



# Next Generation Nano-structured Material Derived from Ocean Waste

Summary Of Applications



# Executive Summary

Neptune Nanotechnologies Inc. is an early-stage tech Startup active in the bio-nano material space. Specifically, **we are commercializing a technology that can convert organic fishing waste into ultra-high-value nanocrystals (chitin nanocrystals). These nanocrystals are stronger than steel, lighter than plastic, entirely bio-based, non-toxic, biocompatible, and biodegradable. They function as physical additives where a small quantity of nanocrystals added can drastically increase the strength, stiffness, crack resistance, and barrier properties of the underlying material.** We own proprietary IP, have a strong team led by a Forbes 30 under 30 founder and we closely collaborate with leading research institutions such as the University of Toronto and York University.

Neptune Nanotechnologies can assist you in three primary areas:

1. **Existing paper products have the following pain points:** Low strength and low rigidity, primarily only suitable for disposable products, unable to meet the performance requirements of durable goods, prone to degradation when exposed to water, and limited recycling capabilities (current recycling processes cause irreversible damage to the paper fibers). Chitin nanocrystals are a novel material able to tackle all existing paper product pains. By leveraging a small portion of chitin nanocrystals as an additive, you can simultaneously improve strength and stiffness, reduce degradation to water, increase sustainability and recyclability, and increase packaging rigidity – eliminating the idea of soggy paper products.
2. **Existing film packaging have the following pain points:** Low strength, toxicity, manufacturing of multiple layers, high permeability, and poor recyclability. By incorporating a small percentage of nanocrystals in your packaging you can eliminate having to manufacture more layers of packaging due to increased strength and permeability up to 400%. With fewer layers manufactured, you not only reduce energy and water consumption in manufacturing but also increase recyclability.
3. **Existing epoxies have the following pain points:** Strength, toughness, cost, weight, and sustainability are five of the most important properties of epoxies. However, there are no solutions on the market today that can satisfy all these conditions. Incumbent chemical additives used in epoxy industries today simply fail in terms of strength and sustainability. In contrast, upcoming legacy nanotechnologies are prohibitively expensive and still carry significant sustainability and toxicity risks. Leveraging chitin nanocrystals as an additive in epoxies can directly replaces traditional toxic chemical additives that grant both high strength and toughness, and chitin nanocrystals are significantly less expensive than legacy nanomaterials – offering superior performance, lighter weight, cost reductions, and environmental value.

# Market Trends: Materials Industry



PERFORMANCE



SAFETY



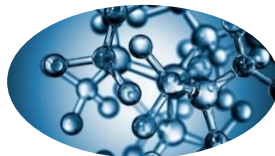
NON-TOXIC



SUSTAINABILITY

Better performance & better sustainability are both mega trends of the material sector

## Traditional materials



High performance but environmentally damaging

## Green materials



Environmentally friendly but poor performance

# Our Experienced Team

## EXECUTIVE TEAM



**Aaron Guan**  
Founder and CEO

- Serial entrepreneur
- Forbes 30 Under 30
- Nanotechnology inventor with 9 patents



**Dr. Sara Koul**  
Sr. Scientist

- PhD in Applied Chemistry
- Former Sr. Scientist at Dow Chemicals
- Over a decade of experience



**Winfield Ding**  
CFO

- CPA, CA
- CFO of Principle Capital Partners
- Former CFO of TSXV public company



**Spencer Pieczonka**  
Business Development Manager

- Serial entrepreneur
- Successful exit: 2021



**Lutfu Okman**  
Advisory Board

- Seasoned Business Executive
- 25+ year of B2B & B2C Experience

## PARTNERS & ADVISORS



**Dr. Hani Naguib**  
R&D Partner

- Professor at University of Toronto



**Dr. Sunny Leung**  
R&D Partner

- Professor at York University



**Matthew Diskin**  
Legal Council

- Partner at Dentons Law



**Dr. Alex Chen**  
Advisor

- Founder & CEO of ALCLE consulting



**Constance Wang**  
Advisor

- Communication and PR strategist



**Matthew Powell**  
IP Advisor

- Sr. Patent Agent



**Dr. Boxin Zhao**  
R&D Partner

- Professor at Waterloo University

# The Solution: Chitin Nanocrystal (CNW)

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**1** 10,000x Smaller Than Hair

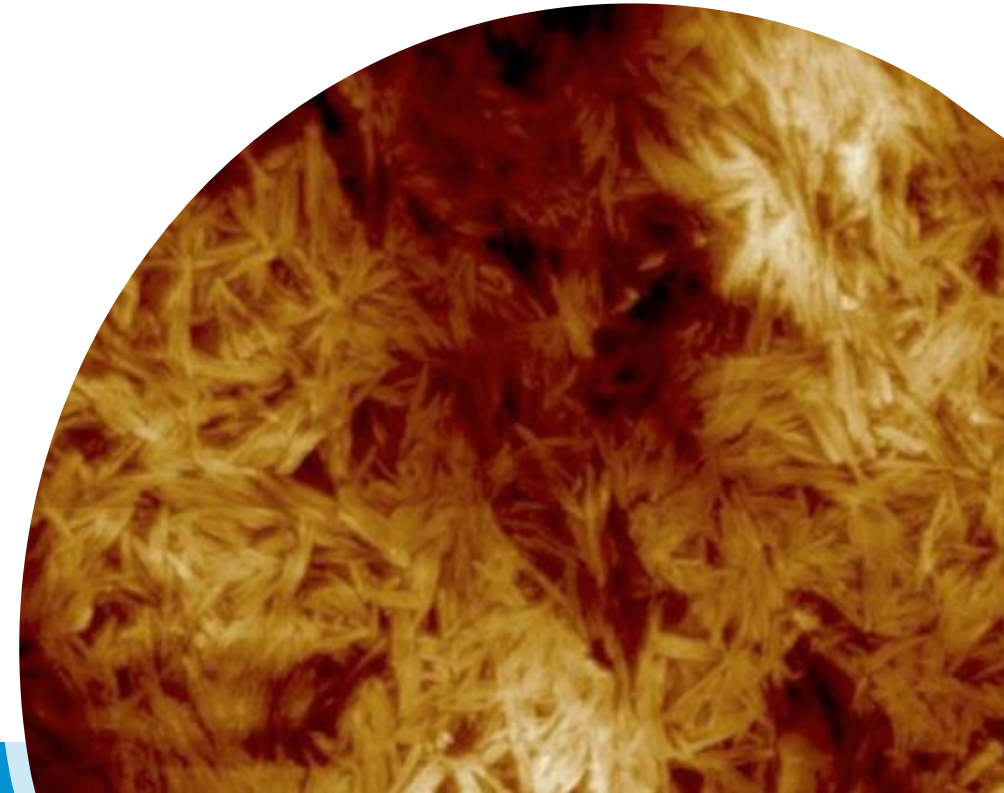
**4** Non-Toxic

**2** Stronger Than Steel

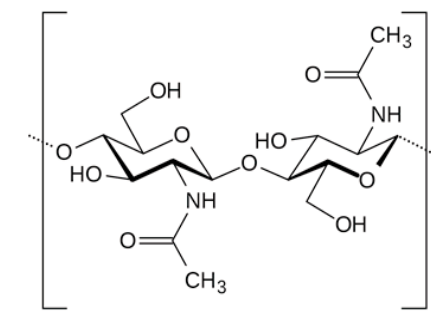
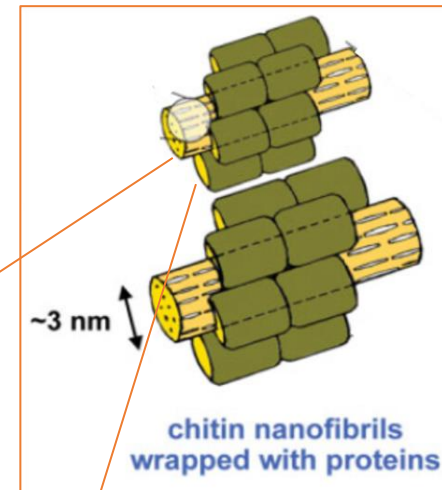
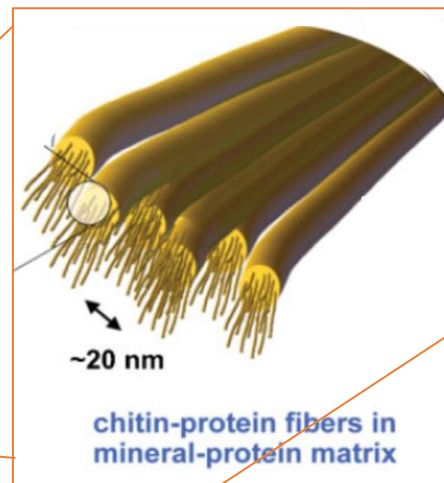
**5** Fully Biodegradable

**3** Lighter Than Plastic

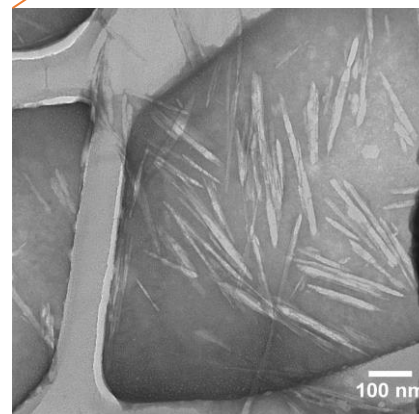
**6** Fully Biocompatible



# The Solution: Chitin Nanocrystal (CNW)

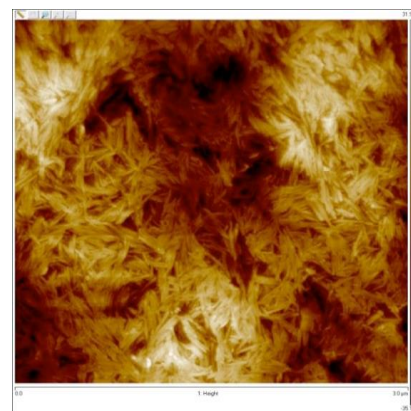
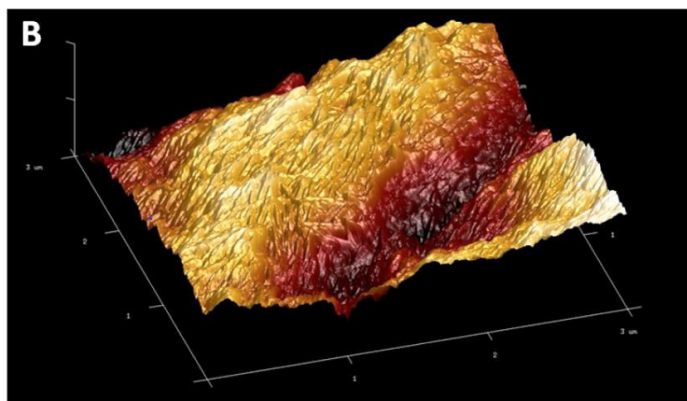
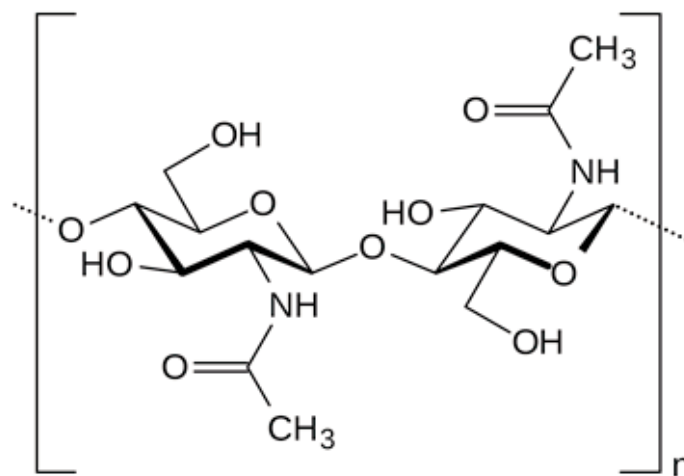
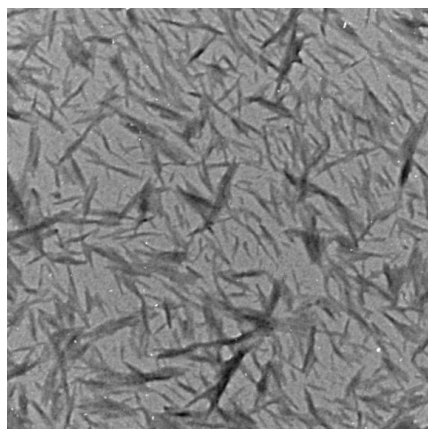


High aspect ratio  
Rod like nanoparticles  
Sustainable and Biodegradable



|                         |             |
|-------------------------|-------------|
| Length (nm)             | 200 - 500   |
| Width (nm)              | ~20         |
| L : D                   | (10-25) : 1 |
| SSA (m <sup>2</sup> /g) | ~300        |

# Our Solution: Chitin Nanocrystal (CNW)



## CNW nanostructure

|                         |             |
|-------------------------|-------------|
| Length (nm)             | 200 - 500   |
| Width (nm)              | ~20         |
| L : D                   | (10-25) : 1 |
| SSA (m <sup>2</sup> /g) | ~300        |

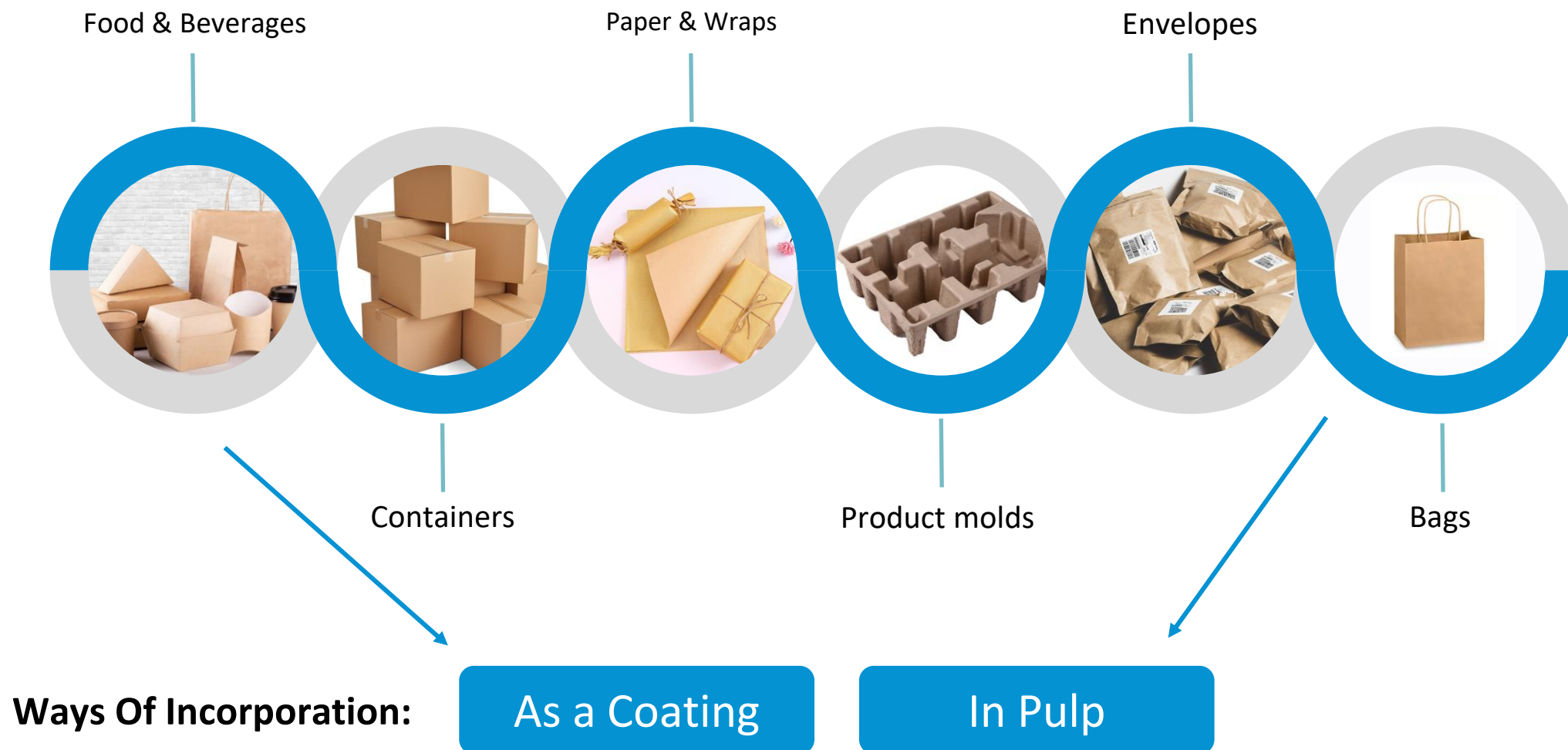
# Pulp & Paper applications



- ✓ Provides 10X water and oil exposure
- ✓ 3X strength and rigidity
- ✓ Low permeability for durable goods
- ✓ 99.99% antibacterial efficacy
- ✓ Significant increase in flame retardancy
- ✓ Enhances recyclability and biodegradability

**Improved Barrier Properties, Mechanical Strength, And Flame Retardancy**

# Chitin Nanocrystal General Applications

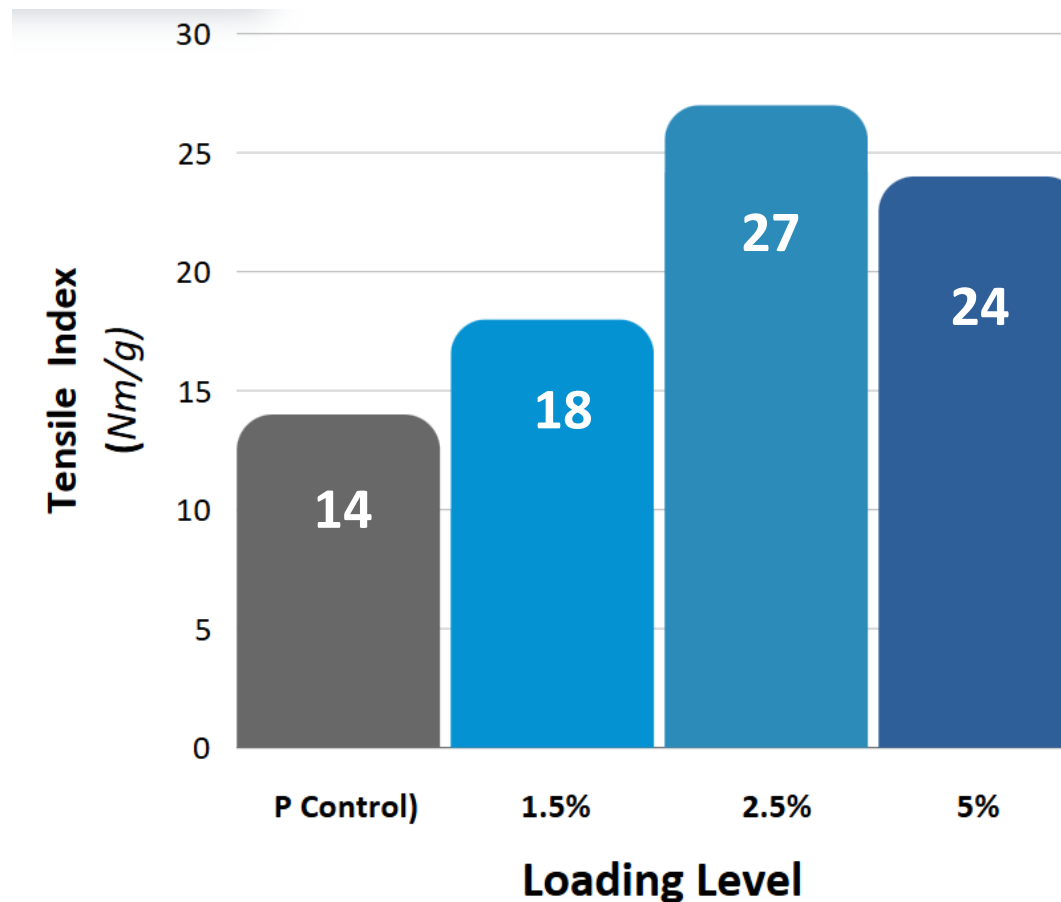


# Optimization of composition

In Pulp  
(unbleached)

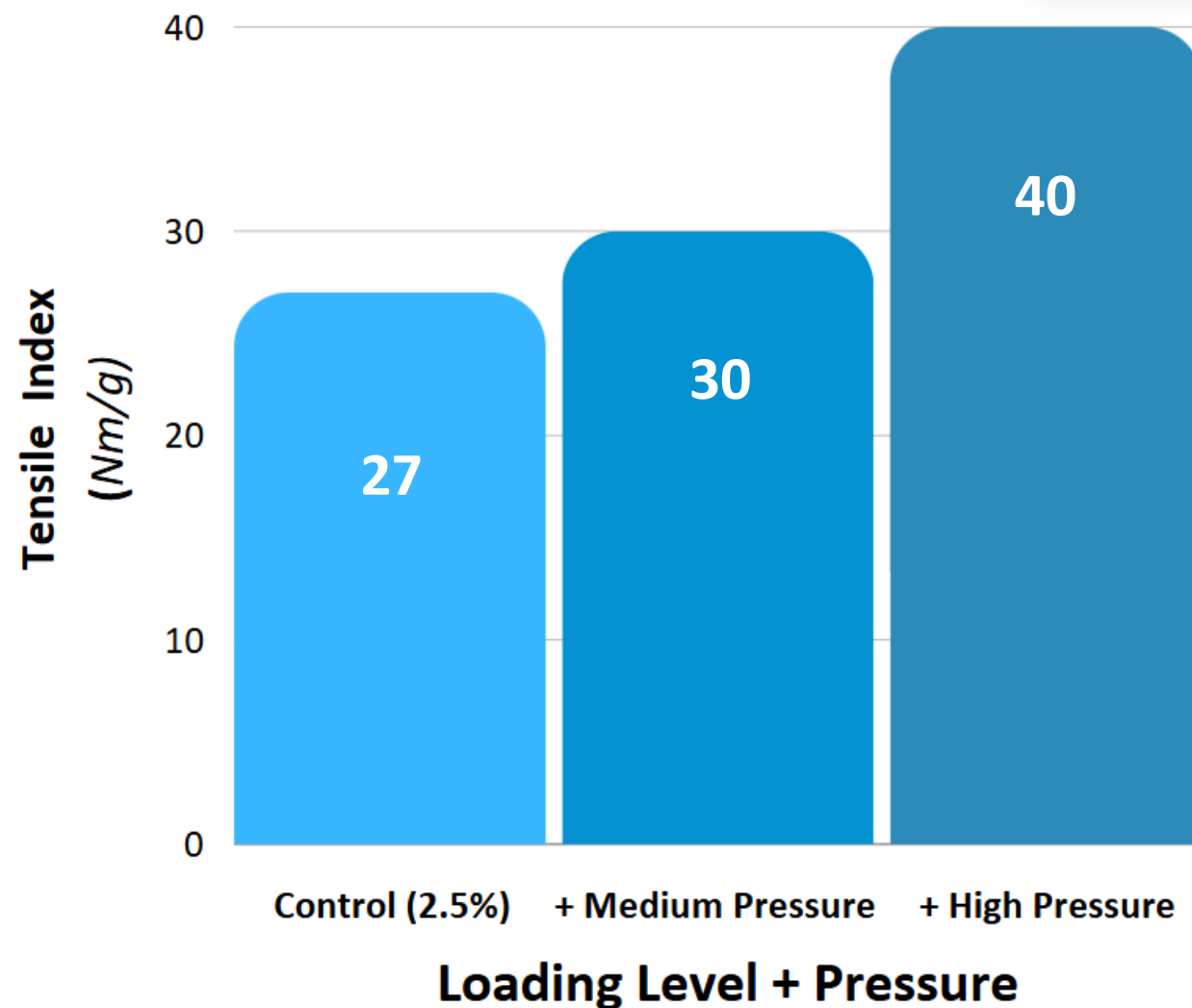
$$\text{Tensile index} = \frac{\text{Max strength}}{\text{width} \times \text{grammage}}$$

Nanochitin concentration  
1.5%, 2.5%, and 5% wt



# Optimization of process conditions using pressure (lbf)

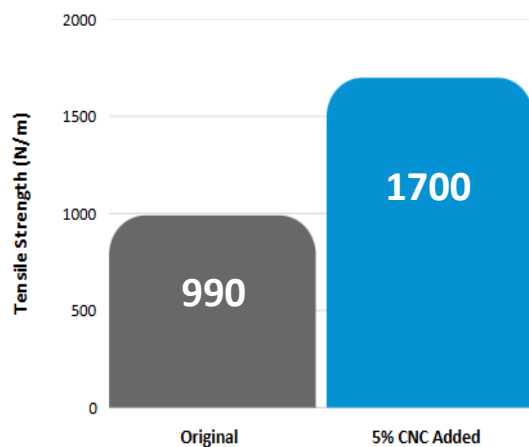
In Pulp  
(unbleached)



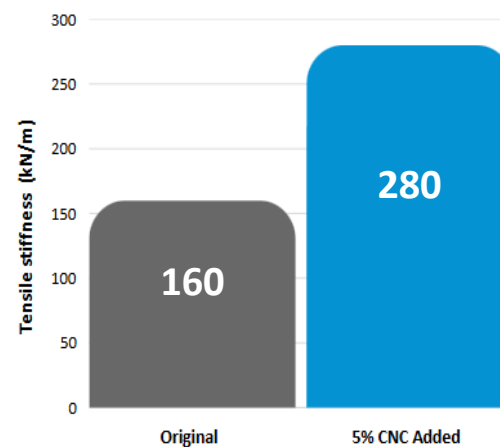
# Mechanical properties of bleached paper

In Pulp (bleached)

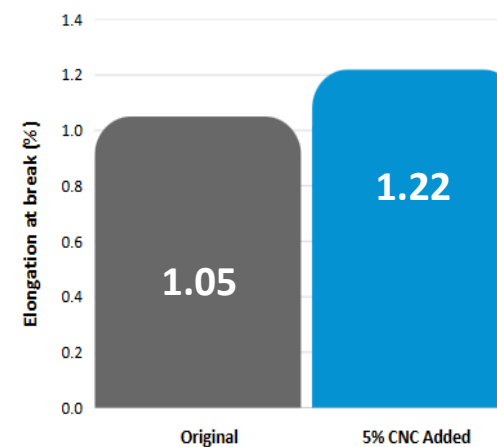
**Tensile Strength (67% Increase)**



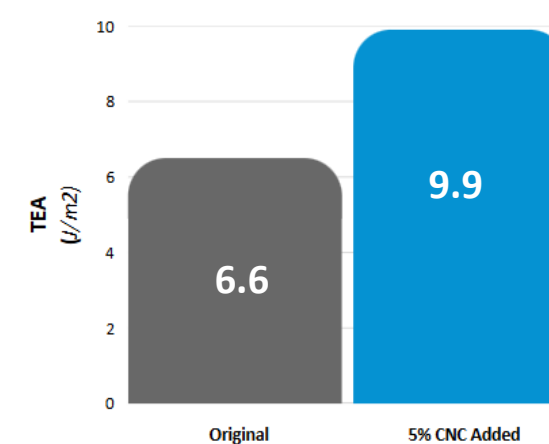
**Tensile Stiffness (78% Increase)**



**Elongation At Break (17% Increase)**



**TEA (52% Increase)**



# Water & Oil Resistance

As A Coating

In September, Neptune ran a new test which included our chitin nanocrystals dip coated onto molded fiber trays at a 3.5% concentration and to observe oil and water resistance. At just 3.5%, a drastic reduction in water and oil resistance was observed.

## After Two Hours



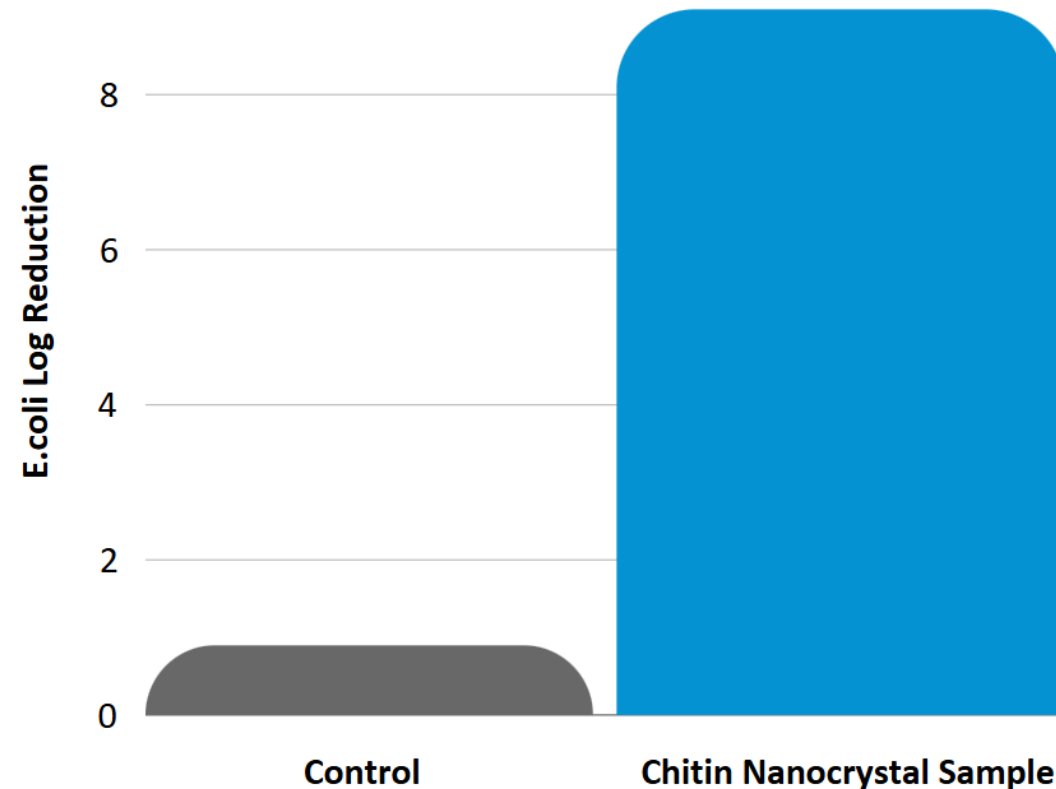
Water Resistance Video ([here](#))



Oil Resistance Video ([here](#))

# Anti-Microbial Properties

In September, Neptune ran another new test with our university partner (University of Waterloo) to measure E.coli log reduction with our additive applied to paper. We saw a Log 9 reduction, correlated to a massive improvements in antimicrobial properties 99.9999999%.



# Flame Retardancy

In September, Neptune also ran multiple flame retardancy tests which observed our chitin nanocrystals as a coating and in the pulp of brown paper products. With just 3.5% coated on paper and 2.5% in pulp, a drastic reduction in flame spreading was observed.

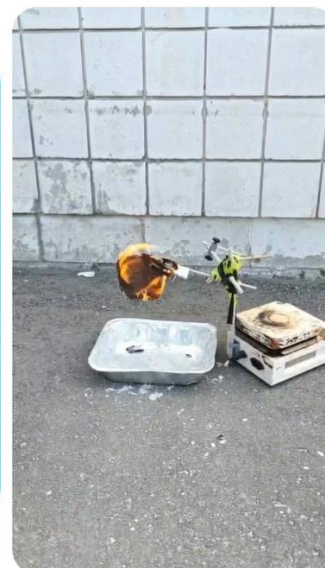
**SAMPLE #1:**  
(without chitin nanocrystals)



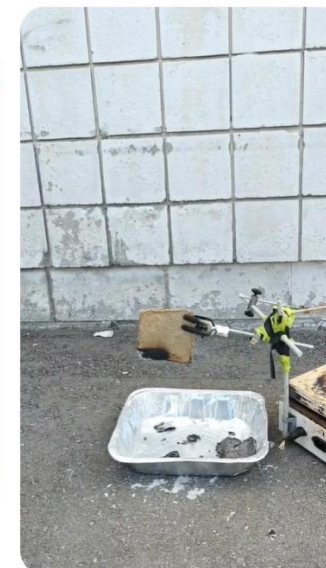
**SAMPLE #2:**  
(With 3.5% chitin nanocrystals dip coated)



**SAMPLE #1:**  
(without chitin nanocrystals)



**SAMPLE #2:**  
(With 2.5% inclusion of chitin nanocrystals)



Chitin Nanocrystals As A Coating ([here](#))

Chitin Nanocrystals In Pulp ([here](#))

# Pulp & Paper: Summary Of Advantages

Chitin nanocrystals compared to chemical additives in pulp and paper packaging exhibit higher strength, lower cost, and no VOC emissions. Compared to legacy nanocrystals, chitin nanocrystals exhibit significantly lower cost and zero toxicity. Not including reduced degradation to water.

|                  | Virgin Paper Products | Additive Enhance/Polymer Coated Paper | Chitin Nanocrystal |
|------------------|-----------------------|---------------------------------------|--------------------|
| High Strength    | X                     | ✓                                     | ✓                  |
| Water Resistance | X                     | ✓                                     | ✓                  |
| Low Cost         | ✓                     | X                                     | ✓                  |
| Low Weight       | X                     | X                                     | ✓                  |
| Sustainability   | ✓                     | X                                     | ✓                  |

# Our Solution: Packaging Film

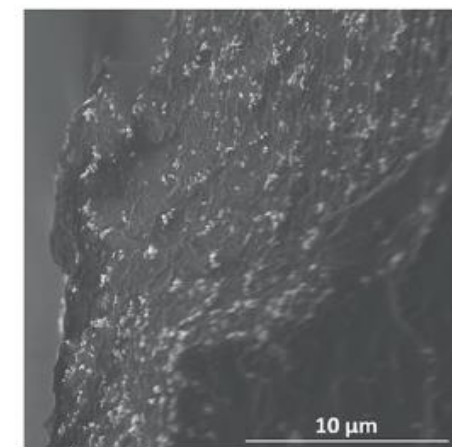
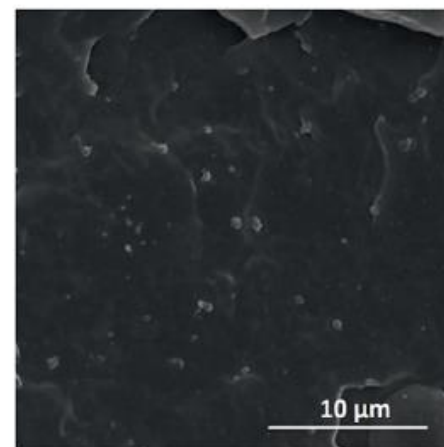
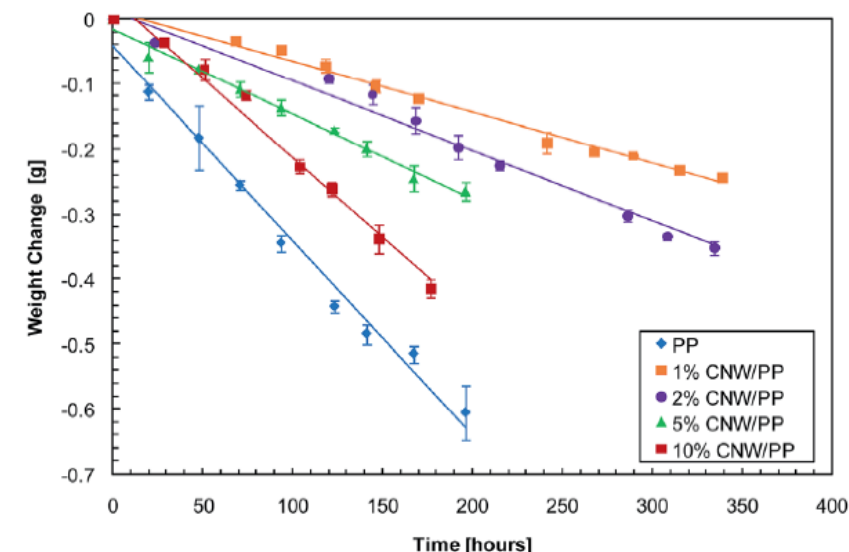
## Market Summary:

Typical plastic film is ineffective at preventing small-molecule penetration. The current solution on the market is to add barrier layers such as different polymers or metal coating to plastics.

## Our solution:

Incorporating chitin nanocrystals in film packaging as tightly packed crystals drastically reduces penetration.

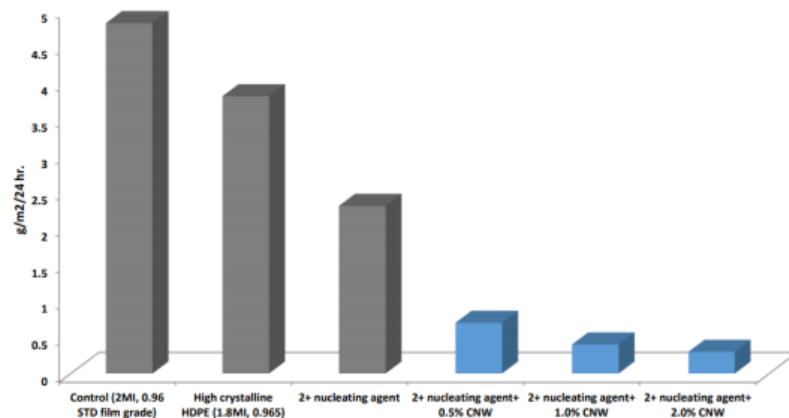
The results show a lab scale with our chitin nanocrystals in a very large specific surface area (over 300 m<sup>2</sup>/g) demonstrating our additive benefit in PP packaging. By incorporating just 1% of chitin nanocrystal in film packaging, strength increases up to 400%.



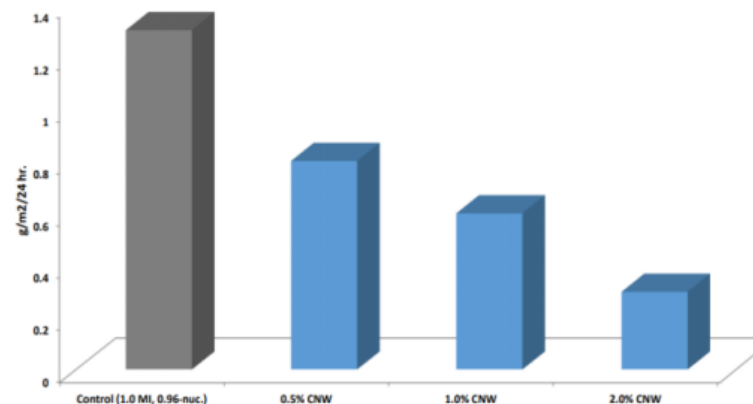
Lab scale results with SCI publication

# PP & PE Packaging Films: OTR & WVTR – Enhanced by Nano Crystals

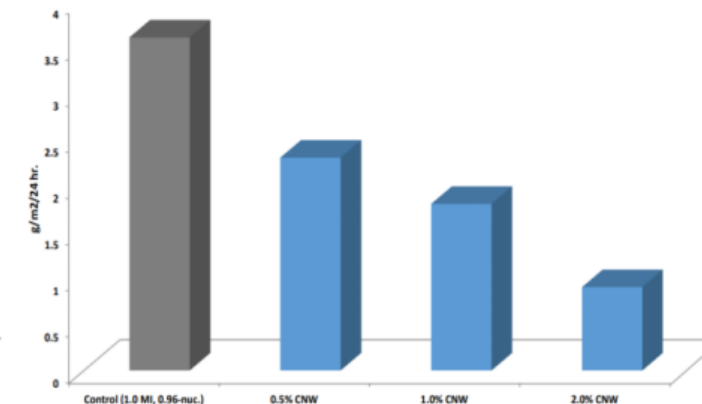
WVTR 1 mil. HDPE blown film



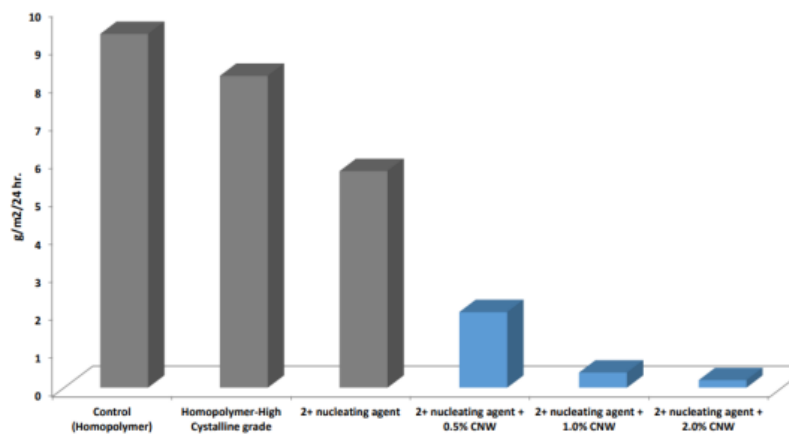
WVTR 2 mil. HDPE blown film



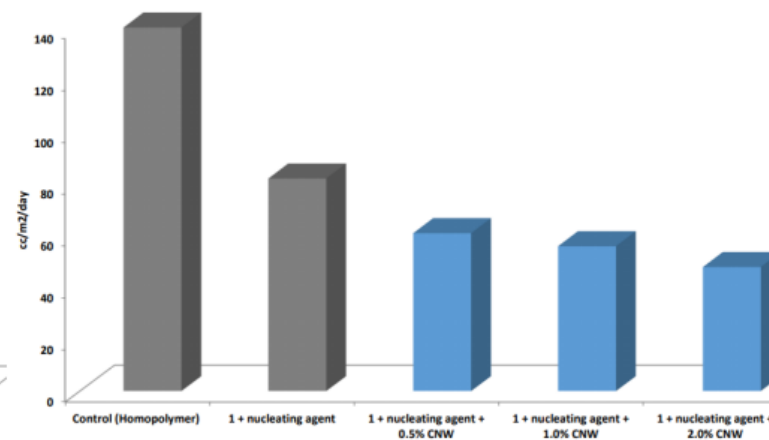
WVTR 0.5 mil. thick HDPE blown film



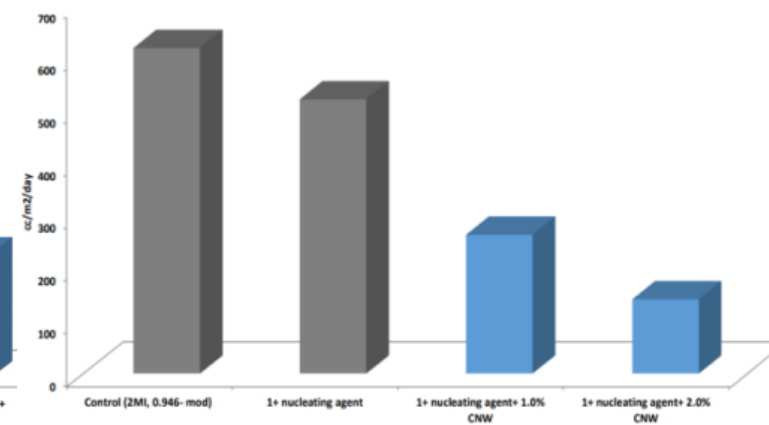
WVTR 1mil. PP cast film



OTR PP cast film



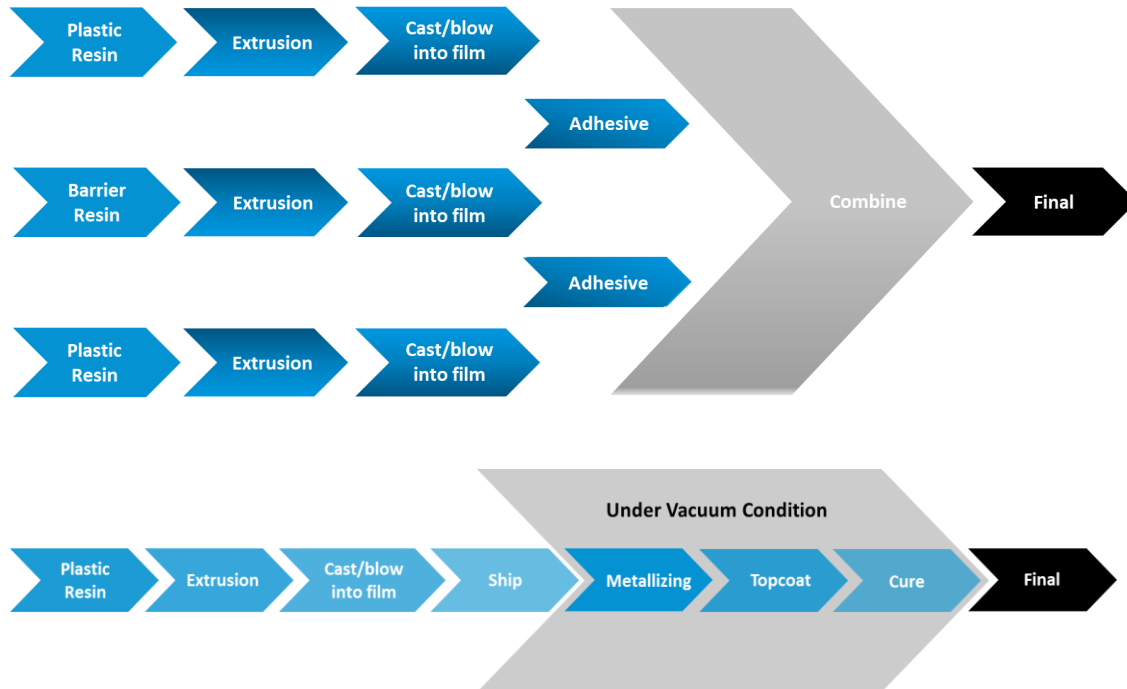
OTR 1 mil. HDPE blown film



# Packaging Film: Primary Advantages

## OLD

### Traditional multi-layer film process



## NEW

### CNW single layer film process



- Simple process
- Low cost
- Low energy
- No VOCs
- Increased strength
- Reduced permeability

CNW: Chitin Nanocrystals

# Packaging Film: Summary of Advantages

Chitin nanocrystals in packaging film exhibit higher strength and barrier properties compared to single-layer film. When compared to multilayer and metal-coated films, chitin nanocrystals exhibit higher strength, recyclability, lower cost, and are environmentally friendly.

|                              | Single Layer Film | Multilayer Film | Metal Coated Film | Nanocrystal Film |
|------------------------------|-------------------|-----------------|-------------------|------------------|
| High Strength                | X                 | X               | ✓                 | ✓                |
| High Barrier                 | X                 | ✓               | ✓                 | ✓                |
| Recyclable                   | ✓                 | X               | X                 | ✓                |
| Low VOC                      | ✓                 | X               | X                 | ✓                |
| Low Cost                     | ✓                 | X               | X                 | ✓                |
| Low Manufacturing Complexity | ✓                 | X               | X                 | ✓                |

# Epoxies: Primary Advantages

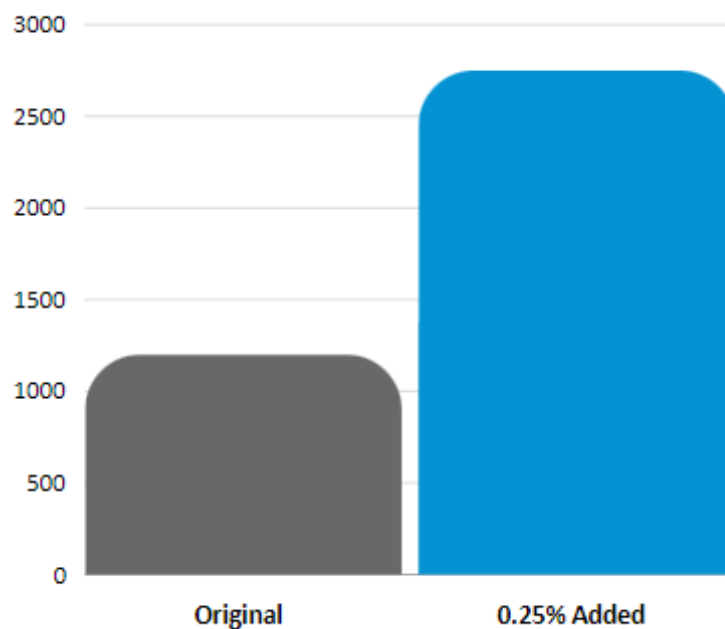


- There are no solutions on the market today that can achieve all 5 (only chitin nanocrystals can)
- Incumbent chemical additive solutions lack strength & sustainability
- Upcoming conventional nanomaterial solutions lack cost & sustainability

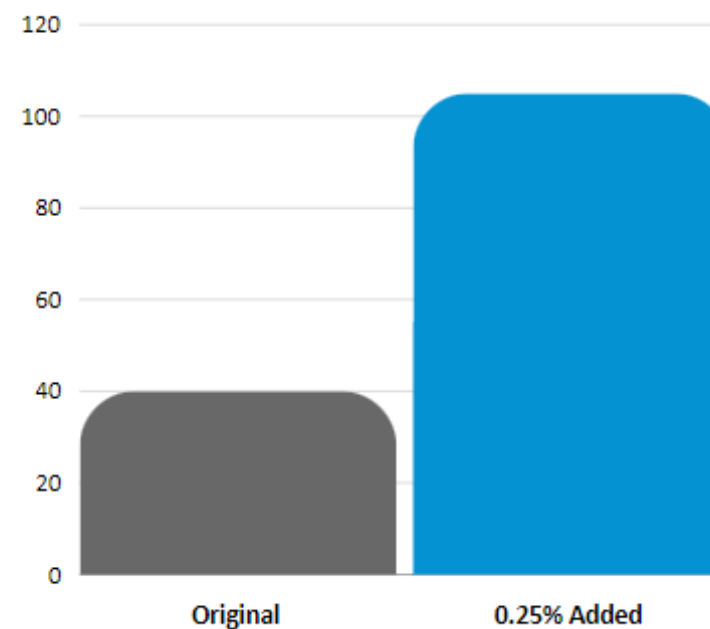
# Bending Strength Advantage

In an ATSM D790 test completed by Lambton College, incorporating just 0.25% of Neptune Nanotechnologies nanocrystals into epoxies can achieve:

**Up to 2.5X increase in bending strength**



**Flexure Modulus**

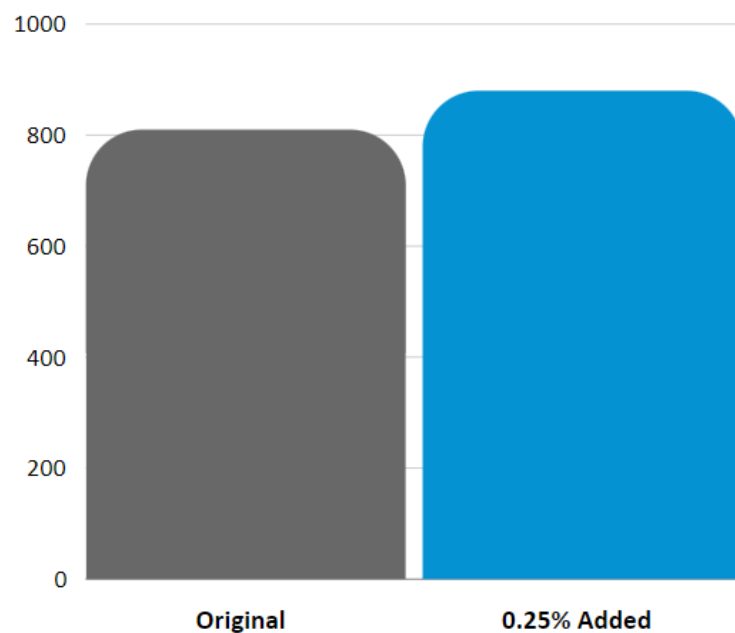


**Flexure Strength**

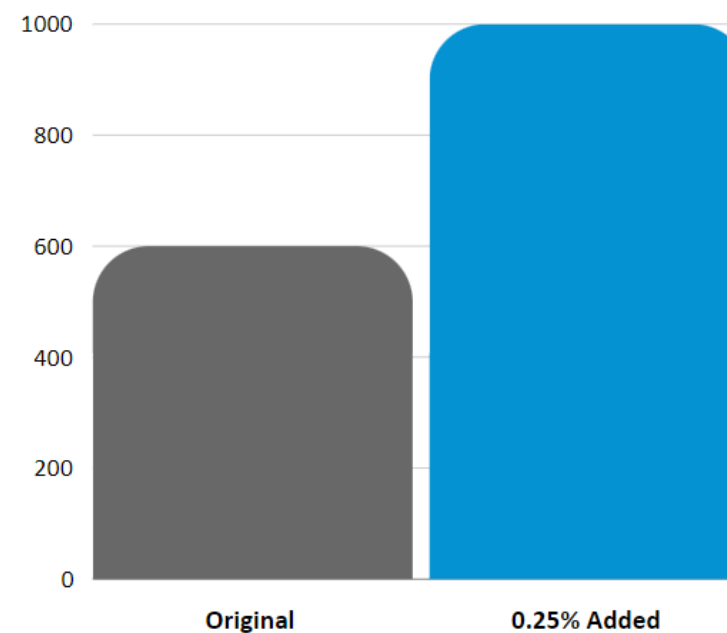
# Tensile Strength Advantage

In an ATSM D638 test completed by Lambton College, incorporating just 0.25% of Neptune Nanotechnologies nanocrystals into epoxies can achieve:

**Up to 67% increase in strength**



**Tensile Modulus**

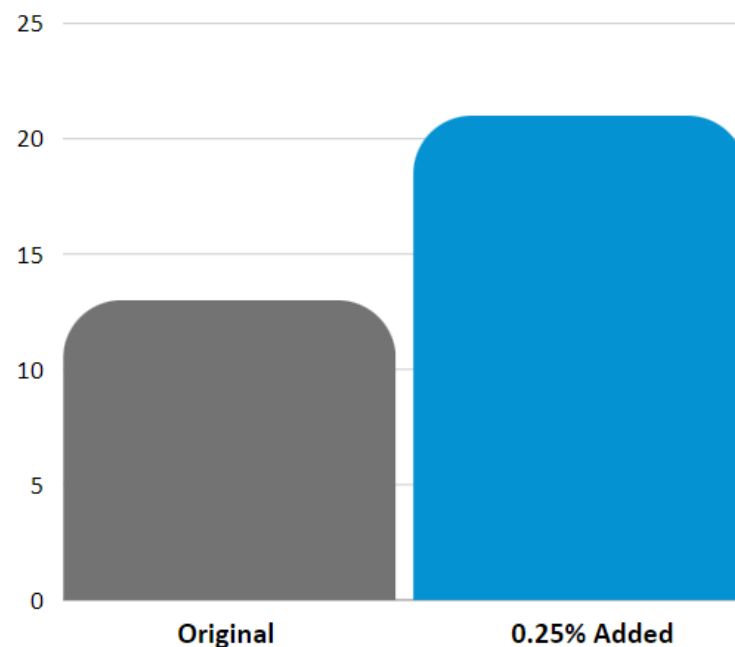


**Tensile Strength**

# Impact Resistance Advantage

In a charpy impact test completed by Lambton College, incorporating just 0.25% of Neptune Nanotechnologies nanocrystals into epoxies can achieve:

**Up to 65% increase in impact resistance**

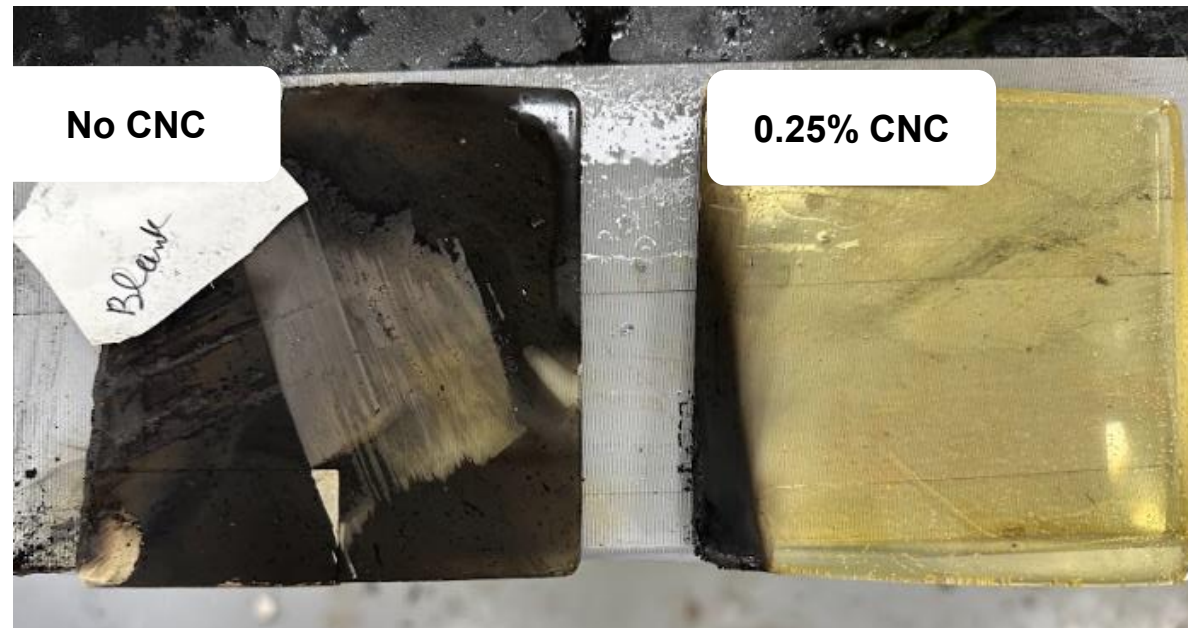


**Charpy Impact Test**

# Flame Retardancy

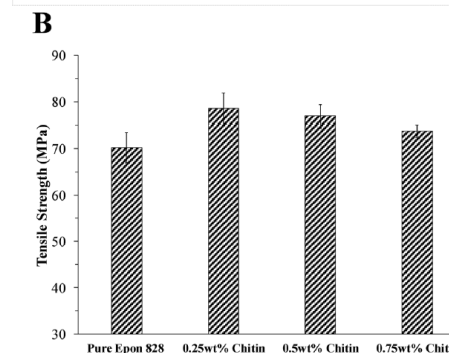
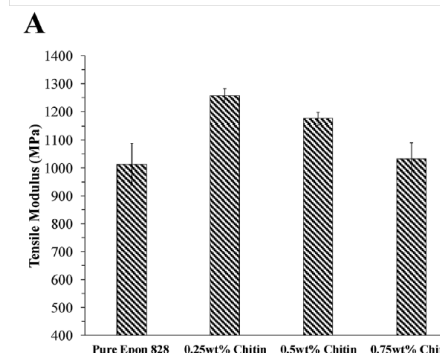
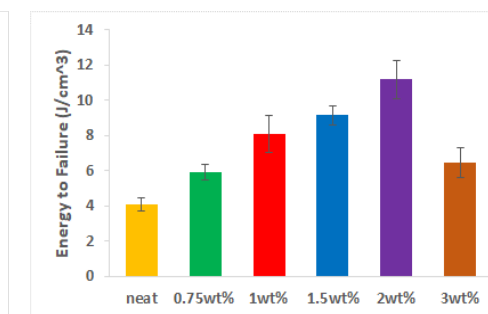
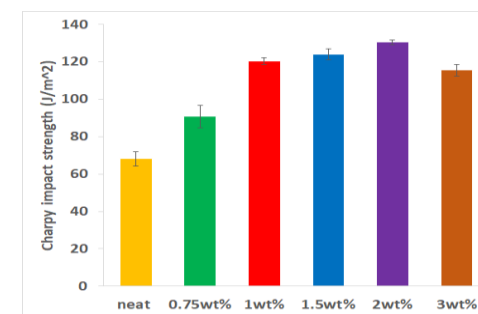
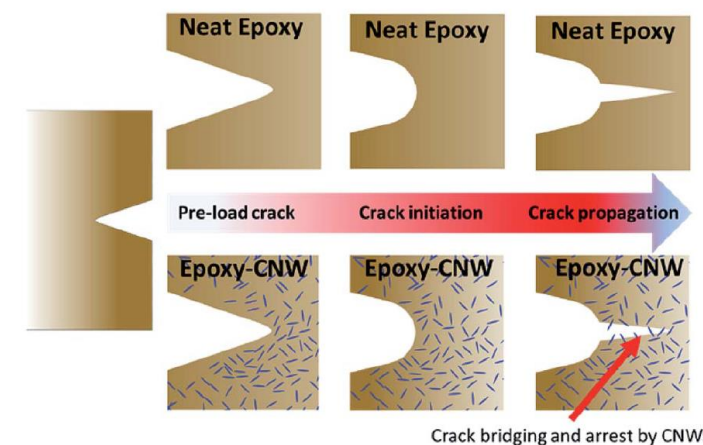
In July 2024, Neptune ran a new test which included our chitin nanocrystals (CNC) loaded into a Bis-A epoxy at 0.25% by weight and to observe flame retardancy. With just 0.25% loaded, a drastic reduction in flame spreading was observed.

Full Video For Reference ([Here](#))



# Additional Advantages

- In epoxies, chemical additives are used to soften epoxies, this improves toughness but trades off strength and stiffness
  - For example, glass is strong and stiff but prone to cracking, rubber is weak (deforms easily) but does not crack
- Chitin nanocrystals function on a completely different mechanism
- Chitin nanocrystals directly improve strength due to their superior material property
- Chitin nanocrystals also act as bridges that prevents micro-cracks from forming
- **1% CNW can simultaneously improve strength by over 35%, Strain Energy by 172%, impact toughness by 91%**



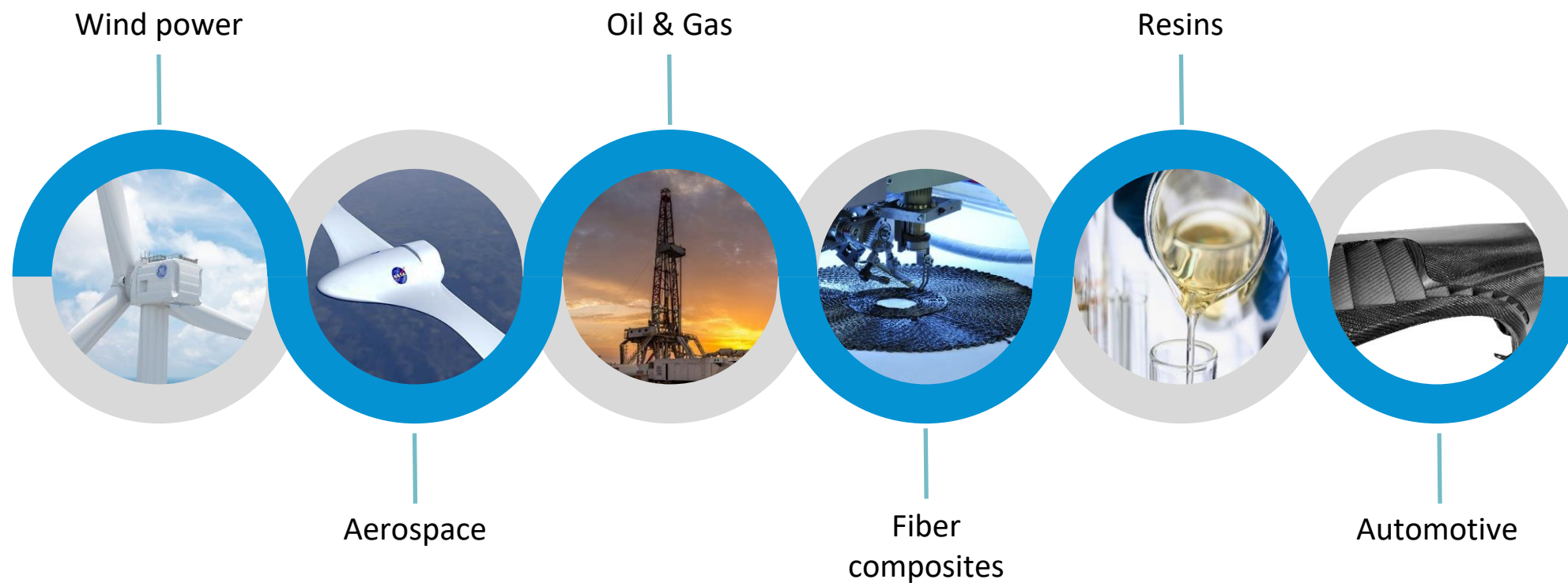
J. Wang, Z. Chen, Q. Guan, N. Demarquette, H.E. Naguib, "Ionic Liquids Facilitated Dispersion of Chitin Nanowhiskers for Reinforced Epoxy Composites" Carbohydrate Polymers Volume 247, 1 November 2020, 116746  
 M. Anwer, J. Wang, Q. Guan and H.E. Naguib "Chitin nano-whiskers (CNWs) as a bio-based bio-degradable reinforcement for epoxy: evaluation of the impact of CNWs on the morphological, fracture, mechanical, dynamic mechanical, and thermal characteristics of DGEBA epoxy resin" RSC Adv., 2019, 9, 11063-11076

# Summary Of Advantages

Chitin nanocrystals compared to chemical additives exhibit higher strength, lower cost, and no VOC emissions. Compared to legacy nanocrystals, chitin nanocrystals exhibit significantly lower cost and zero toxicity.

|                | Chemical Additives | Legacy Nanomaterials | CNW Nanocrystal |
|----------------|--------------------|----------------------|-----------------|
| High Strength  | X                  | ✓                    | ✓               |
| High Toughness | ✓                  | ✓                    | ✓               |
| Low Cost       | ✓                  | X                    | ✓               |
| Low Weight     | ✓                  | ✓                    | ✓               |
| Sustainability | X                  | X                    | ✓               |

# Epoxy Applications By Industry



# Epoxy Applications By Type

## Paints & Coatings



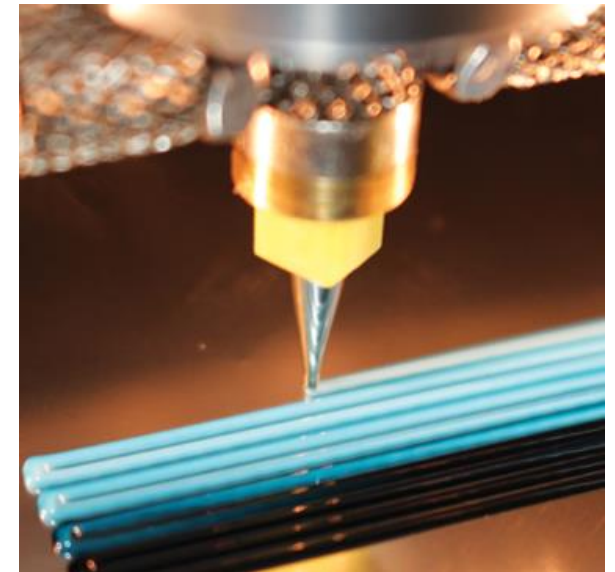
## Adhesives & Sealants



## Composites

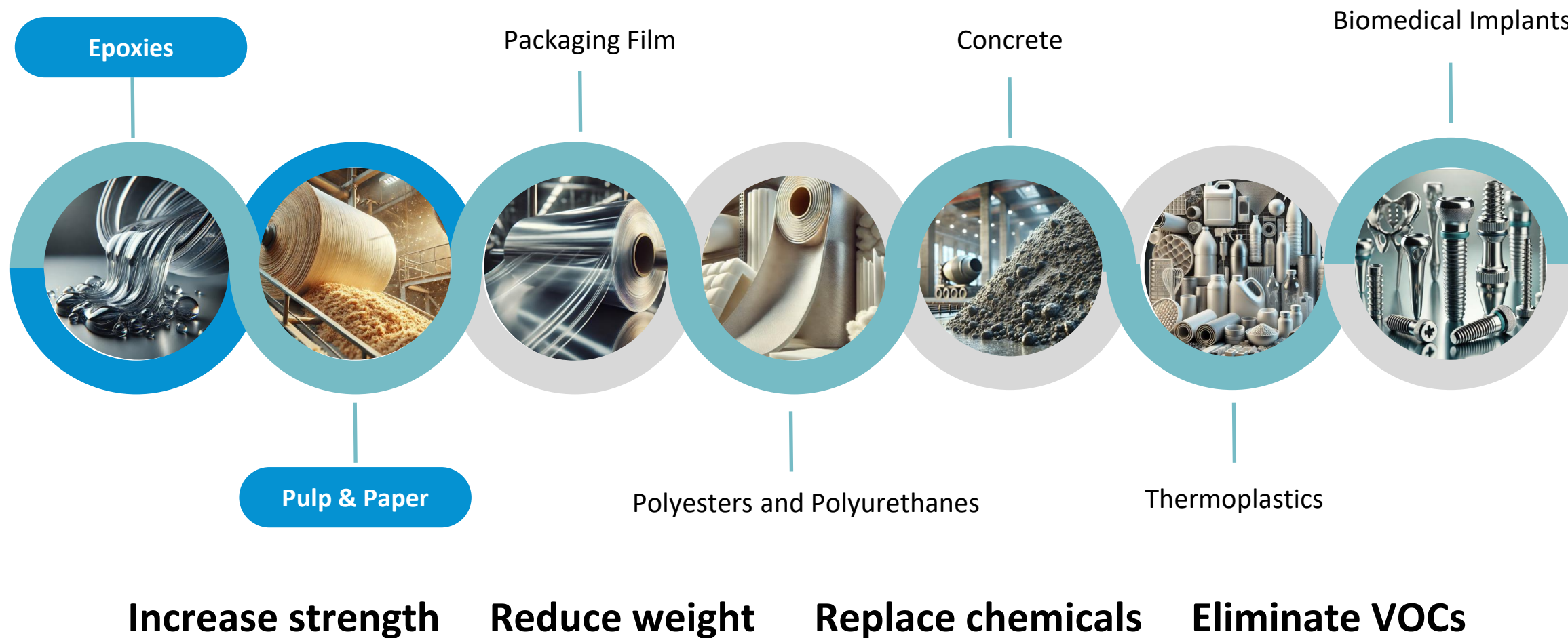


## Ink & 3D Printing



& More

# All Applications

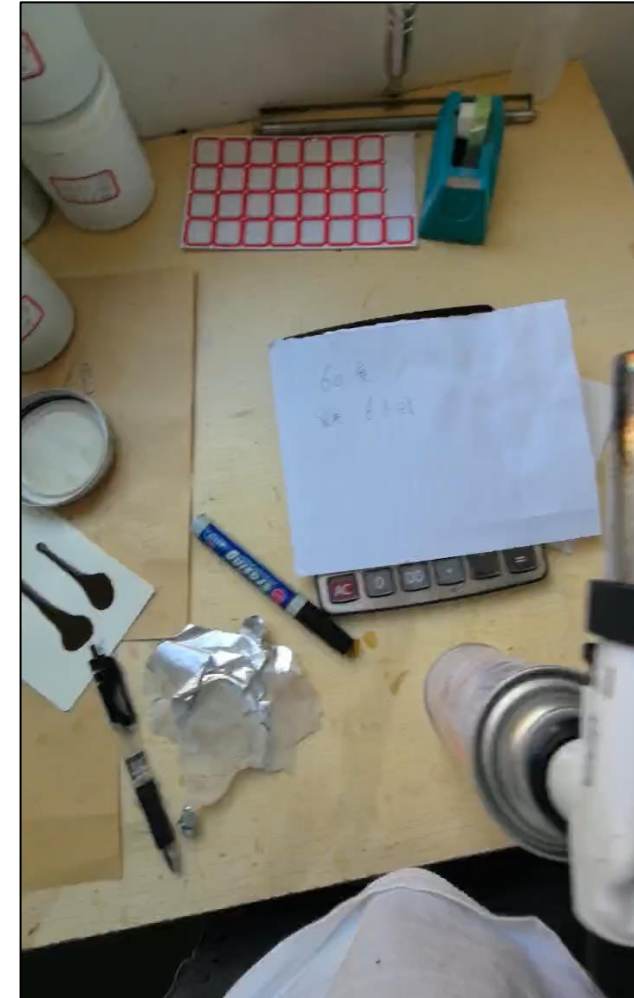


# Glue Update: Improve FR Properties & Bonding With Paper

In two recent separate trials, Neptune dispersed our additive into a client's glue at 5% loading of our CNC.

In a client's water-based glue with 5% CNC, they observe large improvements in the bonding of two paper sheets versus neat glue.

A separate trial with our CNC loading in a PU-based glue observed complete flame retardance, with our additive as a natural flame retardant.



# ESG Benefits with Chitin Nanocrystals

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There are several ESG benefits with our additive in epoxies:

- Chitin nanocrystals are biodegradable, non-toxic, and biocompatible – enhancing epoxy sustainability
- Chitin nanocrystals promote a circular economy as our additive is derived from crustacean shells that we upcycle – 6-8 million crustacean shells are dumped at sea or sent to landfills annually.
- Chitin nanocrystals are lighter than plastic, directly reducing emissions through epoxy weight reduction.
- Considering the drastic increase in strength with chitin nanocrystals, fewer materials can therefore be used in epoxies - directly correlating to less manufacturing emissions (VOCs).

# Product Roadmap

## Epoxy Concentrate Grade Available!

### Applications

- Fiber reinforced composites
- Structural adhesives
- Coatings
- BMCs
- SMCs
- UV 3D Printing

## Water Suspension Grade Available!

### Applications

- Hydrogels
- Water soluble polymers
- Water dispersion paints and coatings
- Rheology modification
- Fundamental research

## Thermoplastic Masterbatch Grade Available!

### Applications

- Films & Packaging
- Thermoplastic composites
- 3D printing

# Contact Information

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