

NatureWorks

Plenary Session 3 - Biomaterials

World Materials Forum | June 17, 2022

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Back in 1989, we had a big, crazy idea.

What if we could turn greenhouse gases like carbon dioxide into products?





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Lactide



Greenhouse Gases Plant Sugar (Dextrose) Lactic Acid

(pol

Ingeo (polylactic acid or PLA)

ingeo





We've been at this evolutionary change for over 20 yrs





The last commodity plastic was introduced in 1975

"specialty resins" Elapsed time from commercialization to sales of 300 million pounds per year 60 (time in years) McKinsey study work for NatureWorks - 2003 / 04 40 "commodity resins" 24 19 15 15 13 12 12 12 6 6 5 LLDPE US material PVC PS LDPE PUR HDPE PP PET Ingeo NYLON PMMA ABS PC 1938 1938 1943 1953 1956 1959 1963 1975 2002 1938 1938 1948 1961 introduction year

...and now we frequently see announcements touting new materials from new biobased sources.

Biopolymer capacity is growing, but still undersized compared to petrochemical plastics

Over the past decade, plastics experienced a 3.9% CAGR that is expected to continue at greater than 10.9 Million MT annually



380 Million MT

More information: www.european-bioplastics.org/market and www.bio-based.eu/markets

Production

Production



New materials must come to market operating within the context of circular economy model that considers the origins of materials as well as the after-use possibilities







THREE AMBITIONS

- 1. Decouple plastics from fossil feedstocks
- Drastically reduce the leakage of plastics into natural systems & other negative externalities (such as greenhouse gas emissions)
- 3. Create an effective after-use plastics economy



Based on The New Plastic Economy Report from the Ellen MacArthur Foundation



Using renewable resources like agricultural crops means prioritizing sustainable growing practices



We incorporate the Food and Agriculture Organization of the United Nations principles for sustainable agriculture in our use of agricultural feedstocks.

Sustainable agriculture is about more than any one feedstock trait.

- · Protecting biodiversity
- Good agricultural practices protecting soil, air and water quality
- Safe working conditions
- Compliance with law and treaties
- Compliance with human, labor and land rights
- Good management practices and continuous improvement
- Understanding land use impacts



* In relation to global agricultural area ** Also includes approx. 1% fallow land *** Land-use for bioplastics is part of the 2% material use



Peer-reviewed data benchmarks claims of 68% reduction in GHG footprint



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Composting is a way to address plastic waste, food waste, and climate change with one end-of-life solution



"Food waste, a main contributor to methane emissions, alone accounts for 22% of all municipal solid waste. Diverting large amounts of food waste to composting has the potential to significantly reduce the large amount of methane emissions contributed by landfills."



Compostable garbage bag w/ organic waste

– USCC

Compostable coffee pods



It takes multiple solutions to create an after-use plastics economy...one solution can not do it all





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Applications made with new materials need to perform for end-users and in commercial-scale manufacturing







The Telegraph

PG tips switches to plastic-free tea bags after 200,000 sign gardener's petition

February 28, 2018





Solved: Why your teabags won't disappear from the compost heap

Green campaigners take on tea manufacturers after the revelation that their bags are not fully biodegradable

December 17, 2017







PG Tips from Unilever Compostable tea bags

PG Tips are switching to a plant-based, compostable material derived from corn starch for their tea bags. This enables both the packaging and the tea leaves to be composted together. The brand has also started the removal of the plastic overwrap from the box.

Ellen MacArthur Upstream Innovation Report from Dec 2020

Combining biobased materials, paper + Ingeo bioplastic, to create better food serviceware options





Safe Serviceware

FOOD SERVICE WARE 10 20211163

- FDA compliant
- No taste or odor impact
- Approach 100% biobased
- Certified GreenScreen
 Platinum as free of PFAS and other chemicals of concern





 Certified compostable, repulpable, & recyclable to flexibly fit with available

infrastructure

Circular

Manufacturing at Scale

- Modeled the process of coating paper to recommend optimizations that increase output and line speeds by 150-200%
- Stable web for faster line speeds, lower coating weights, less scrap



ENGINEERED SYSTEMS Ingeo Nonwovens Offer Fluid Management Superior to Polypropylene for Hygiene Applications



PERFORMANCE	INGEO ¹	TYPICAL PP ²
Finish-on yarn [%FOY]	0.3 wt. %	0.6 wt. %
Strike-through [over 3 results]	1.3 - 1.9 sec.	1.8 - 2.3 sec.
Run-off [%]	0	0.4%
Re-wet [grams]	0.10 / 0.08 g	0.21 / 0.25 g
Wash-off / Surface tension reduction [0.9 wt. % NaCl = 73.1 dynes/cm]	70.8 dynes/cm	47.8 dynes/cm

1. 18 gsm spunbond modified with Goulston Lurol PL-15231-25

2. 14 gsm spunbond modified with Goulston Lurol PP-15163





Switching the PP topsheet in a diaper to one made with Ingeo, can maintain absorption efficiency while reducing SAP content by 30%.



Value chain partnerships are key to delivering high performance, compostable coffee capsules to the market in North America & Europe

90%

of a brewed pod is coffee, valuable organics mostly **lost** to landfills due to a complicated recycling process from packaging Compostable capsules simplify the recovery of organics for composting

Heat & pressure resistance, barrier, and other properties need to come together to brew an excellent tasting cup of coffee



Nature Works



Flo Presents Gea, a New Generation of Coffee Capsules Developed with NatureWorks



New partnerships expand our product development capabilities targeting a wider spectrum of mechanical properties and degradation rates

Announcing May 24, 2022

CJ BIO and NatureWorks Working Towards a Master Collaboration Agreement to Commercialize Novel Biopolymer Solutions

Companies announce signed letter of intent to collaborate on creating advanced products based on industry-leading Ingeo™ PLA and PHACT® PHA technologies to meet growing demand for sustainable materials across wide array of markets.





- Bringing together two biobased polymers, PLA and PHA, to jointly develop new biobased products
- Modifying PLA with amorphous PHA leads to improvements in mechanical properties, such as toughness, and ductility, while maintaining clarity.
- New after-use opportunities with tunable degradation timelines
- Jointly developing products (resin grades) to be branded as Ingeo with PHACT inside.

BIO

From feedstocks to product to end-of-use, safety & sustainability claims must be supported by rigorous 3rd party testing and credentials.











Thank you.

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