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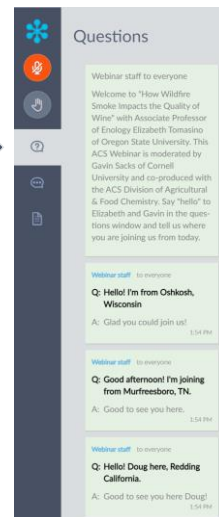


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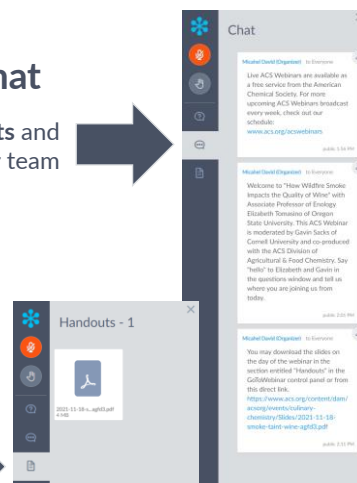


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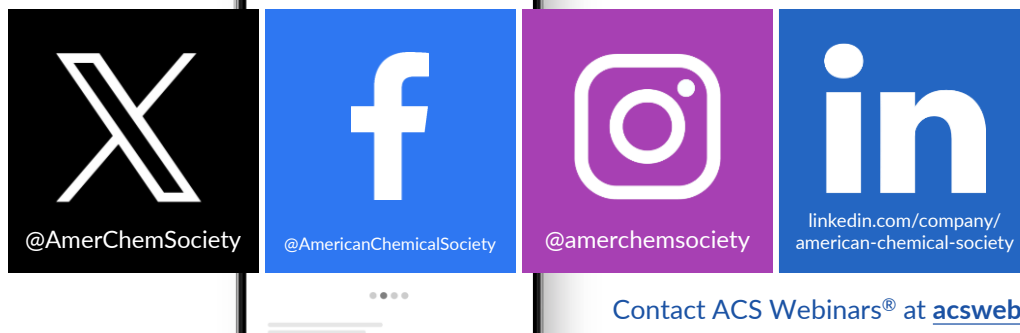


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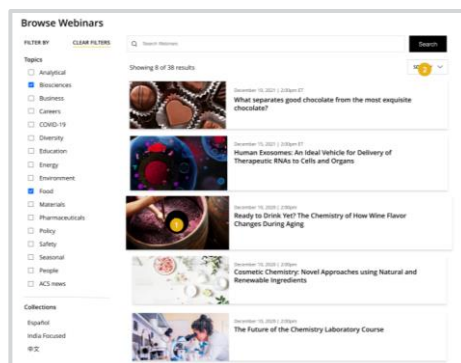
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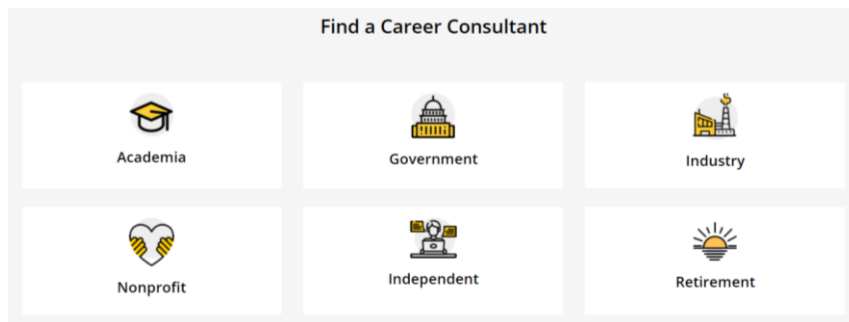


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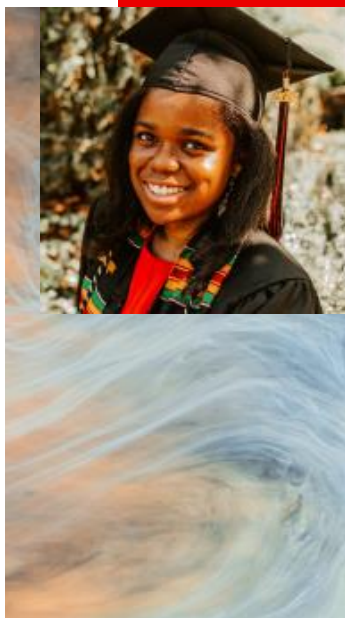
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## ACS Scholar Adunoluwa Obisesan

BS, Massachusetts Institute of Technology, June 2021  
(Chemical-biological Engineering, Computer Science & Molecular Biology)



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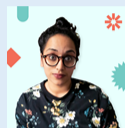
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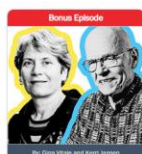
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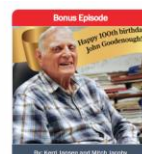
**Bonus Episode**  
Carolyn Bertozzi and K. Barry Sharpless chat about sharing the 2022 Nobel Prize in Chemistry  
December 6, 2022



**Bonus Episode**  
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October 5, 2022



**Episode #46**  
Lithium mining's water use sparks bitter conflicts and novel chemistry  
September 13, 2022



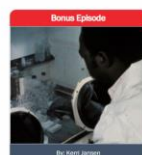
**Bonus Episode**  
Happy 100th birthday, John Goodenough!  
For John Goodenough's 100th birthday, Stereo Chemistry revisits a fan-favorite interview with the renowned scientist  
July 25, 2022



**Bonus Episode**  
Jess Wade on Wikipedia and work-life balance  
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 On the right, a group of diverse, smiling students are shown in a modern, brightly lit setting. The background is a vibrant, abstract geometric pattern in shades of blue, green, and purple. At the bottom left, the website address [acsoncampus.acs.org](https://acsoncampus.acs.org) is displayed.

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## ACS Career Resources



### Virtual Office Hours



<https://www.acs.org/careerconsulting.html>

### Personal Career Consultations

**Jim Tung**  
Senior  
Lachema Laboratories  
B.S., Biochemistry, University of Oregon  
Ph.D., Organic Chemistry, University of Notre Dame

Jim Tung works at Lachema Laboratories in Portland, OR, currently as a business development manager. He has been with Lachema for 10 years, working on developing new chemical manufacturing projects. Before that, he was a senior research chemist at Glaber Research in Champaign, IL, performing kilo-scale organic chemistry.

An Oregon native, Jim got his B.S. in biochemistry from the University of Oregon, his Ph.D. in organic chemistry from the University of Notre Dame, with postdoctoral experience at Pfizer's laboratories in La Jolla, CA. He is past chair of the Portland Section of the American Chemical Society and was 2019 general co-chair of NORM 2019. He has interests in process chemistry, labor economics, social media outreach and encouraging career exploration and development for younger chemists.

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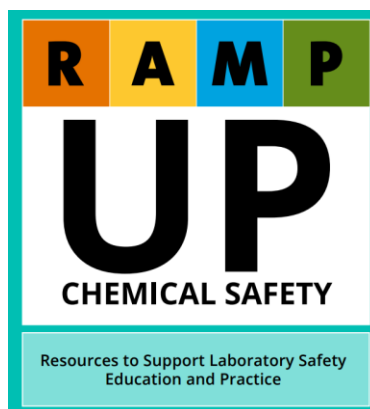
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## A complete listing of ACS Safety Programs and Resources



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## Resources

<p><b>Inclusivity Style Guide</b> Designed to help staff and members use language and images that respect diversity in all its forms.</p> <p>→</p>	<p><b>ACS Webinars on Diversity</b> Covering diversity and inclusion at the workplace</p> <p>→</p>
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<p><b>C&amp;EN Trailblazers</b> C&amp;EN highlights scientists from different backgrounds who are making an impact in chemistry.</p> <p>→</p>	<p><b>NEW! Download DEIR Educational Resources</b> Download this educational guide for additional recommendations on videos, articles, books, podcasts, and more on diversity, inclusion, and related topics.</p> <p>→</p>
<p><b>Quick Guide: Inclusion Moments</b> Learn more about what Inclusion Moments are and see ideas to host them during your meetings.</p> <p>→</p>	<p><b>Quick Guide: How to host inclusive in-person events</b> Recommendations and best practices to ensure that your events can accommodate everyone.</p> <p>→</p>

**Diversity, Equity, Inclusion, and Respect**  
\*\*Adapted from definitions from the Ford Foundation Center for Social Justice:

**Equity\*\***  
Seeks to ensure fair treatment, equality of opportunity, and fairness in access to information and resources for all. We believe this is only possible in an environment built on respect and dignity. Equity requires the identification and elimination of barriers that have prevented the full participation of some groups.

**Diversity\*\***  
The representation of varied identities and differences (race, ethnicity, gender, disability, sexual orientation, gender identity, national origin, tribe, caste, socio-economic status, thinking and communication styles, etc.), collectively and as individuals. ACS seeks to proactively engage, understand, and draw on a variety of perspectives.

**Inclusion\*\***  
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**Respect**  
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Thursday, March 7, 2024 | 2-3pm ET

**The Art of Self-Reinvention**

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## Natural Polymers Consortium (NPC)

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For more information please contact:

 Isamir Martinez ([i\\_martinez@acs.org](mailto:i_martinez@acs.org))

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## Harnessing the Power of Natural Polymers: Innovation Opportunities for Circular Materials



**BENJAMIN S. HSIAO, PhD**

Distinguished Professor, Stony  
Brook University



**CHRISTIAN LENGES, PhD, MBA**

Venture Director, International  
Flavors and Fragrances (IFF)



**LYNDSAY LEAL, PhD**

Lyndsay Leal  
Research Scientist, Dow  
Chemical Company



**EDMOND LAM, PhD**

Assistant Director, ACS Green  
Chemistry Institute

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# From Waste to Harvest: New Circular Solutions for Agriculture

**Benjamin S. Hsiao**

Distinguished Professor of Chemistry  
Stony Brook University  
New York, USA

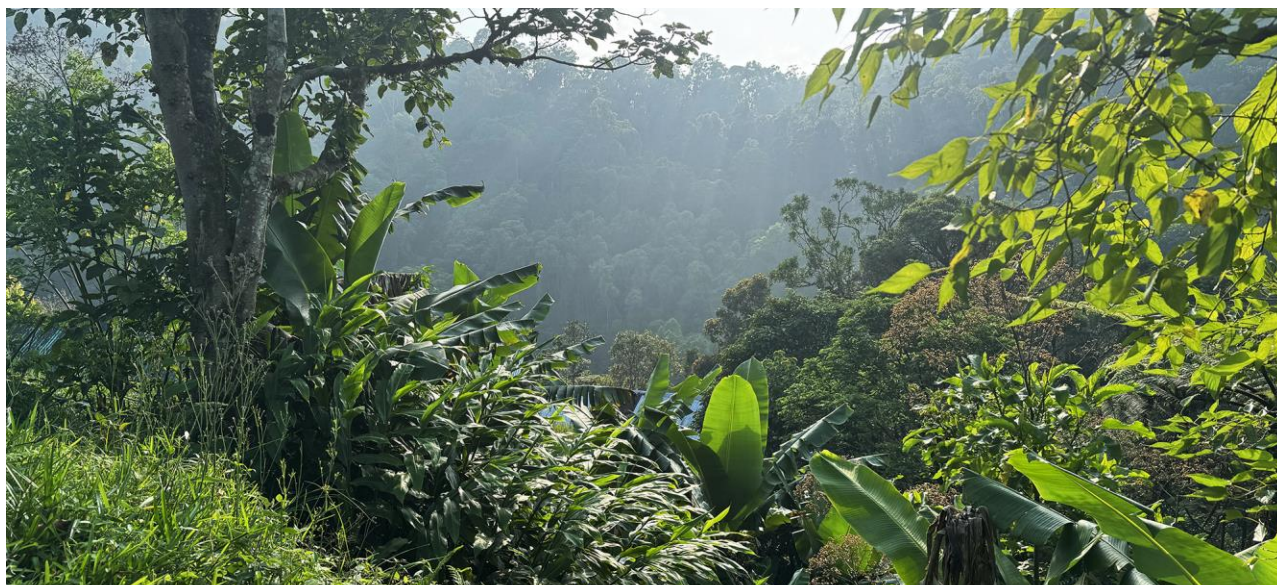


**Stony Brook University**

*ACS Webinars on Natural Polymers  
February 28, 2024*

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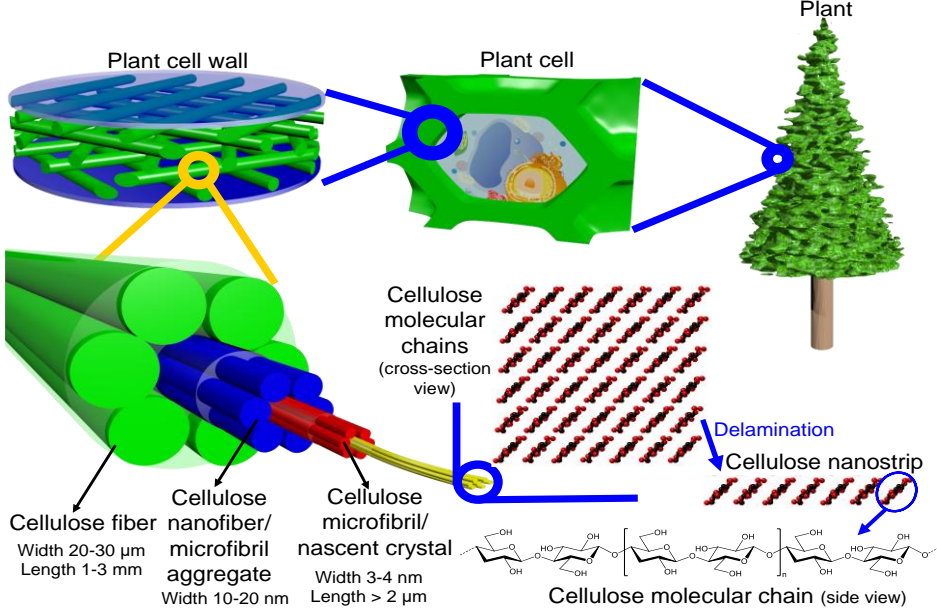


There are orders of magnitude more natural polymers  
than synthetic polymers

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# Natural polymer fibers at varying scales



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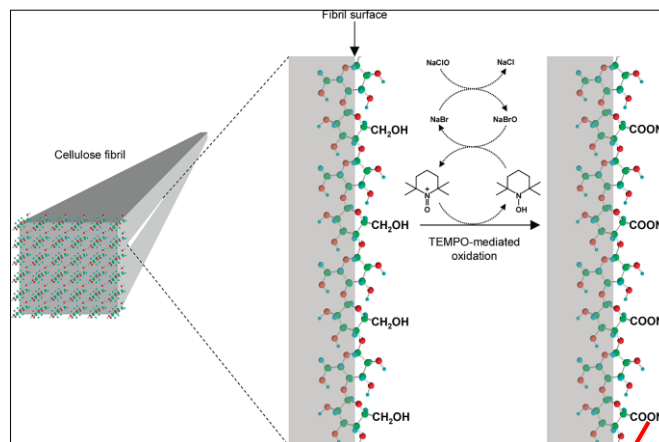
## Typical manufacturing processes to produce nanoscale cellulose fibers (nanocelluloses)

Type of nanocellulose	Treatment	Delamination
CNC/MCC	HCl H <sub>2</sub> SO <sub>4</sub>	Low/Medium energy demand
CNF/MFC	No pretreatment	Very high energy demand
	Enzymatic	Medium energy demand
	Carboxy-methylation	Low energy demand
	<b>TEMPO-treatment</b>	<b>Very low energy demand</b>
BNC	Fermentation/ (Acetobacter Xylinum)	No delamination

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## Using chemistry to break cellulose down into nanocellulose



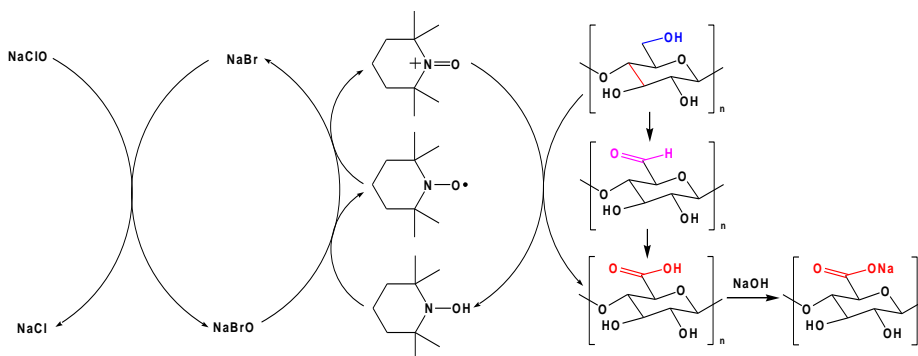
Carboxylate at C<sub>6</sub> position on cellulose surface

Y. Okita, T. Saito, A. Isogai, *Biomacromolecules*, 2010, 11, 1696–1700

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## But ... the TEMPO chemistry was expensive and not environmentally friendly



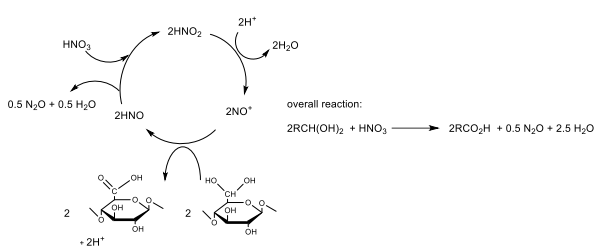
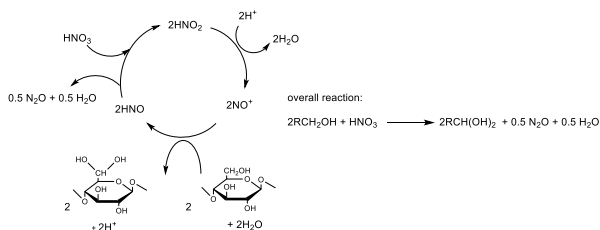
T. Saito, S. Kimura, Y. Nishiyama, A. Isogai, *Biomacromolecules*, 2007, 8(8), 2485–2491

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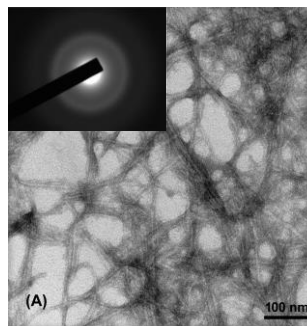
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## Our lab developed a simple nitro-oxidation method (nitric acid + sodium nitrite) to prepare CNF from raw biomass

initiation- separate from the catalytic cycle  
 $\text{NaNO}_2 + \text{H}^+ \longrightarrow \text{HNO}_2 + \text{Na}^+$



P. Sharma, R. Joshi, S. Sharma, B. S. Hsiao, *Biomacromolecules*, 2017, 18(8), 2333–2342

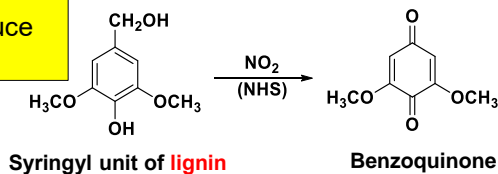


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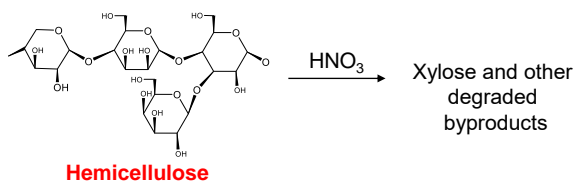
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## Hypothesis behind nitro-oxidation on pulping of raw biomass

Nitric acid can generate nitrogen dioxide, which can react with syringyl moiety of lignin to produce soluble benzoquinone



Nitric acid can decompose hemicellulose to xylose and other degraded byproducts



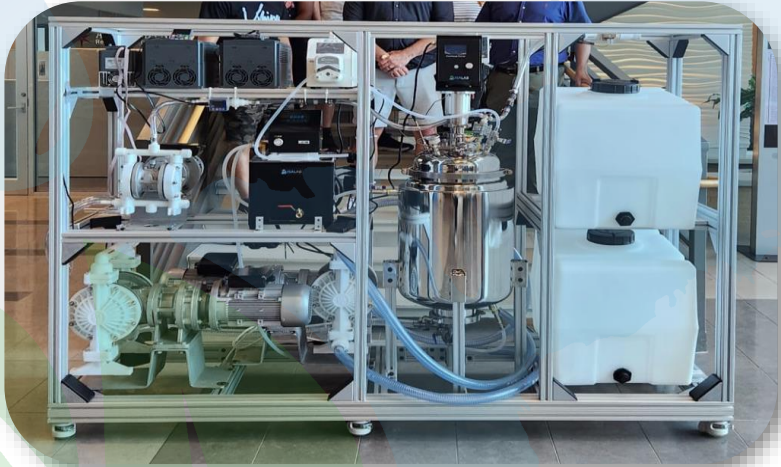
*J. Wood Chem. Technol.*, 1996, 16(2), 169-189

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# SBU's NOP Technology - a zero waste process

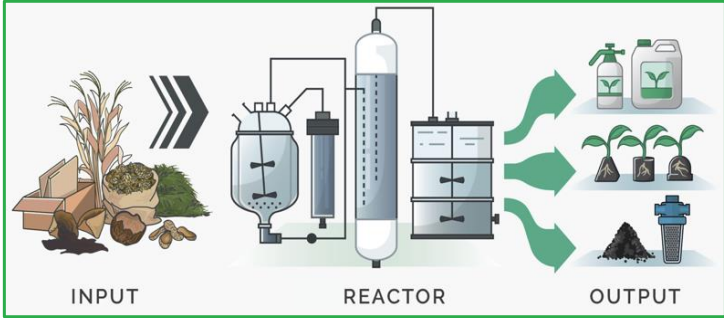


focused on upcycling food & agricultural waste into value-added products

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# Nitro-oxidation process technology - a zero waste process



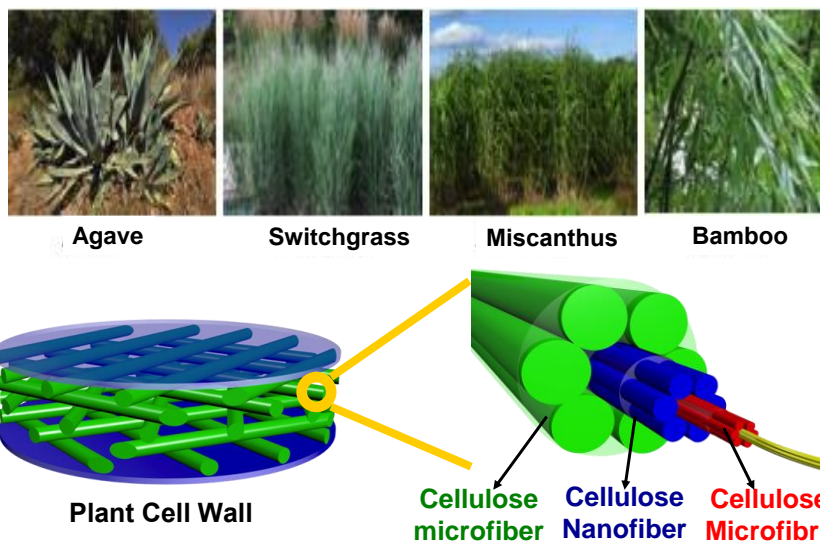
## Environmentally friendly products

- low-cost fertilizers
- water remediation materials
- water retention biogels
- plant growth media

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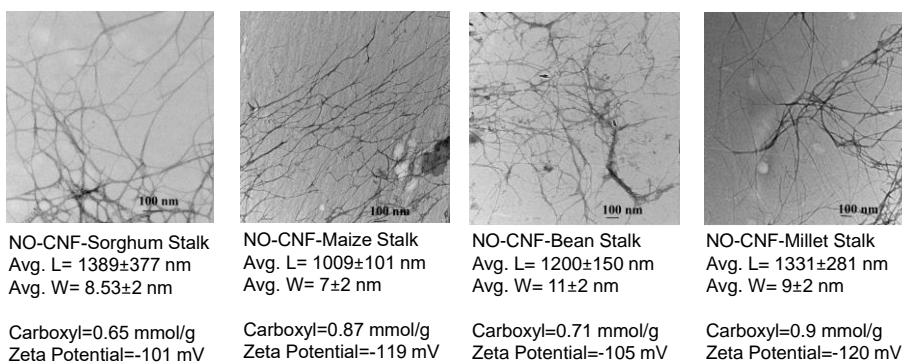
## Nitro-oxidation is particularly suited to produce nanocelluloses from (underutilized) non-wood plants



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## Nitro-oxidation on agricultural residues

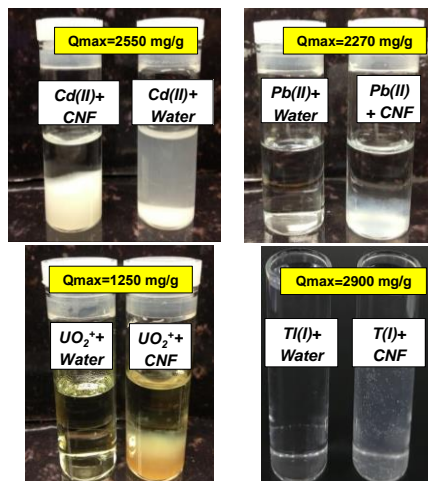


Successfully tested the nitro-oxidation treatment on 16 raw plants

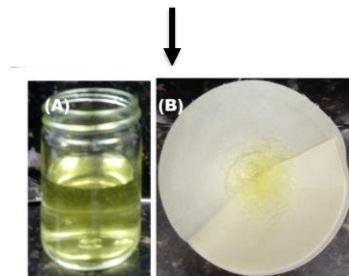
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## Nanocellulose: an effective flocculating/coagulating agent for removal of metal ions



Gravity microfiltration can be used to remove the floc



(A) Uranyl impurities in water  
(B) Uranyl impurities remediated by nanocellulose using gravity driven filtration

Efficiency of nanocellulose for metal ion removal is between 50-80%.

P. Sharma et al., *Cellulose*, 2018, 25(3), 1961-1973

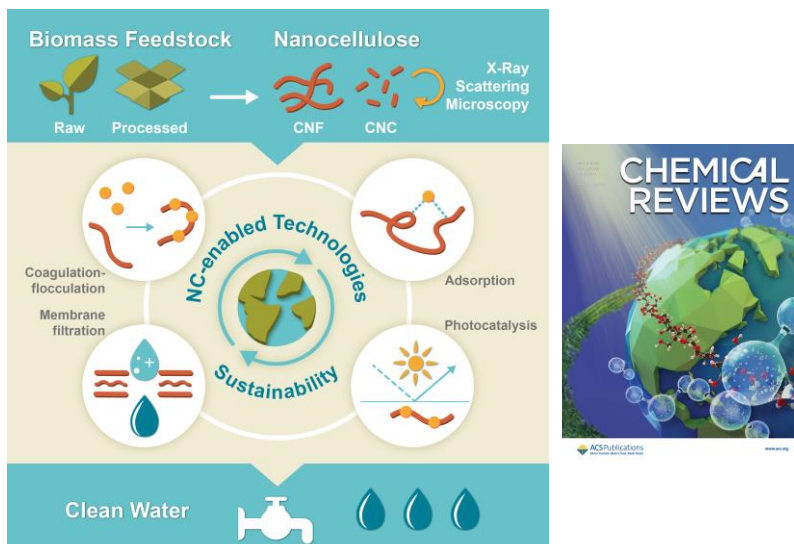
P. Sharma et al., *ACS Sustain. Chem. Eng.*, 2018, 6(3), 3279-3290

P. Sharma et al., *Ind. Eng. Chem. Res.*, 2017, 56(46), 13885-13893

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## Nanocellulose for water purification

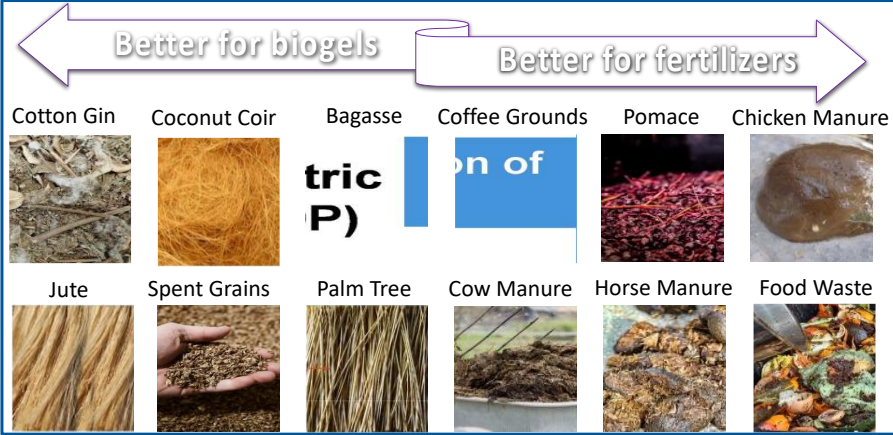


R. Das, T. Lindström, P. Sharma, K. Chi, B. S. Hsiao, *Chem. Rev.*, 2022, 122(9), 8936–9031

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# Diverse biowaste for different NOP products



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## Benefits of NOP-fertilizers

- Slow-released fertilizers
- Does not require additional hydrocarbon feedstock
- Eco-friendly, zero-waste process
- Cost-effective
- Granular or liquid based delivery
- Can replace synthetic fertilizers



Liquid or Granular

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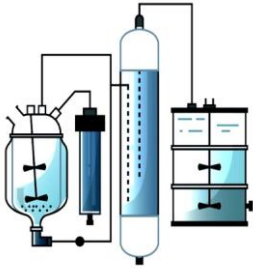
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# We also learned NOP-biogels are cost competitive *from techno-economic analysis*

- NOP recovered fertilizers 20% cheaper than synthetic fertilizers
- Growing media 60% cheaper than peat moss
- Soil amendments 30% cheaper than commercial products
- Biogels 80% cheaper than synthetic hydrogels



## NOP vs Composting







**cleaner, safer,  
6-9 hours**



**GHG, land intensive,  
9 months**

# NOP Technology is superior to compost to treat natural organic waste

	Composting	NOP
Nutrient recovery	✓	✓
Soil safe	✗  ✓	✓
Human/animal safe	✗  ✓	✓
No odor/GHG	✗  ✓	✓
Biogas production	✗  ✓	✓
Speed	months	hours







**Impacts of climate change  
are accelerating the problem**



23

47



**Most nutrients  
are lost**



**or left behind in agriculture residues,  
and animal and food waste**



48

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3 billion tons of agricultural residues



5 billion tons of animal waste (annually)

49

49



Globally 1/3 food is wasted

1.3 billion tons

In US, 40 million tons/year (\$161 billion)

+ more \$ to remove or compost

50

50

# NOP technology can create new circular solutions

- 1. **NOP is a zero-waste processing technology for upcycling natural organic waste**
- 2. **New farming products: growing media, soil amendments, and biogels**



## Acknowledgement

### Stony Brook University Team

Prof. Dilip Gersappe  
 Dr. Rasel Das (senior postdoc)  
 Dr. Yasmeen Aziz (Fulbright postdoc)  
 Grenalynn Ilacas (PhD student)  
 Jiajun Tian (PhD student)  
 Kaushanie Gunarathne (PhD student)  
 Nadege Durand (PhD student)  
 Noel Womack (PhD student)  
 Rebecca Potoff (PhD student)  
 Madani Khan (PhD student)  
 Mahdi Rezaei (PhD student)  
 Kathy Chu (MS student)



**NSF: EAGER, DMR-Polymer, PFI-TT, and Convergence Accelerator**

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 A photograph of two scientists, a man and a woman, in white lab coats looking at a computer monitor displaying data. The woman is pointing at the screen.
 

**CATALYSTS FOR GOOD**

**iff**

**Harnessing the Power of Natural Polymers:  
Innovation Opportunities for Circular Materials**

Christian Lenges

02-28-2024

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**OUR PURPOSE**  
**Applying science and creativity for a better world**

**OUR FINANCIALS\***

**~\$12.5B**  
SALES

**~20%**  
ADJUSTED OPERATING  
EBITDA  
MARGIN\*

**~\$2.5B**  
ADJUSTED OPERATING  
EBITDA\*

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**NOURISH**

Nourish is a leading supplier of specialty ingredients, creating the future of innovative food & beverage experiences and helping people live better, more fulfilled lives

To 'Nourish' is to feed with purpose; designing better products for people and planet



**SCENT**

Global leader in creating and supplying superior fragrance experiences and cosmetic actives for consumer product goods and beauty brands

The Ingredients unit serves internal needs and supplies to the fragrance and flavor industries



**HEALTH & BIOSCIENCES**

Inspired by nature and distinguished by its world-class bioscience and microbiome capabilities, H&B develops products that deliver safe, healthy and sustainable solutions for customers around the world



**PHARMA**

Creates unique functional ingredients and solutions that support global applications in pharmaceutical, dietary supplement and industrial industries

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<b>1 out of 3</b> probiotic supplements contain IFF Probiotics	<b>10</b> R&D Centers	<b>~50%</b> of cold laundry wash products contain IFF enzymes	<b>~7,000</b> Patents and pending applications
<b>One of the broadest and largest</b> biotechnology, microbiome and fermentation capabilities in the industry	<b>30</b> Manufacturing Sites	<b>Technology Leadership</b> within Enzymes, Yeasts, Cultures, Probiotics, Prebiotics, Plant-Extracts	<b>Strong innovation, manufacturing and sales</b> global footprint
<b>~20%</b> of the global beer volume is made with IFF enzymes	<b>600+</b> Dedicated Scientists	<b>1 out of 5</b> baked goods are manufactured with our anti-staling enzymes	<b>1 out of 3</b> yogurts globally are made with our cultures

**Leadership in Biosciences**

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Public

ALIGNING WITH KEY GLOBAL MACRO THEMES

# INNOVATION-BASED GROWTH ALIGNED WITH KEY GLOBAL MACRO THEMES

## INSIGHTS

Improving Home & Personal Care

Empowering Wellbeing & Healthy Lives

Transforming Food Systems

Accelerating Climate Solutions

INSIGHT-LED INNOVATION GROWTH THEMES



FOUNDATIONAL TECHNOLOGY LEADERSHIP



## SUSTAINABILITY



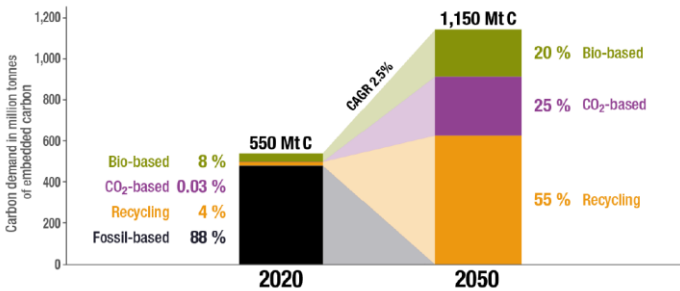
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# SUSTAINABLE MATERIAL TRANSITION

## Factors Driving Change...



Nova Institute 2023

600 – 1000 B\$ Capex..

But...

- Assumes direct replacement...
- Growing Middle Class – Up-trading
- Regional Focus – Reconfigure Supply Chains



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# INSPIRED BY NATURE

Polysaccharides extracted from plants are widely used to provide unique end-use applications but are limited by processes and raw material source. Nature often produces mixtures.




**Cellulose**  
 $\beta(1,4)$  linkage

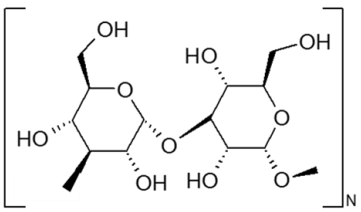
[\*]OC1OC(O)C(O)C(O)O1




**Carrageenan**




**Guar Gum**




**alpha (1,3) linkage  
Engineered Polysaccharide**






**Starch**  
 $\alpha(1,4)$  linkage

[\*]OC1OC(O)C(O)C(O)O1



**Pectin**



**Must Bean Gum**

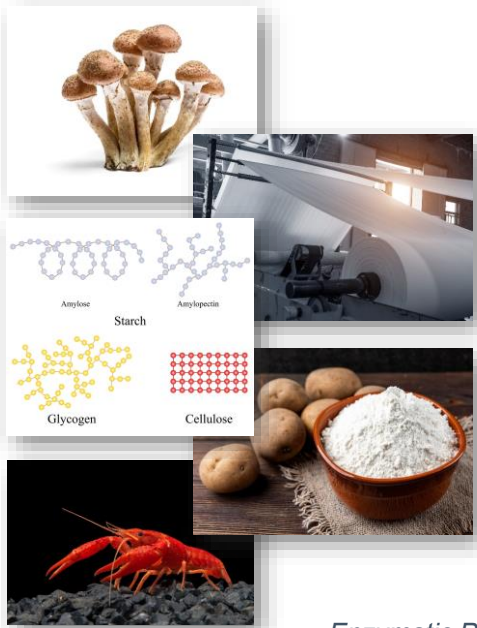



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Public

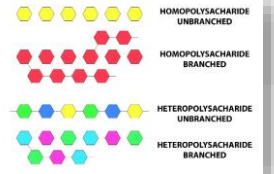
## Complexity of Carbohydrates “sugar code”



<b>DNA</b>	ATG	$4^3$	64
<b>Protein</b>	Met-Asp-Pro	$20^3$	8.000
<b>Carbohydrate</b>		$[20^3 \cdot 2^3 \cdot 2^3 \cdot 12]$ [sugar x anomeric x ring size x linkages]	> 6.000.000

**Material Properties:**

- solubility
- molecular weight
- molecular weight distribution



*Enzymatic Polymerization to enable Industrial Glycomics*

Laine (1997) Pure & Appl. Chem. (69) 1867-1873



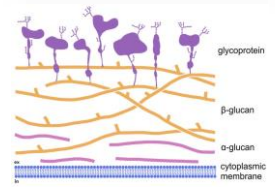
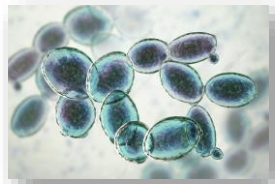
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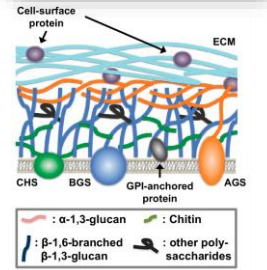
Public

# ALPHA 1,3 GLUCAN IS A NATURALLY OCCURRING STRUCTURAL POLYSACCHARIDE

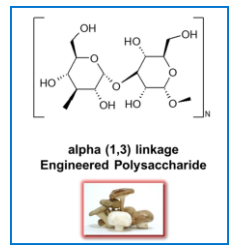
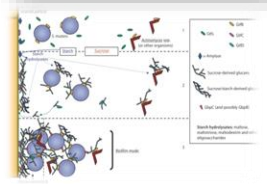
Saccharomyces Cerevisiae



Hyphae



Dental Plaque



- Alpha 1,3 glucan is an insoluble polysaccharide used by nature to build cell walls
- Typically found in fungi – e.g. saccharomyces cerevisiae (bakers yeast), truffle mushrooms etc.
- Alpha 1,3 glucan is part of our diet!



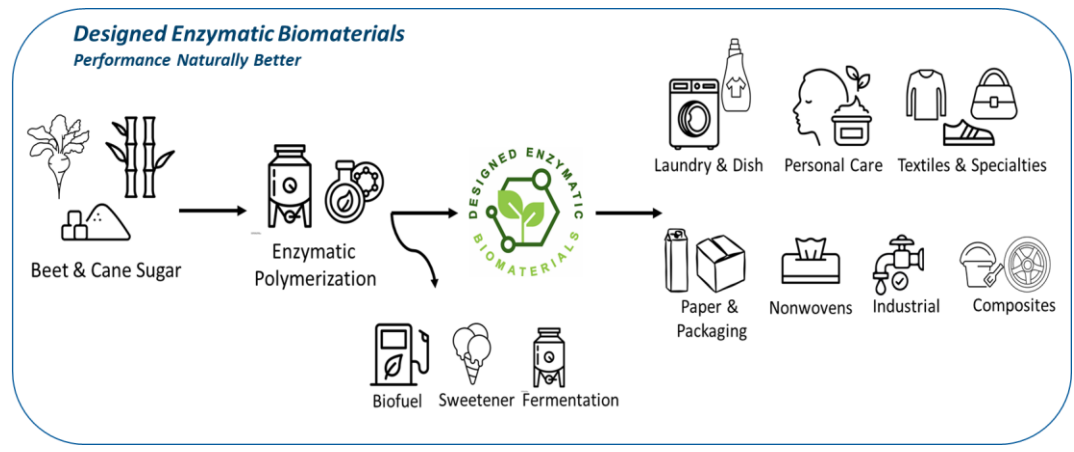
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## INNOVATIVE BIOMATERIALS WITH TRANSFORMATIONAL IMPACT

Renewably Sourced – Biodegradable – Performance Advantaged – Ready to Scale – GHG Avoidance, Positive Life Cycle



DEB products support the UN Sustainable Development Goals. Through its inherent circularity and low and even net positive environmental impacts, DEB products set a new standard for responsible consumption and production. UN SDG 8, 9, 12, 13



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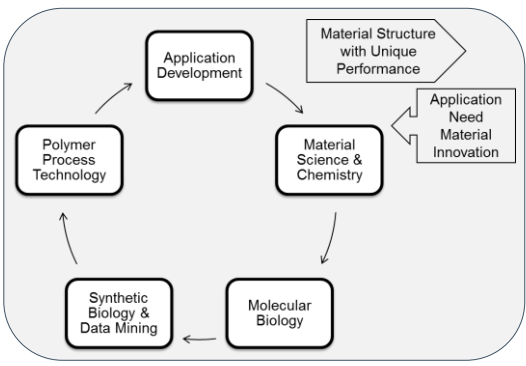
62



# BIOTECHNOLOGY COMPETITIVE ADVANTAGE: ENZYME ENGINEERING FOR DIFFERENTIATED MATERIAL PERFORMANCE

Public

- Diversity Search Mining**
  - Identify, express enzymes
  - Rapid assay development
  - Small scale predictive method development
- Result-Knot: Enzyme Engineering**
  - Rapid enzyme optimization
  - Generative machine learning models
  - Directed evolution - large unique libraries
  - Active site architecture modulation
- Production Host Adoption**
  - Express enzymes in production hosts
  - Enable commercial enzyme manufacture
  - Build on regulatory cleared & cost enabled hosts
- Leverage Commercial Strains**
  - Adopt formulation for commercial process & supply chain
  - Contingency to switch production hosts
  - Protein Design Space



Structure – Stability – Selectivity – Affinity - Activity



Public

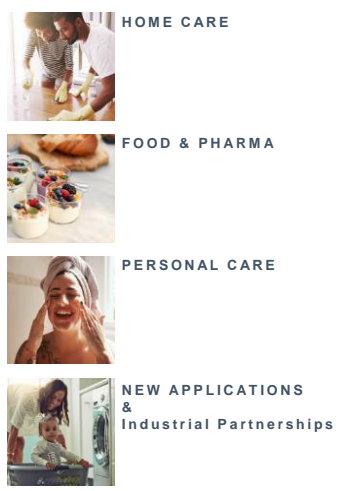
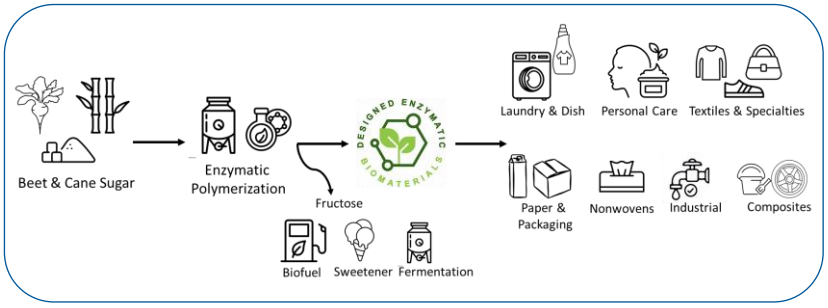
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# DESIGNED ENZYMATIC BIOMATERIALS™

Enzymatic Polymerization: From Molecular Design to Polysaccharide Architecture & Particle Morphology

Renewably Sourced – Biodegradable – Performance Advantaged – Carbon Negative – Ready to Scale

Public



- Polymerization works at **room temperature/pressure** (low energy)
- No sugar is wasted (fructose co-product) — **attractive variable cost**
- Adopts readily to sugar industry to scale – **fungible & sustainable feedstock**
- Enzyme controls how glucose molecules are linked: **tunable polymer properties**
- Pure sugar for **polymer grade products** - natural performance materials



Public

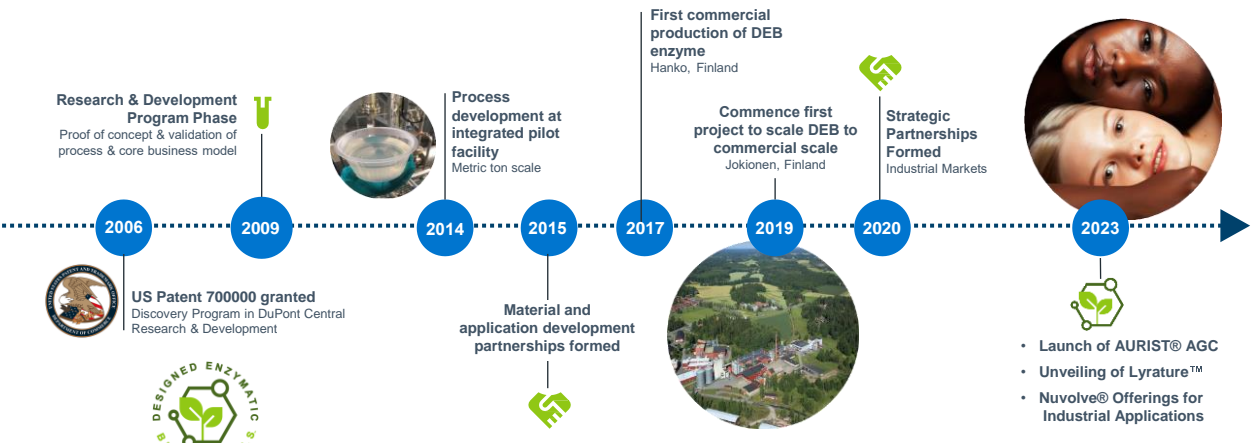
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# DEB™ represents a transformative technology platform over a decade in the making...



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Confidential

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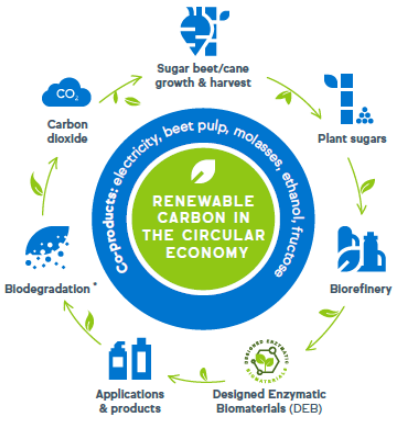
## DESIGNED ENZYMATIC POLYSACCHARIDE MATERIAL PLATFORM: ENABLING SUSTAINABILITY POSITION

### Biobased & Biodegradable

- Certified End of Life Characteristics:
- 100% biobased material content
  - home compost
  - industrial compost
  - soil biodegradability
  - marine biodegradability
  - biodegradable water (OECD 301B)



### DESIGNED ENZYMATIC BIOMATERIALS (DEB): PERFORMANCE, NATURALLY BETTER



\* Depending on the industry and application-specific DEB based product formulation and certification requirements.



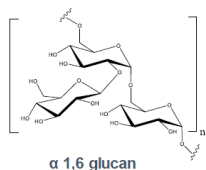
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Public

## TWO COMPLEMENTARY DESIGNED POLYSACCHARIDE MATERIAL PLATFORMS

### A16 Platform: Alpha-1,6–short-chain branched polysaccharide

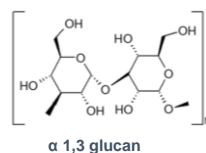
A16



- Water-soluble
- Balance of low viscosity & high-solids
- Film-forming at low functionalization
- Engineered solubility profile to balance biodegradability with film formation/deposition

### A13 Platform: Alpha-1,3–linear & hyperbranched polysaccharide

A13



- Linear, semi-crystalline & structural
- Targeted molecular weight
- Rheology control & Emulsion stabilization
- Graft-technology to access hyperbranched systems
- Particle shape design
- Morphology engineering for delivery & deposition



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## COMMERCIAL MILESTONES: FIRST CAPACITY INCREMENTS

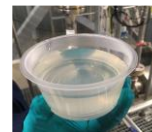
Integration into biorefineries enables first commercial programs & offtake



IFF site integration, Finland

Designed Enzymatic Polysaccharide Platform:

- 1<sup>st</sup> Commercial scale production commissioned
- Start up & operating phase



Meeting critical product milestones:

- Consistent purity, quality and stability demonstrated
- Regulatory milestones achieved for commercialization
- Selected derivative technologies to enable platform
- Strategic offtake & customers

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## AURIST™ AGC

### CONDITIONING, NATURALLY BETTER!

AURIST™ AGC: new-to-the-world, readily biodegradable,

Lead Application: cationic hair conditioning biopolymer  
AURIST™ AGC

has been created using IFF's Designed Enzymatic Biopolymers (DEB) technology



Improves  
Combability



Easy  
to Formulate



Readily  
Biodegradable



Transformational  
science



**KEMIRA - IFF  
PARTNERSHIP**

IN

**PAPER BASED  
PACKAGING**

**& WATER  
TREATMENT**

**Board  
Strength**



**Barrier in  
Packaging**



**Water  
Treatment**



Public

## HARNESSING THE POWER OF NATURAL POLYMERS: INNOVATION OPPORTUNITIES FOR CIRCULAR MATERIALS

Critical themes for sustainable material innovation...

**#0: Performance Differentiation through Innovation – through Biotechnology**

**#1: Bio-based – Renewable carbon**

**#2: Process & Sustainability Profile – Life-cycle Assessment - GHG Avoidance**

**#3: Bioeconomy: biomanufacture and the role of the biorefinery and sustainable feedstock/land use**

**#4: End of Life - Biodegradation – Recycle / Reuse**

Definitions Matter – Regulations can select or de-select material / polymer classes  
Natural Polymer Definition and Advocacy

Health &amp; Biosciences



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## Leveraging Biopolymers for Sustainable Home and Personal Care Solutions

ACS GCI Webinar: Harnessing the Power of Natural Polymers

February 28, 2024

Lyndsay Leal

Seek **Together**<sup>™</sup>

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### Outline

- Personal Introduction
- Overview of Home and Personal Care business unit at Dow
- Leveraging biopolymers for innovation
- Product development stories
  - Rheology modifiers for liquid and solid formats
  - Natural styling polymers
  - Deposition aids to enhance efficiency of rinse-off products
- Final thoughts



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## FROM ACADEMIA TO INDUSTRY

**2010**  
B.S., Biology & Chemistry  
The College of New Jersey

**2015**  
Senior Chemist  
Dow, HPC

**2018**  
Associate Research Scientist  
Dow, HPC

**2021**  
Research Scientist  
Dow, HPC

**2023**  
Polysaccharide Technology  
Segment Leader; Dow, HPC

**Awards:** BIG INNOVATION 2022, I-C-I-S (2022, 2023), PCHE, 2023 R&D 100 FINALIST.

## Value proposition and sustainable innovations

**Business Value Pools**

- LOW-CARBON FOOTPRINT AND SUSTAINABLE MATERIALS**
  - Enabling creative design, reduced energy use, and lower lifecycle costs with DOWSIL™ and SILASTIC™ silicones
- BIO-BASED AND BIO-DEGRADABLE MATERIALS**
  - Tackling biodegradation, carbon footprint and resource efficiency in personal care and home care
- CONNECTIVITY**
  - Supporting technology for 5G ecosystem
  - Differentiated portfolio enabling EV and AV transitions, while capturing the momentum of combustion engines

**Our Unique Capabilities**

- The only silicone producer with world-class siloxane plants in Europe, Asia and North America
- Sustainable silicon metal produced with best-in-class, low-emission technologies, renewable energy and natural resources for captive use
- Successful B2B digital platform accessible by customers anytime, everywhere
- An unmatched portfolio of performance enhancing silicone and specialty materials
- Market-driven and sustainable innovations to address lower-carbon footprint and circularity goals

**Enabling Customers and Consumers to Reduce their Resource Footprint**

Designing energy-efficient, aesthetic and durable buildings

Enabling thermal management in 5G electronics

Using less water and lower temperatures in home care

Collaborating to offer sustainable durable water-repellant emulsions for fabrics

Enabling electrification and autonomous vehicles

Offering bioderived and biodegradable personal care innovations

# Leading R&D and one of the broadest portfolios in the industry

For sustainable and inclusive personal care solutions

Silicones				Innovate <i>safe, sustainable</i> formulations and processes <hr/> Respond to <i>global emerging</i> trends <hr/> Grow <i>digitalization/customization</i>
Conditioner Polymers				
Rheology Modifiers				
Hair Fixatives				
Biosurfactants				
Emollients				

<sup>1</sup>AP/Deo: Antiperspirant and Deodorant



# Leading R&D and one of the broadest portfolios

For sustainable home care solutions

Surfactants/Solvents/ Glycols	<b>Sustainability, Safety &amp; Hygiene</b>	<b>Care &amp; Aesthetics</b>	<b>Efficacy &amp; Convenience</b>	Innovate <i>safe, sustainable</i> formulations and processes <hr/> Respond to <i>global emerging</i> trends <hr/> Grow <i>digitalization/customization</i>
Film Formers				
Polyacids/Acrylates/ Urethane				
Modified Cellulose				
Amines/Chelants				
Natural Source				
Silicone Technology				



## Home & Personal Care Solutions for a Sustainable Future

### Industry Trends



Bio-based



More with less: improved efficiency, compacted formats



Biodegradable

### Our Value Proposition

#### ACCELERATE SUSTAINABLE GROWTH

Investing in sensorial and safe skincare solutions

#### CUSTOMER-CENTRIC SERVICE

Key partnerships with industry leaders as well as offering technology access to upcoming brands

#### INCLUSION FOR ALL

Designing with human diversity at the heart of new application technology – skin tones and hair types

### Award-Winning Innovations



Focus on sourcing certified biomaterials



Driving formulation efficacy by reducing the quantity of actives (up to 50%)



Excellent for pleasing aesthetics and consumer experiences



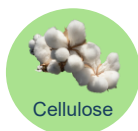
Readily biodegradable



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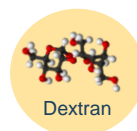
## Biopolymers for Sustainable Growth



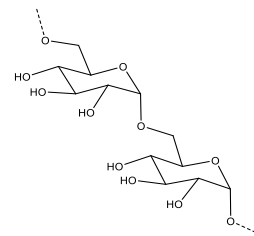
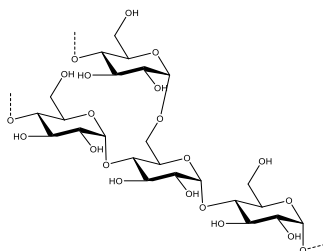
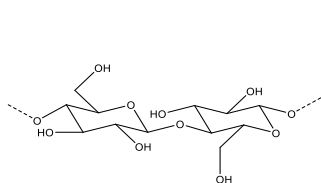
Cellulose



Starch



Dextran



Using a variety of polysaccharide backbones, unique performance properties can be achieved. Anionic derivatives for dispersants and rheology modifiers, cationic derivatives for care & deposition, and nonionic rheology modifiers.

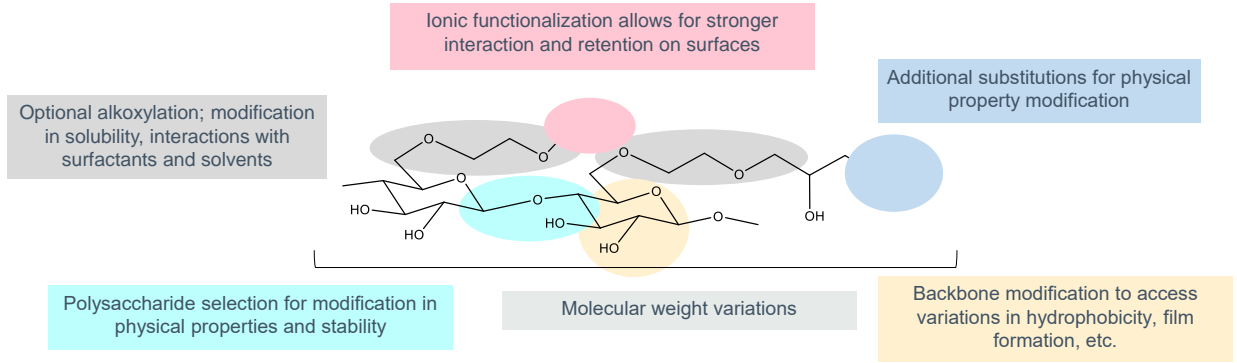


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# Polysaccharide Design

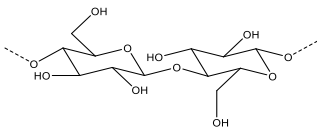


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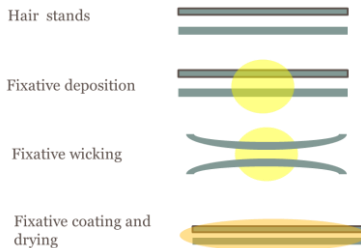
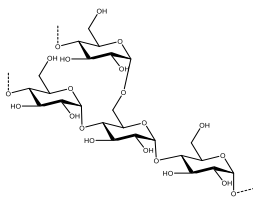
81

# Product Development Stories

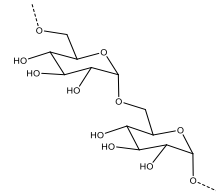
*Rheology modifiers for liquid and solid formats*



*Natural styling polymers*



*Deposition aids to enhance efficiency of rinse-off products*

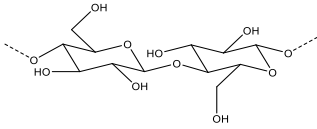


82

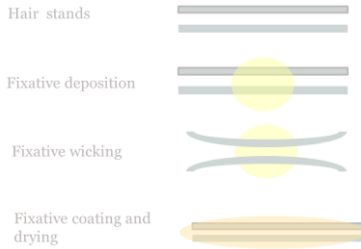
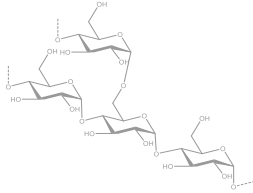
82

## Product Development Stories

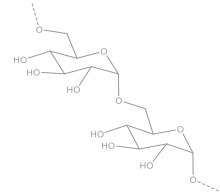
Rheology modifiers for liquid and solid formats



Natural styling polymers



Deposition aids to enhance efficiency of rinse-off products

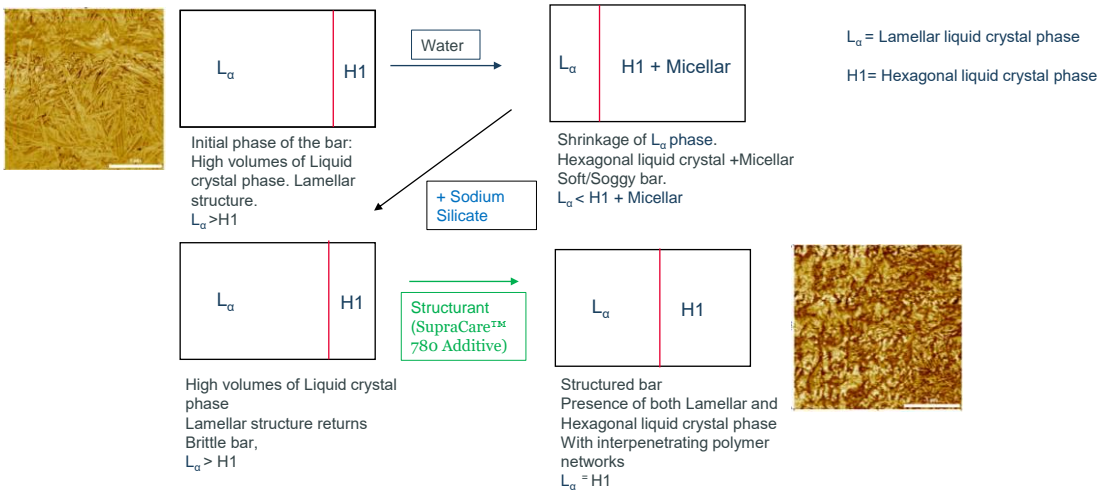


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## Working hypothesis – structuring with Supracare 780

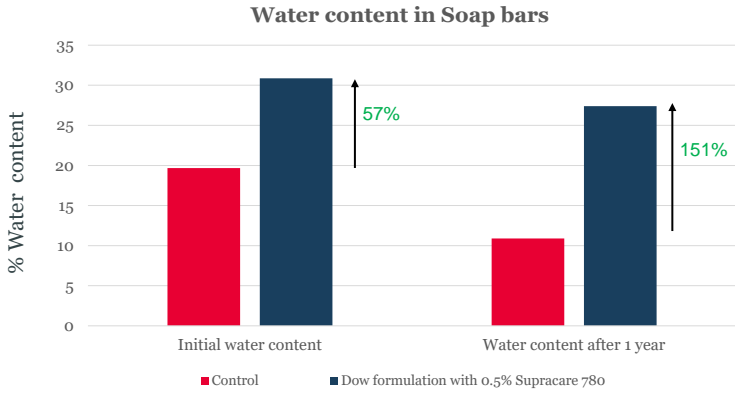
Addition of a structurant helps to make the bar lasting longer and with improved use characteristics



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### Water content as a function of storage time

SupraCare™ 780 Additive enables high water structuring and retention



SupraCare™ 780 Additive helps to bind more water while maintaining the bar characteristics. Lower TFM can translate into reduced formulation cost.

SupraCare™ 780 Additive helps to retain more moisture content in the soap bar as a function of storage time

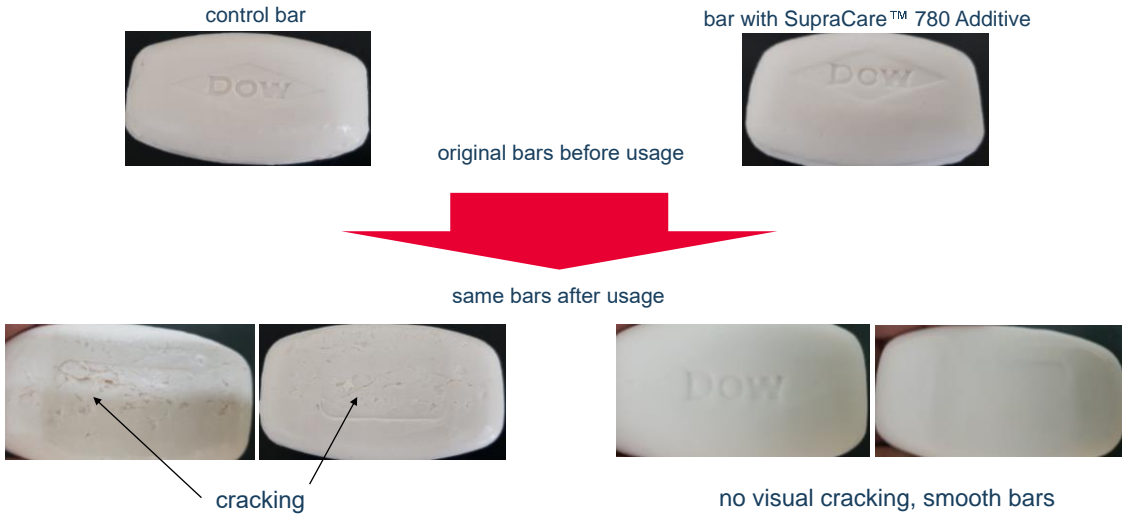


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### Avoiding soap bar cracking

SupraCare™ 780 Additive acts as a structurant leaving the bars smooth and without cracks

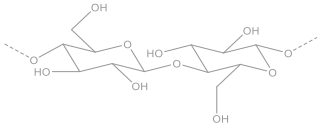


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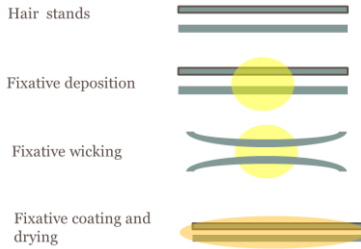
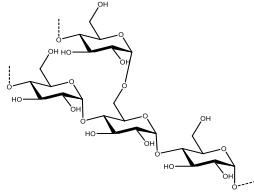
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## Product Development Stories

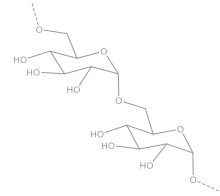
*Rheology modifiers for liquid and solid formats*



*Natural styling polymers*



*Deposition aids to enhance efficiency of rinse-off products*



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## Creating MaizeCare™ Polymers



Corn-based ingredient



Natural Origin Content ISO 16128



Supports market demand for natural & clear formulations



Delivers various styling benefits



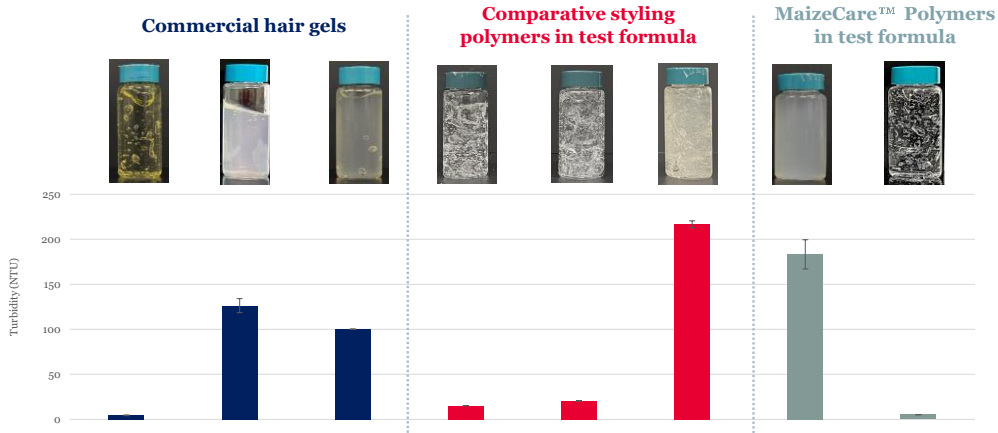
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## Styling Gel Formulation

Performance data – Clarity

MaizeCare™ Clarity Polymer gives excellent clarity in hair gel formulas that is superior to other natural hair fixatives and comparable to PVP.



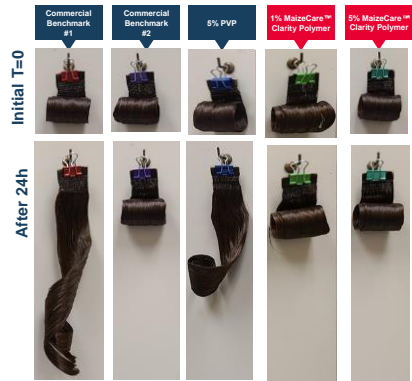
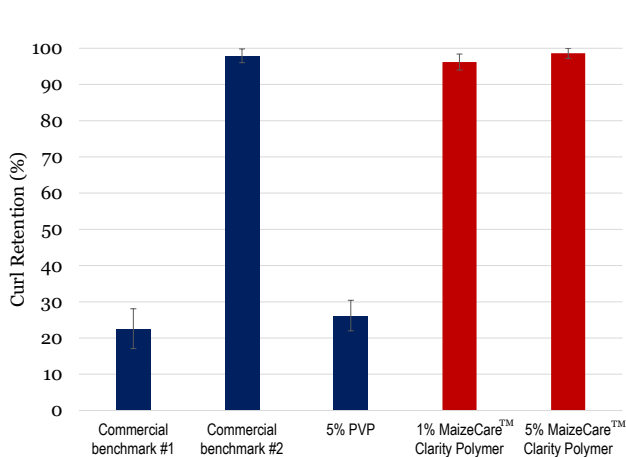
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## Styling Gel Formulation

Performance data – High Humidity Curl Retention - 25°C/80%RH

MaizeCare™ Clarity Polymer exhibits superior humidity resistance compared to PVP.



Testing details:  
0.3 grams (or 0.3mL) of product on 3 grams of virgin medium brown hair  
5wt% Hair fixative Polymer in base hair gel formula  
Data collected: 0min, 30min, 2hr, 4hr, 6hr and 24hr



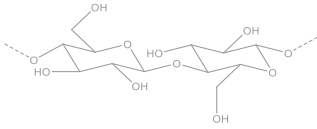
Test conditions: 25°C / 80%RH

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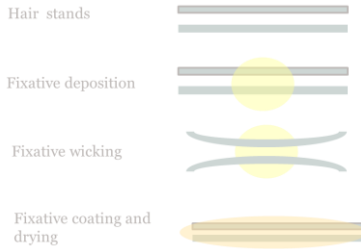
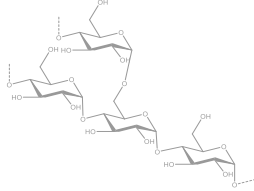
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## Product Development Stories

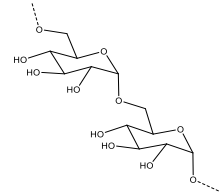
*Rheology modifiers for liquid and solid formats*



*Natural styling polymers*



*Deposition aids to enhance efficiency of rinse-off products*



## DEXCARE™ CD-1 Polymer *The natural path*

From sugar to a **deposition aid**



Bioderived from sugar

Extracted leveraging advanced biofermentation process

Easy to use: Liquid format

Highly effective deposition aid in shampoo and body wash formulations

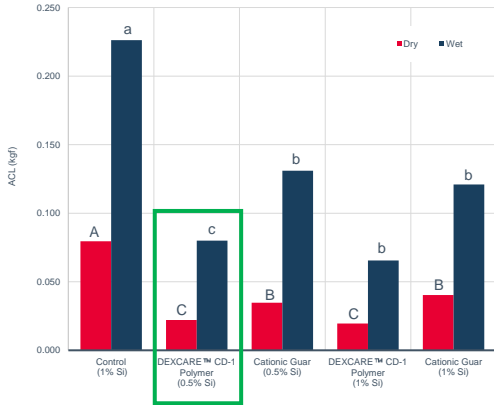
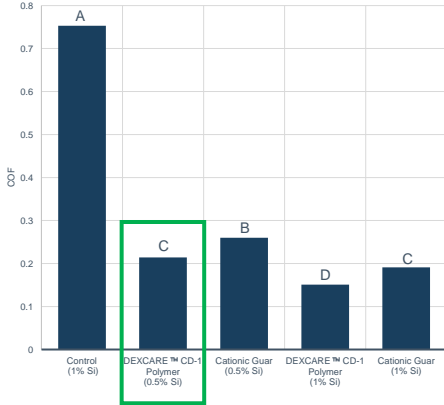




# Reduced friction and enhanced combability

Comparison with Cationic Guar at two silicone use levels

DEXCARE™ CD-1 Polymer provides similar friction and enhanced combing using half the silicone level as cationic guar.



**Treatment:** 0.4 g / g hair virgin brown hair tresses

- DEXCARE™ CD-1 Polymer: Care & Extra Combing Shampoo (CPF 4578)
- Cationic Guar: 0.3 wt.% in CPF 4578
- Control: CPF 4578 without deposition aid polymer

(% Si) indicates the silicone use level

Cationic Guar: Guar hydroxypropyltrimonium chloride

COF: coefficient of friction, ACL: average combing load

Measured using Diastron (left), Instron tensile tester (right)

**Statistics:** Different letters show a statistical difference at 95% confidence



# Thank you

Please contact me for further discussion and questions at [lmleal@dow.com](mailto:lmleal@dow.com) or find me on LinkedIn!



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## Natural Polymers Consortium (NPC)

A **pre-competitive partnership** with industry leaders to explore the utilization of natural polymers to accelerate the development of more sustainable functional materials.

1. Examining how different natural polymers can provide more **sustainable functional replacements** of incumbent commercial materials.
2. Accelerating industrial innovation by partnering with researchers in academia and government, while providing **financial research support**.
3. Identifying and prioritizing **industry-relevant innovation gaps** that can be used to encourage relevant fundamental research.



[www.acs.org/npc](http://www.acs.org/npc)

For more information please contact:

Isamir Martinez ([i\\_martinez@acs.org](mailto:i_martinez@acs.org))

Edmond Lam ([e\\_lam@acs.org](mailto:e_lam@acs.org))

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