regional authority requirements.

Section 7: Handling and Storage

Handling: Avoid contact with eyes and skin. Do not ingest.
Storage: Normal temperatures for short term storage and transportation. Refrigerated storage recommended for long-term storage to avoid spoilage.

Section 8: Exposure Controls/Personal Protection

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection: Safety glasses. Lab coat. Gloves (impervious).
3
Personal Protection in Case of a Large Spill: Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product, especially the product is contaminated with other chemicals or substances.
Exposure Limits: TWA: 10 (mg/m3) from ACGIH (TLV) [United States] Inhalation Total. TWA: 10 (mg/m3) from British Columbia Occupational Exposure Limit [Canada] Inhalation Total. TWA: 3 from British Columbia Occupational Exposure Limit [Canada] Inhalation Respirable. TWA: 5 (mg/m3) from OSHA (PEL) [United States] Inhalation Respirable. TWA: 15 (mg/m3) from OSHA (PEL)[United States] Inhalation Total. TWA: 10 STEL: 20 (mg/m3) [United Kingdom (UK)] Inhalation Total. TWA: 4 (mg/m3) [United Kingdom (UK)] Inhalation Respirable. Consult local authorities for acceptable exposure limits.

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Section 9: Physical and Chemical Properties

Physical state and appearance: Translucent white gel.
Odor: Odorless.
Taste: Tasteless.
Molecular Weight: N/A
Color: White.
pH: Neutral.
Boiling Point: 100°C.
Melting Point: Not applicable.
Specific Gravity: 1.01 @ 0°C (32°F) (Water = 1)
Dispersion Properties: Not available.
Solubility: Insoluble in cold water, hot water. Insoluble in organic solvents. It will swell in dilute alkaline solutions such as sodium hydroxide and will dissolve in caustic alkali with carbon disulfide. It is soluble in ammoniacal copper hydroxide solution (Schweitzer's reagent) and concentrated zinc chloride solution.

Section 10: Stability and Reactivity

Stability: Stable under ordinary conditions of use and storage.
Instability Temperature: Around 300°C when water has evaporated.
Conditions of Instability: Excess heat, incompatible materials.
Incompatibility with various substances: Not available.
Corrosivity: Non-corrosive in presence of glass or plastic.
Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.
Toxicity to Animals:
4 WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): >5000 mg/kg [Rat]. Acute dermal toxicity (LD50): >2000 mg/kg [Rabbit]. Acute toxicity of the dust (LC50): 5800mg/m 4 hours [Rat].
Chronic Effects on Humans: Not available.
Other Toxic Effects on Humans: Slightly hazardous in case of ingestion, of inhalation. Non-irritant for skin.
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: Not available.
Special Remarks on other Toxic Effects on Humans: Acute Potential Health Effects: Skin: It is not known to cause skin irritation. Ingestion: Ingestion of large amounts of cellulose may cause digestive tract irritation. Eyes: Dust may cause mechanical irritation. To the best of our knowledge, there are no known cases of adverse effects or disease in humans from exposure to cellulose. Health effects from cotton fibers, wood, flax, jute, and hemp are usually due to other substances. Purified cellulose is known to be essentially inert. Pure cellulose dust is not known to be irritating or toxic. Chronic Potential Health Effects: Chronic inhalation from cellulose-containing fibers can cause byssinosis. Allergies can develop to cellulose-containing fibers, but these are probably due to plant proteins or other components. In chronic feeding studies with purified cellulose in mice and rats, no significant adverse reactions were seen.

Section 12: Ecological Considerations

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.
Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal: Non-contaminated, properly inhibited product is not a potential hazardous waste. However, introduction of other substances may make the mixture hazardous. It is the responsibility of the generator to determine at the time of disposal whether the product meets the criteria of a hazardous waste. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transportation Information

Not Regulated as hazardous material by the Canadian (TDG) or USA (DOT) transportation regulations

Section 15: Regulatory Information

Federal and State Regulations: Illinois toxic substances disclosure to employee act: Cellulose Rhode Island RTK hazardous substances: Cellulose Pennsylvania RTK: Cellulose Minnesota: Cellulose Massachusetts RTK: Cellulose TSCA 8(b) inventory: Cellulose
Other Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.
Other Classifications:
WHMIS (Canada): Not controlled under WHMIS (Canada).
DSCL (EEC): This product is not classified according to the EU regulations. Not applicable.
Protective Equipment: Gloves (impervious). Lab coat. Not applicable. Safety glasses.

Section 16: Other Information

References: ScienceLab. *(2010).MSDS for cellulose*.
http://www.sciencelab.com/msds.php?msdsId=9927490.
J.T.Baker. (2008). *MSDS for Microcrystallined Cellulose.*
http://www.jtbaker.com/msds/englishhtml/c1683.htm.
Other Special Considerations: Not available.
Created: 02/23/2011; updated: 17 April, 2015
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Multipurpose Nanocellulose Film Properties

Appearance	Transparent sheet in desired dimensions
Cellulose Content	According to custom specifications
Strength (cured with acrylic)	150 MPa (Fibre loading: 43%)
Modulus (cured with acrylic)	6.1 GPa (Fibre loading: 43%)
Transparency (cured with acrylic)	76%@600nm (Fibre loading: 66%)
Degradation Temperature (cured with acrylic)	299^{o}C (on-set); 435^{o}C (maximum weight loss); (Fibre loading: 30%)
Coefficient of Thermal Expansion (cured with acrylic)	9.2ppm/K (Fibre loading: 30% , original matrix has CTE of 36ppm/K)
Thermal Aging (70^{o}C for 7 days)	CIE 1976 (L*, a*, b*) color space test showed less than 0.06% in the a* (redness) plane and 0.57% in the b* (yellowness) plane No reduction in light transmittance and strength
Abrasion Resistance (ASTM D1044)	Merely 2% reduction in light transmittance

NanoCellulose Film – Excellent Barrier Properties

Film	OTR g/m^2/day	WVTR g/m^2/day
Nanocellulose Film (GNT Product)	0.0003	0.0004
PET/SiO_x*	0.006 – 0.06	0.0024 – 0.06
PET/AI-foil/PE*	0	0

PET=polyethylene terephthalate; PE = polyethylene low density; SiO_x = silicon oxide; Al-foil = aluminum foil; *Conventional Film (Altered table from: Brody et al., Journal of Food Science, Vol. 73, Number 8, 2008).

Effect of GNT Chemical as Wet Strength Additive

SL No*	Kitchen Towel (g/m^2)	GNT Chemical Dosing (kg/MT)	Conventional Resin dosing (kg/MT)	Wet Tensile^{+} Value (N/M)
1	35	NIL	20	310
2	35	13	NIL	255
3	35	8.5	11	325

* Average of two industrial runs.

$^{+}$ GNT chemical alone cannot maintain the required wet strength. However, together with resin it can achieve that value.

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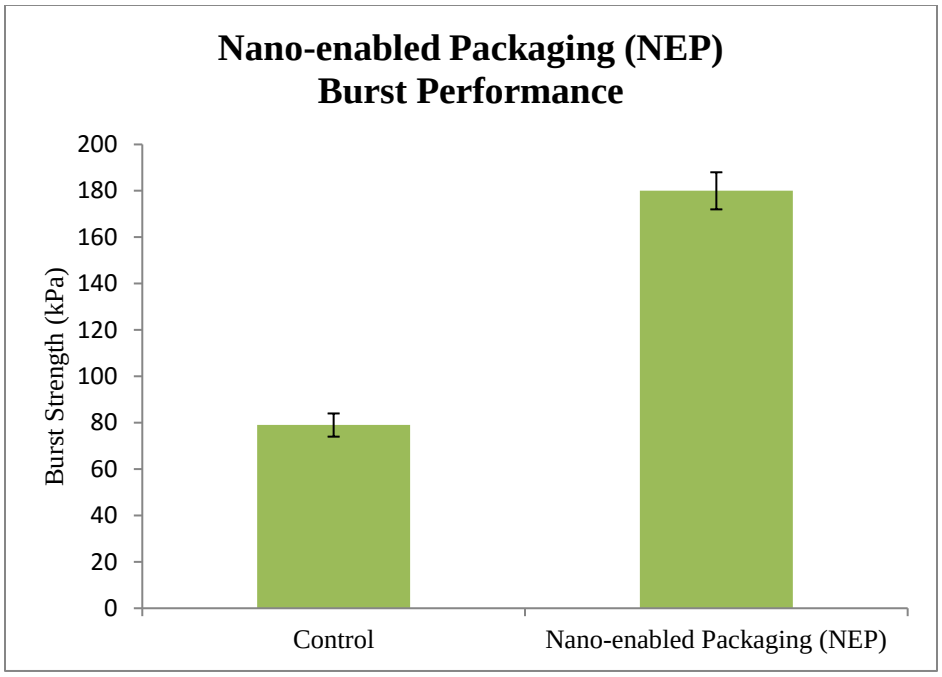
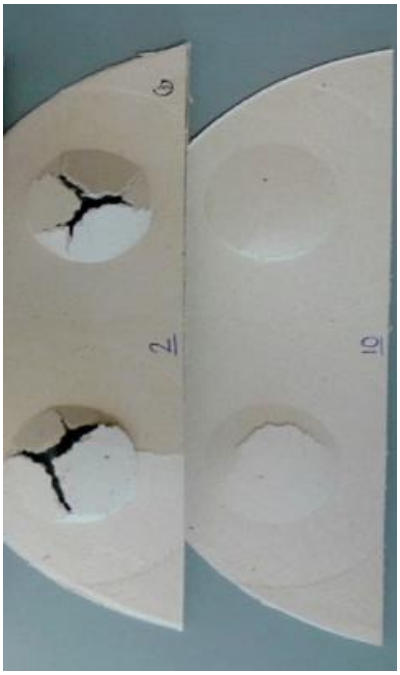
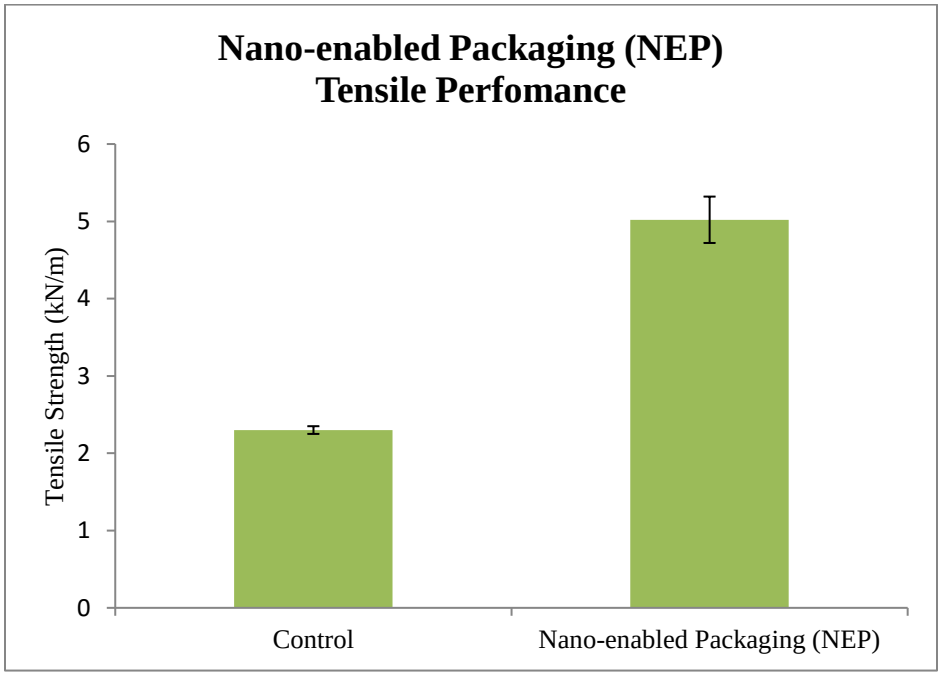
Nano-enabled Packaging performance improvement

Burst Strength: + 100 - 125%
Tensile Strength: + 100 - 110%
Tear Strength: + 190 - 210%







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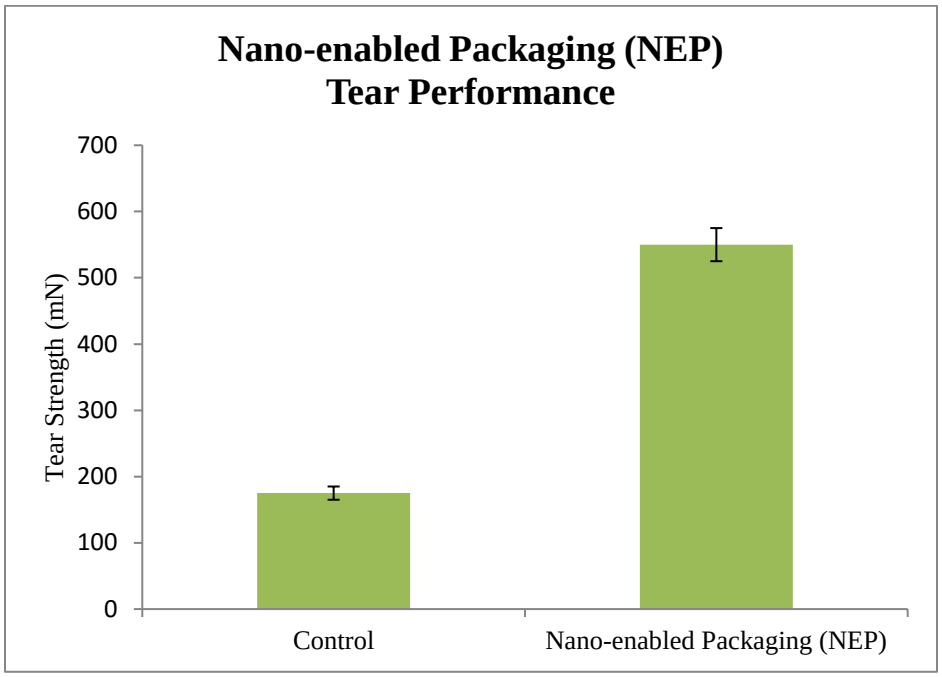

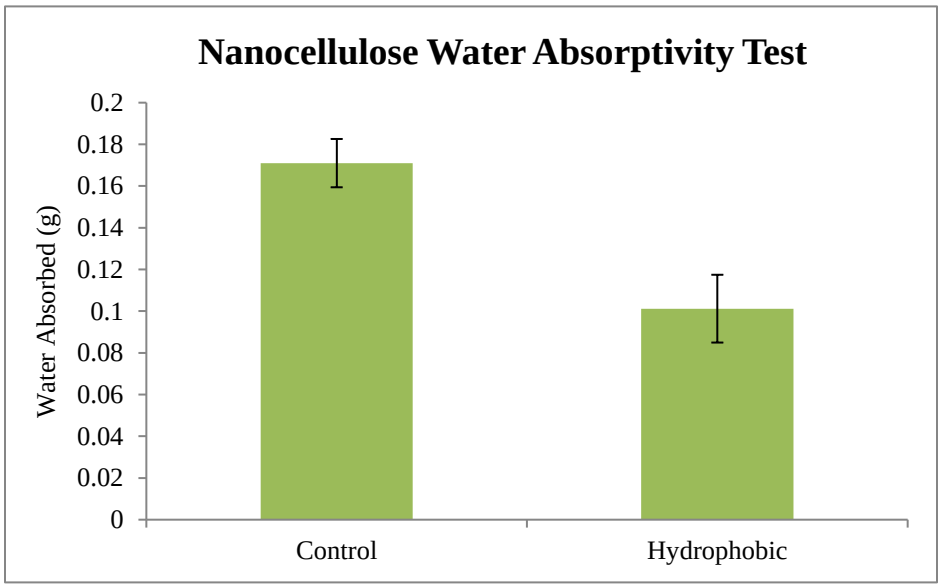

40% improvement in hydrophobicity.

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1611-225 The East Mall
Toronto, ON
Canada, M9B 0A1